Estd. 1962
"A++" Accredited by NAAC (2021)
With CGPA 3.52

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दूरध्वनी - इपीबीएक्स - २०६०९०००, अभ्यासमंडळे विभाग : ०२३१- २६०९०९४. २६०९४८७
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जा.क्र./शि.वि/अं.म./ 608 दिनांक:— ०७/१०/२०२५

प्रति,

१. मा. संचालक / प्राचार्य,
सर्व संलग्नीत अभियांत्रीकी महाविद्यालये,
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२.प्र. संचालक,
स्कुल ऑफ इंजिनिअरींग ॲण्ड टेक्नॉलॉजी,
शिवाजी विद्यापीठ, कोल्हापूर

३.प्र. संचालक,
यशवंतराव चव्हाण स्कुल ऑफ रुरल डेव्हलपमेंट,
शिवाजी विद्यापीठ, कोल्हापूर

विषय:— एम. टेक अभ्यासक्रमातील किरकोळ दुरुस्तीबाबत.

संदर्भ:— १.एसयु/बीओएस/सायन्स&टेक/३१७ व ५३४ दि.२३/५/२०२५ व दि.४/९/२०२५
२.एसयु/बीओएस/सायन्स&टेक/५३९ दि.०८/०९/२०२५

महोदय,

उपरोक्त संदर्भिय विषयास अनुसररुन आपणास आदेशान्वये कळविण्यात येते की, शैक्षणिक वर्ष २०२५—२६ पासून लागू करण्यात आलेल्या खालील **एम.टेक** अभ्यासक्रमामध्ये किरकोळ दुरुस्ती करण्यात आलेली आहे.

Sr.	Course/Syllabus	Sr.	Course/Syllabus
1	Enargy Technology (ON)	6	Rural Technology (ON)
2	Computer Science and Technology (ON)	7	Computer Science and Engineering (OFF)
3	Electronics and Telecommunication (ON)	8	Mechanical (CAD/CAM/CAE) (OFF)
4	Environmental Science and Technology (ON)	9	Electronics and Telecommunication Engineering (OFF)
5	Food Technology (ON)		

सोबत सदर अभ्यासक्रमाची प्रत जोडली आहे. तसेच विद्यापीठाच्या https://www.unishivaji.ac.in (NEP-2020@suk/ Online syllabus) या संकेस्थळावर ठेवण्यात आला आहे. सदर दुरुस्ती ही शैक्षणिक वर्ष २०२५—२६ पासून लागू राहील.

सदर अभ्यासक्रम सर्व संबधित विद्यार्थी व शिक्षकांच्या निदर्शनास आणून द्यावेत ही विनंती.

कळावे.

आपला विश्वासू,

डॉ. एस. एम. कुबल
उपकुलसचिव

सोबत — अभ्यासक्रमाची प्रत,

प्रत :— **माहितीसाठी व पुढील योग्यत्या कार्यवाहीसाठी**

मा. संचालक, परीक्षा व मुल्यमापन मंडळ	प्र. अधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा
अध्यक्ष, संबंधित अभ्यास /अस्थायी मंडळ	इतर परिक्षा ४ विभागास.
परीक्षक नियुक्ती ए व बी विभागास.	संलग्नता टी. १ व टी. २ विभागास
पीजी प्रवेश विभागास	पीजी सेमिनार विभागास
संगणक केंद्र / आयटी सेल	पात्रता विभागास

Shivaji University

Vidya Nagar, Kolhapur, Maharashtra

Department of Technology

M. Tech.

(Environmental Science and Technology)

Curriculum Structure
w. e. f. 2025-26 onwards

SHIVAJI UNIVERSITY, KOLHAPUR
Department of Technology
First Year M. Tech. (Environmental Science and Technology) Part-I Semester - I
w. e. f. Academic Year 2025-26

Sr. No	Course Code	Course Title	Teaching Scheme (Hours/week)				Evaluation Scheme			
			L	T	P	Credits	Theory		Practical	
							Scheme	Max. marks	Scheme	Max. marks
1	ESTAE1	Research Methodology	2	-	-	2	---	---	IOE	50
2	ESTC11	Physico-chemical and Biological Treatment Processes	3	-	-	3	ISE	40	--------	-------
							ESE	60	--------	-------
3	ESTC12	Remote Sensing and GIS Applications in Environmental Engineering	3	-	-	3	ISE	40	--------	-------
							ESE	60	--------	-------
4	ESTC13	Air Pollution and Control	3		-	3	ISE	40	--------	-------
							ESE	60	--------	-------
5	ESTE1	Elective-I	3		-	3	ISE	40	--------	-------
							ESE	60	--------	-------
6	ESTOE1	Elective- II (Open Elective)	3	-	-	3	ISE	40	--------	-------
							ESE	60		
7	ESTC14	Seminar-I	-	-	2	1	--------	-------	IOE	50
8	ESTC15	Water Quality Analysis Lab	-	-	2	1	--------	-------	IOE	50
9	ESTC16	Remote Sensing and GIS Applications in Environmental Engineering Lab	-	-	2	1	--------	-------	IOE	50
Total			**17**	**-**	**6**	**20**		**500**		**200**
Total Contact hours per week =23*										

Elective – I
ESTE11. Environmental Chemistry and microbiology
ESTE12. . Sustainable Engineering Concepts and Life Cycle Analysis
ESTE13. . Municipal Solid Waste Management

Elective II (Open Elective): choose from list given below

*** Students from M. Tech any branch of Department of Technology can opt for this Elective.**

Semester –I (Open Elective*)

Sr. No.	Elective-II (Open Elective*)	Branch
1	Advanced Communication System	Electronics Technology
2	Reconfigurable Computing	
3	VLSI Testing & Testability	
4	FTE-21:Advances in processing of dairy Technology	Food Technology
5	FTE-22: Food Trade Management	
6	FTE-23: Advances in Grain Science and Technology	
7	ETOE11: Electric Vehicles and Renewable Energy	Energy Technology
8	ETOE12: Energy Efficient Buildings	
9	ETOE13: Computational Fluid Dynamics	
10	ESTOE-21 Environmental Biotechnology	Environmental Science and Technology
11	ESTOE-22 Energy Efficient Building	
12	ESTOE-23 Operational Health and Safety Management	
13	CSTEOE1: Advanced Operating Systems	Computer Science and Technology
14	CSTOE2: Internet of Things	
15	CSTOE3: Data Analytics	

SHIVAJI UNIVERSITY, KOLHAPUR
Department of Technology
First Year M. Tech. (Environmental Science and Technology) Part-I Semester - II
w. e. f. Academic Year 2025-26

Sr. No	Course Code	Course Title	Teaching Scheme (Hours/week)				Evaluation Scheme			
							Theory		Practical	
			L	T	P	Credits	Scheme	Max. marks	Scheme	Max. marks
1	ESTAE2	Intellectual Property Rights	2	-	-	2	---	---	IOE	50
2	ESTC21	Industrial Waste Treatment	3	-	-	3	ISE	40	--------	-------
							ESE	60	--------	-------
3	ESTC22	Environment Management Systems	3	-	-	3	ISE	40	--------	-------
							ESE	60	--------	-------
4	ESTC23	Advanced Water and Wastewater Treatment	3	-	-	3	ISE	40	--------	-------
							ESE	60	--------	-------
5	ESTE2	Elective-III	3	-	-	3	ISE	40	--------	-------
							ESE	60	--------	-------
6	ESTOE2	Elective- IV (Open Elective)	3	-	-	3	ISE	40	--------	-------
							ESE	60		
7	ESTC24	Seminar-II	-	-	2	1	--------	-------	IOE	50
8	ESTC25	Wastewater Characterization Lab	-	-	2	1	--------	-------	IOE	50
9	ESTC26	Specific Treatment Lab	-	-	2	1	--------	-------	IOE	50
Total			**17**	**-**	**6**	**20**		**500**		**200**
Total Contact hours per week =23*										

Elective - III
ESTE21. Environmental Modeling and Simulation
ESTE22. Environmental, Social and Governance
ESTE23. Environmental Policies and Legislation

Elective IV (Open Elective): Choose from list on next page

*** Students from M. Tech any branch of Department of Technology can opt for this Elective.**

Semester –II (Open Elective*)

Sr. No.	Elective-IV (Open Elective*)	Branch
1	METCOE21: MIMO Systems	Electronics Technology
2	METCOE22: Satellite Communication	
3	METCOE23:Smart and Phased Array Antenna Design	
4	FTE-41: Recent developments in processing of plantation crops	Food Technology
5	FTE-42: Project Management for Food Processing Industries	
6	FTE-43: Sustainable Food Process Engineering	
7	ETOE21 : Energy Modeling and Project Management	Energy Technology
8	ETOE22 : Artificial Intelligence in Energy Systems	
9	ETOE23 : Design and Optimization of Energy Systems	
10	ESTOE-41 Operation and Maintenance of Environmental Facilities	Environmental Science and Technology
11	ESTOE-42 Rural Water Supply and Sanitation	
12	ESTOE-43 Environmental Biotechnology	
13	CSTOE21: Geographical Information Systems	Computer Science and Technology
14	CSTOE22: Natural Language Processing	
15	CSTOE23: Blockchain Technology	

SHIVAJI UNIVERSITY, KOLHAPUR
Department of Technology
Second Year M. Tech. (Environmental Science and Technology) Part-II Semester - III
w. e. f. Academic Year 2026-27

Sr. No	Course Code	Course Title	Teaching Scheme (Hours/week)				Evaluation Scheme			
							Theory		Practical	
			L	T	P	Credits	Scheme	Max. marks	Scheme	Max. marks
1	ESTE31	Industrial Training	-	-	2*	5**	--------	-------	IOE	50
									EOE	50
2	ESTE32	Dissertation Phase-I	-	-	2*	15	--------	-------	IOE	100
									EOE	100
Total			**-**	**-**	**4**	**20**				**300**
Total Contact hours per week =4*										

*Students are expected to do self-study for two hours as per the guidance given by the Project Guide and report to the department once in a week. Hence contact hours to be taken as two for the calculation of contact hours.

** Industrial Training of Eight weeks at the end of First Year
OR
Industrial training will be split in two slots of four weeks during semester III

Evaluation at end of III semester on the basis given report and Presentation to concern Guide.

SHIVAJI UNIVERSITY, KOLHAPUR
Department of Technology
Second Year M. Tech. (Environmental Science and Technology) Part-II Semester - IV
w. e. f. Academic Year 2026-27

Sr. No.	Course Code	Course Title	Teaching Scheme (Hours/week)				Evaluation Scheme			
							Theory		Practical	
			L	T	P	Credits	Scheme	Max. marks	Scheme	Max. marks
1	ESTE41	Dissertation Phase-II	-	-	4*	20	---------	--------	IOE	100
									EOE	200
Total			**-**	**-**	**4**	**20**	--------	-------		**300**
Total Contact hours per week =4*										

*Students are expected to do self-study for four hours as per the guidance given by the project Guide and report to the department once in a week. Hence contact hours to be taken as four for the calculation of contact hours.
Note:

$: Minimum 40% marks required in ESE as passing head.

• Tutorials and practical shall be conducted in batches with batch strength not exceeding 18 students.

ISE – In Semester Examination,

ESE –End Semester Examination,

IPE – Internal Practical Evaluation,

EPE–External Practical Examination,

IOE– Internal Oral Evaluation,

EOE–External Oral Examination

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-I**					
Course Title	**:**	**Research Methodology**			***Course Code*:**	**:**	ESTAC1
Teaching Scheme (Hours)	**:**	Lecture :	2 Hrs/week		***Total Credits***	:	2
Evaluation Scheme (Marks)	**:**	IOE= 50	ESE = NIL	Grand Total=50	---	**:**	--
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	The student should be familiarize with basic of research.					
Course Domain	**:**	Audit Course					

Course Rationale: This course aims to lay a foundation for your research. The goal is to help you to design and develop your future research projects.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1.	Familiarize students with basic of research and the research process.	**1.**	Understand basic concepts of research and its methodologies
2.	Familiarize Research Design.	**2.**	Select and define appropriate research problem and parameters
3.	Introduce measurement and scaling techniques in research.	**3.**	Apply Measurement and Scaling Techniques
4.	Familiarize methods of data collection and analysis	**4.**	Use Methods of Data Collection and Analysis
5.	Introduce techniques of hypotheses, parametric or standard tests	**5.**	Apply techniques of hypotheses, parametric or standard tests
6.	Help to analyze variance and co-variance	**6.**	Present and defend research ideas using Analysis of Variance and Co-variance

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	3	2	1	1	2	2	2			
CO 2	3	3	3	3	2	1	2	2	2	2			
CO 3	3	3	3	3	2	1	1	2	2	2			
CO 4	3	3	3	3	2	1	1	2	2	2			
CO 5	3	3	3	3	2	1	1	2	2	2			
CO6	3	3	3	3	2	1	1	3	2	2			

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content	**Hours**
Unit I Research Methodology: An Introduction Objectives of Research, Types of Research, Research Methods and Methodology, Defining a Research Problem, Techniques involved in Defining a Problem	8
Unit II Research Design Need for Research Design, Features of Good Design, Different Research Designs, Basic Principles of Experimental Designs, Sampling Design, Steps in Sampling Design, Types of Sampling Design, Sampling Fundamentals, Estimation, Sample size Determination, Random sampling	9
Unit III Measurement and Scaling Techniques Measurement in Research, Measurement Scales, Sources in Error, Techniques of Developing Measurement Tools, Scaling, Meaning of Scale, Scale Construction Techniques.	7
Unit IV Methods of Data Collection and Analysis Collection of Primary and Secondary Data, Selection of appropriate method, Data Processing Operations, Elements of Analysis, Statistics in Research, Measures of Dispersion, Measures of Skewness, Regression Analysis, Correlation	8
Unit V Unit 5 Techniques of Hypotheses, Parametric or Standard Tests Basic concepts, Tests for Hypotheses I and II, Important parameters, Limitations of the tests of Hypotheses,. Chi-square Test, Comparing Variance, As a non-parameteric Test, Conversion of Chi to Phi, Caution in using Chi-square test	8
Unit VI Unit 6 Analysis of Variance and Co-variance ANOVA, One way ANOVA, Two Way ANOVA, ANOCOVA, Assumptions in ANOCOVA, Multivariate Analysis Technique, Classification of Multivariate Analysis, factor Analysis, R-type Q Type factor Analysis, Path Analysis	8

Suggested Text Books:	
1.	"Research Methodology", C.R. Kothari, Wiley Eastern.
Suggested Reference Books:	
1.	"Formulation of Hypothesis", Willkinson K.P, L Bhandarkar, Hymalaya Publication, Bombay.
2.	"Research in Education", John W Best and V. Kahn, PHI Publication.
3.	"Research Methodology- A step by step guide for beginners", Ranjit Kumar, Pearson Education
4.	"Management Research Methodology-Integration of principles, methods and Techniques", K.N. Krishnaswami and others, Pearson Education.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-I**					
Course Title	**:**	**Physico-chemical and Biological Treatment Processes**			***Course Code*:**	**:**	ESTC11
EE	**:**	Lecture :	3 Hrs/week		***Total Credits***	:	3
Evaluation Scheme (Marks)	**:**	ISE=40	ESE = 60	Grand Total=100	***Duration of ESE***	**:**	2 hrs
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	Basic Knowledge physical and biological process.					
Course Domain	**:**	Environmental Engineering					

Course Rationale: This course provides a fundamental understanding of physical, chemical, and biological processes involved in water and wastewater treatment. It covers treatment mechanisms, design aspects, and their applications in environmental engineering.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain the fundamental concepts of transport phenomena, reaction kinetics, and their role in water and wastewater treatment.	**1.**	Apply transport phenomena and reaction kinetics to analyze and optimize water and wastewater treatment processes.
2.	Provide knowledge of aeration, mixing, coagulation, flocculation, and sedimentation processes, including their design principles.	**2.**	Demonstrate a clear understanding of aeration, coagulation, flocculation, and sedimentation mechanisms and their role in treatment systems.
3.	Teach the principles and practical aspects of filtration, adsorption, and ion exchange processes for effective contaminant removal.	**3.**	Assess and design filtration, adsorption, and ion exchange systems for efficient water treatment.
4.	Introduce membrane filtration techniques, disinfection methods, and their applications in ensuring safe water quality.	**4.**	Evaluate membrane filtration processes and disinfection methods for ensuring microbial and chemical safety in treated water.
5.	Develop students' ability to analyze biological treatment processes and evaluate different treatment technologies for wastewater management	**5.**	Interpret and apply biological treatment principles for wastewater treatment, including activated sludge and anaerobic processes.
6.	Enhance problem-solving and design skills related to water and wastewater treatment systems, promoting sustainable and efficient practices.	**6.**	Develop practical and analytical skills to design and troubleshoot water and wastewater treatment plants, incorporating sustainability principles.

Course Outcome and Program Outcome Mapping

	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PSO	PSO	PSO

	1	2	3	4	5	6	7	8	9	10	1	2	3
CO 1	3	2	2	2	2	1		2	2	2	3		
CO 2	3	3	3	2	2	2	1	2	2	2	2		
CO 3	3	2	2	2	2	2	1	2	2	2		3	
CO 4	3	3	3	2	3	1	2	2	2	2		3	
CO 5	3	3	3	2	2	2	2	2	3	3			3
CO6	3	3	3	3	3	3	3	2	3	3	3		3

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content	**Hours**
Unit I- Transport phenomena and Reaction kinetics Review of conventional unit operations and processes in water and wastewater treatment, Transport processes, Kinetics and Reaction rates, System material balance, Hydraulic transport flow regimes, Reactor Engineering (CMBR, CMFR, CMFRS, PFR, PFRD), Processes and rates of gas transfer	5
Unit II- Aeration, mixing and Settling Types of aerator, Design of gravity aerators Coagulation and flocculation, Stability and destabilization of colloids, Transport of colloidal particles, Design of rapid and slow mix units Types of settling, Design of sedimentation tanks, Tube settler, Grit chamber (horizontal flow and aerated)	7
Unit III Filtration Gravity and pressure filtration, filter hydraulics, Analysis of filtration process, Backwash hydraulics, Rate control patterns and methods, Design of dual media and pressure filter	6
Unit IV Adsorption and Ion exchange Causes and Types of adsorption, Adsorption equilibria and adsorption isotherm, Process, Analysis and design of batch and continuous flow activated carbon adsorber Ion Exchange process, Exchange materials and capacity, Exchange reactions, Design and operation of softener for hardness and TDS removal	6
Unit V Membrane filtration Membrane separation processes, Design and operation of Reverse osmosis, Ultrafiltration, and Electrodialysis. Membrane fouling: Causes, and Control **Disinfection** Kinetics of disinfection Ozone disinfection: Chemistry, System components, Modeling. UV disinfection: Source, System components, Estimation of UV dose. Principles and theories of Chemical oxidation.	6
Unit VI Biological Treatment Processes Objectives and fundamentals of biological treatment, types of biological treatment processes. Conventional activated sludge process, process kinetics and design considerations, process control	9

measures, operational problems, Introduction to modifications. Trickling filter, classification, process design considerations. Fundamentals of anaerobic treatment, general design considerations, types of anaerobic reactors.	

Suggested Reference Books:	
1.	Droste, Ronald L "Theory and Practice of Water and Wastewater Treatment", Wiley student Edition, 2009.
2.	Weber W, J, "Physico-Chemical Processes of Water quality control", Wiley-Interscience, 1994.
3.	Sincero A, P and Sincero G, A, "Environmental Engineering A Design approach", PHI learning private limited, 2004
4.	Unit Operations and Processes in Environmental Engineering, 2nd Edition, by Tom D. Reynolds and Paul A. Richards, PWS Publishing Company, 1995.
5.	Quasim, S. R., Motley E, M, and Zhu G, "Water works engineering", PHI learning private limited,2000.
	Suggested Textbooks Books:
1	Peavy H, S, Rowe D, R, and Tchobanoglous G, "Environmental Engineering", McGraw-Hill Book Company, Indian edition 2017.
2	Metcalf and Eddy "Wastewater Engineering Treatment and Reuse", Tata McGraw Hill Publication, Indian Edition 2017
3	Davis, M, L, and Cornwell, D, A, "Introduction to Environmental Engineering", Tata McGraw Hill Publishing Company, Special India Edition, 2010

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-I**					
Course Title	**:**	**Remote Sensing and GIS Applications in Environmental Engineering**			***Course Code*:**	**:**	ESTC12
Teaching Scheme (Hours)	**:**	Lecture :	3 Hrs/week		***Total Credits***	:	3
Evaluation Scheme (Marks)	**:**	ISE=40	ESE = 60	Grand Total=100	***Duration of ESE***	**:**	2 hrs
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	NIL					
Course Domain	**:**	Environmental Engineering					

Course Rationale: This course provides an understanding of the principles of remote sensing and GIS and their applications in environmental engineering. It covers data acquisition, processing, and analysis techniques, along with their practical use in environmental monitoring, resource management, and decision-making.			
Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1.	Introduce the fundamentals of remote sensing, GIS, and GPS technologies	**1.**	Understand the fundamental concepts of remote sensing, GIS, and GPS technologies.
2.	Explain the principles of electromagnetic radiation and their interactions with the Earth's surface	**2.**	Analyze electromagnetic radiation principles and their relevance in remote sensing.
3.	Provide knowledge of different types of remote sensing sensors, platforms, and data acquisition techniques.	**3.**	Evaluate different types of remote sensing sensors and data acquisition methods.
4.	Explore applications of remote sensing and GIS in water resource management, pollution monitoring, and land use planning.	**4.**	Utilize GIS for spatial data processing, analysis, and visualization.
5.	Explore applications of remote sensing and GIS in water resource management pollution monitoring, and land use planning.	**5.**	Apply remote sensing and GIS in environmental engineering applications such as water management and pollution control.
6.	Enable students to integrate remote sensing and GIS for effective environmental decision making and management.	**6.**	Integrate remote sensing and GIS for sustainable environmental planning and management.

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	1	3	1	1	2	2	2	2		
CO 2	3	3	2	2	3	1	1	2	2	2	3		
CO 3	3	3	3	2	3	2	1	2	2	2	3		
CO 4	3	3	3	2	3	2	2	3	2	2	3	2	
CO 5	3	3	3	3	3	2	2	3	3	3	3	3	
CO6	3	3	3	3	3	3	3	3	3	3	2	3	

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content	**Hours**
Unit I - Fundamentals of Remote Sensing Concepts of remote sensing, electromagnetic spectrum, energy interactions with the atmosphere and Earth's surface, spectral reflectance characteristics, types of sensors and platforms, remote sensing data acquisition.	6

Unit II- Image Processing and Interpretation Preprocessing of remotely sensed data, radiometric and geometric corrections, image	8
Unit III - Geographic Information System (GIS) Introduction to GIS, spatial and non-spatial data, GIS data models (vector and raster), data input, editing, database management, spatial analysis techniques.	6
Unit IV - GIS Applications in Environmental Engineering GIS-based hydrological modeling, land use/land cover mapping, watershed management, flood risk assessment, environmental impact assessment, site suitability analysis.	7
Unit V - Remote Sensing Applications in Environmental Engineering Remote sensing for air and water quality monitoring, forest and vegetation mapping, disaster management (floods, droughts, landslides), climate change studies.	
Unit VI - Integration of Remote Sensing and GIS for Environmental Management Decision support systems, spatial modeling, integration of GIS and remote sensing in sustainable development, case studies on environmental applications.	6

Suggested Text Books:	
1.	Lillesand, T. M., Kiefer, R. W., and Chipman, J. W., "Remote Sensing and Image Interpretation", John Wiley & Sons, 2015.
2.	Burrough, P. A., and McDonnell, R. A., "Principles of Geographical Information Systems", Oxford University Press, 2015.
3.	Jensen, J. R., "Remote Sensing of the Environment: An Earth Resource Perspective", Pearson Education, 2013.
Suggested Reference Books:	
1.	Lillesand, T. M., Kiefer, R. W., and Chipman, J. W., "Remote Sensing and Image Interpretation", John Wiley & Sons, 2015.
2.	Burrough, P. A., and McDonnell, R. A., "Principles of Geographical Information Systems", Oxford University Press, 2015.
3.	Jensen, J. R., "Remote Sensing of the Environment: An Earth Resource Perspective", Pearson Education, 2013.

Class, Part & Semester	**:**	**First Year M. Tech (Environment Science and Technology), Part I, Sem-I**

Course Title	**:**	**Air Pollution and Control**			***Course Code*:**	**:**	ESTC13
Teaching Scheme (Hours)	**:**	Lecture :	3 Hrs/week		***Total Credits***	:	3
Evaluation Scheme (Marks)	**:**	ISE =40	ESE = 60	Grand Total=100	***Duration of ESE***	**:**	2 hrs
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	NIL					
Course Domain	**:**	Environmental Engineering					

Course Rationale: This course provides an understanding of air pollution sources, effects, and control technologies. It covers air quality monitoring, atmospheric dispersion, regulatory standards,and advanced control measures for minimizing air pollution.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain the fundamentals of air pollution, including sources, types, and effects on health and the environment.	**1.**	Identify air pollution sources and evaluate their environmental and health impacts.
2.	Provide knowledge of air quality monitoring techniques and regulatory standards.	**2.**	Apply air quality monitoring techniques and interpret regulatory standards.
3.	Teach the principles of atmospheric dispersion and modeling of air pollutants.	**3.**	Analyze atmospheric dispersion models, including Gaussian and eddy diffusion models, and predict pollutant behavior.
4.	Introduce different air pollution control technologies, including particulate and gaseous pollutant removal methods.	**4.**	Evaluate and design air pollution control technologies for particulate and gaseous pollutants.
5.	Develop an understanding of indoor air quality management, noise pollution control, and vehicular emissions.	**5.**	Implement strategies for improving indoor air quality, managing noise pollution, and reducing vehicular emissions.
6.	Enable students to analyze case studies and design air pollution control strategies for real-world applications.	**6.**	Develop solutions for air pollution control through case study analysis and practical applications.

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	2	2	1	1	2	2	3	3		2

CO 2	3	2	2	2	3	1	1	2	2	3		2	2
CO 3	3	3	3	3	3	2	1	2	2	2		2	3
CO 4	3	3	3	3	3	2	2	2	2	3	2	3	3
CO 5	3	3	3	2	2	2	2	2	2	3	2	2	3
CO6	3	3	3	3	3	3	3	3	3	3	3	3	3

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content	**Hours**
Unit I: Physics of Atmosphere and Air Pollution Fundamentals Solar radiation, wind circulation, lapse rate, inversion, stability conditions, Pasquill stability model, maximum mixing depth, wind rose, plume behavior, heat island effect, greenhouse effect, raindrop formation, visibility, photochemical reactions.	6
Unit II: Dispersion of Pollutants in the Atmosphere Eddy diffusion model, Gaussian dispersion model, point source and line source emissions, maximum ground-level concentration, determination of stack height, sampling time corrections, effects of inversion trap.	7
Unit III: Particulate Matter and Its Control Definition and classification of particulate matter (SPM, PM10, PM2.5), sources and distribution, terminal settling velocity, hood and duct design, particulate collection design.	7
Unit IV: Control Equipment for Particulate Matter Settling chambers, cyclones, wet collectors, fabric filters, electrostatic precipitators, component detailing, collection efficiency, and design of particulate control devices.	6
Unit V: Control of Gaseous Pollutants Principles of absorption and adsorption, basic design of absorption and adsorption units, incineration and afterburners, control of sulfur dioxide (SO_2) and nitrogen oxides (NO_x),control of volatile organic compounds (VOCs).	7
Unit VI: Vehicular Emissions and Strategies for Air Pollution Control Emission of pollutants from automobiles, reduction of emissions through different methods, alternative fuels and their utilization, strategies for effective air pollution control in India.	6

Suggested Text Books:	
1	Seinfeld, J. H., and Pandis, S. N., "Atmospheric Chemistry and Physics", Wiley, 2016.
2	Cooper, C. D., and Alley, F. C., "Air Pollution Control: A Design Approach", Waveland Press, 2011.
3	Rao, C. S., "Environmental Pollution Control Engineering", New Age International, 2006.
Suggested Reference Books:	
1.	Bitton, G., "Wastewater Microbiology", Wiley, 2011.
2.	Pepper, I. L., Gerba, C. P., and Brusseau, M. L., "Environmental Microbiology", Academic Press, 2014.
3.	Stumm, W., and Morgan, J. J., "Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters", Wiley, 2012.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-I**					
Course Title	**:**	**Elective-I** **Environmental Chemistry and Microbiology**			***Course Code*:**	**:**	ESTE11
Teaching Scheme (Hours)	**:**	Lecture :	3 Hrs/week		***Total Credits***	:	3
Evaluation Scheme (Marks)	**:**	ISE =40	ESE = 60	Grand Total=100	***Duration of ESE***	**:**	2 hrs
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	NILL					
Course Domain	**:**	Environmental Engineering					

Course Rationale: This course provides an understanding of the fundamental principles of environmental chemistry and microbiology. It covers chemical and biological processes governing environmental systems, including water and wastewater treatment, pollutant degradation, and ecological interactions

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain the fundamental concepts of environmental chemistry, including water and atmospheric chemistry.	**1.**	Understand the fundamental principles of environmental chemistry and microbiology.
2.	Provide knowledge of chemical kinetics, equilibrium, redox reactions, and instrumental analysis techniques.	**2.**	Analyze chemical reactions, including acid- base equilibria, oxidation-reduction, and kinetic processes in environmental systems.
3.	Introduce microbial diversity, microbial metabolism, and their role in environmental processes.	**3.**	Identify the role of microorganisms in natural and engineered environments.
4.	Develop an understanding of biodegradation, bioaccumulation, and microbial interactions in ecosystems.	**4.**	Evaluate the significance of microbial processes in water and wastewater treatment.
5.	Explore the role of microorganisms in wastewater treatment, bioremediation, and pollution control.	**5.**	Apply biodegradation and bioremediation techniques for environmental pollution control.
6.	Enable students to apply chemical and microbiological principles in environmental engineering applications.	**6.**	Integrate chemical and microbiological knowledge to develop sustainable environmental engineering solutions.

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	2	2	1	1	2	2	2	3		2
CO 2	3	3	3	3	3	2	1	2	2	2	3	2	2
CO 3	3	2	2	2	2	2	1	2	2	2	3	2	2
CO 4	3	3	2	3	2	2	2	2	2	3	3	3	3
CO 5	3	3	2	3	3	2	2	2	3	3	2	3	3
CO6	3	3	2	3	3	3	3	3	3	2	2	3	3

Curriculum Content	**Hours**
Unit I: Fundamentals of Environmental Chemistry Significance of chemistry in environmental engineering, atomic structure, molecular weight, equivalent weight, normality, molarity, stoichiometric reactions, oxidation- reduction equations, basics of mass balance. Environmental significance of pollutant parameters: temperature, pH, hardness, iron, manganese, fluoride, nitrogen, phosphorus,carbon, sulfate, DO, BOD, COD, TOC	7
Unit II: Colloidal Chemistry and Instrumental Analysis Size, methods of formation, properties of colloidal dispersions in liquids and air, environmental significance. Absorption spectroscopy (UV-visible, atomic absorption spectroscopy), flame photometry, mass spectroscopy, gas chromatography, Lambert-Beer's law, colorimetric analysis, spectrophotometry.	7
Unit III: Environmental Organic and Inorganic Chemistry Toxic effects of organic compounds such as phenols, pesticides, surfactants, tannin, lignin, and hydrocarbons. Heavy metals and trace contaminants: significance and health effects, hazardous material characteristics. Environmental characteristics of organic compounds: solubility, hydrolysis, photolysis. Bio-geochemical cycles: phosphorus, carbon, nitrogen cycles.	6
Unit IV: Physical and Quantitative Chemistry in Environmental Engineering Gravimetric and volumetric analysis, physical chemistry principles: thermodynamics, heat and work, enthalpy, entropy, vapor pressure, binary mixtures, oxidation-reduction reactions, osmosis, dialysis, electrodialysis, solvent extraction, electrochemistry, chemical kinetics, catalysis, adsorption, ion exchange.	8

Unit V: Environmental Microbiology (6 Hrs) Microscopic flora and fauna in environmental engineering, classification and characteristics of bacteria, bacterial cytology, cell structure, metabolism (photosynthesis, chemosynthesis, autotrophic and heterotrophic), bacterial reproduction, growth cycle. Culture techniques, selective methods, pure cultures, isolation methods, gram staining, indicator organisms (coliform group), bacteriological techniques (MPN, standard plate count).	6
Unit VI: Environmental Biochemistry Classification, characteristics, and environmental significance of carbohydrates, proteins, lipids, and high-energy compounds. Enzyme catalysis, enzyme properties, reaction mechanisms, Michaelis-Menten equation, factors affecting enzymatic reactions, enzyme inhibition, enzyme formation, denaturation.	6
Suggested list of Tutorials and Assignments: The tutorial consists of a set of minimum 8-10 Tutorials / Research Problems based on the syllabus.	

Suggested Text Books:	
1.	Sawyer, C. N., McCarty, P. L., and Parkin, G. F., "Chemistry for Environmental Engineering and Science", McGraw-Hill, 2017.
2.	Manahan, S. E., "Environmental Chemistry", CRC Press, 2017.
3.	Pelczar, M. J., Chan, E. C. S., and Krieg, N. R., "Microbiology: Concepts and Applications", McGraw-Hill, 2015.
Suggested Reference Books:	
1.	Bitton, G., "Wastewater Microbiology", Wiley, 2011.
2.	Pepper, I. L., Gerba, C. P., and Brusseau, M. L., "Environmental Microbiology", Academic Press, 2014.
3.	Stumm, W., and Morgan, J. J., "Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters", Wiley, 2012.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-I**					
Course Title	**:**	**Elective -1 Sustainable Engineering Concepts and Life Cycle Analysis**			***Course Code*:**	**:**	ESTE12
Teaching Scheme (Hours)	**:**	Lecture :	3 Hrs/week		***Total Credits***	:	3
Evaluation Scheme (Marks)	**:**	ISE =40	ESE = 60	Grand Total=100	***Duration of ESE***	**:**	2 hrs
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites	**:**	NILL					

(if any)		
Course Domain	**:**	Environmental Engineering

Course Rationale: This course provides an understanding of sustainability principles and life cycle analysis (LCA) methodologies. It covers environmental impact assessment, risk management, data collection, and sustainable design strategies to support decision-making in engineering and environmental management.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1.	Introduce key sustainability concepts, material flow, and waste management principles.	**1.**	Understand sustainability principles, resource management, and their engineering implications.
2.	Provide knowledge of environmental risk assessment and life cycle framework applications.	**2.**	Apply life cycle assessment (LCA) in evaluating environmental risks and impacts.
3.	Develop an understanding of environmental data collection, statistical analysis, and LCA methodology.	**3.**	Collect, analyze, and interpret environmental data for sustainability studies.
4.	Explain the use of LCA software tools and the role of ISO standards in sustainability assessment.	**4.**	Utilize LCA methodologies and software tools for sustainability assessment.
5.	Introduce sustainable design principles, green materials, and their economic, environmental, and social impacts.	**5.**	Integrate sustainable design and material selection into engineering practices.
6.	Enable students to apply sustainability concepts to real-world case studies and emerging trends.	**6.**	Evaluate case studies and emerging trends in sustainability for practical applications.

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	2	2	2	2	2	2	3	2	2	3
CO 2	3	3	3	3	3	2	2	2	2	3	3	2	3
CO 3	3	3	3	3	3	2	2	2	2	2	3	2	2
CO 4	3	3	3	3	3	2	2	2	2	2	3	2	3
CO5	3	3	3	2	3	3	3	2	2	3	2	3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content	**Hours**
Unit I: Fundamentals of Sustainability and Life Cycle Analysis Introduction to sustainability concepts, material flow, and waste management. Water- energy-food nexus and engineering implications. Basics of life cycle analysis (LCA) and its role in sustainability.	6
Unit II: Environmental Risk and Life Cycle Framework Environmental risks and assessment methods, case studies on chemical risks and health impacts, characterization of environmental problems. Introduction to the LCA framework and its role in risk management.	7
Unit III: Environmental Data Collection and LCA Methodology Environmental data collection methods and challenges, statistical analysis of environmental data, common analytical instruments. Overview of LCA methodology: goal definition, life cycle inventory, impact assessment, and	6

interpretation.	
Unit IV: Life Cycle Assessment and ISO Standards Detailed LCA methodology with practical examples, benefits and limitations of LCA, ethical considerations. ISO framework for LCA: standards, best practices, and interpretation of LCIA results in decision-making.	7
Unit V: Sustainable Design and Materials Factors for a good LCA study (data quality, system boundaries), selection of sustainable materials and green technologies. Design for sustainability: economic, environmental, and social indicators. Environmental cost analysis and principles of sustainable engineering.	7
Unit VI: Applied Sustainability – Case Studies and Real-World Applications Sustainability in waste management and water treatment, energy and resource efficiency in industrial processes. Case studies: comparison of hand drying methods, biofuels for transportation, kerosene lamp vs. solar lamp, bioplastics, etc. Emerging trends in sustainability and future directions.	7

Suggested list of Tutorials and Assignments: Students have to perform 6-8 tutorials based on the curriculum.	
Suggested Text Books:	
1.	Graedel, T. E., and Allenby, B. R., "Industrial Ecology and Sustainable Engineering", Pearson, 2010.
2.	Finnveden, G., Hauschild, M. Z., Ekvall, T., and Guinee, J., "Life Cycle Assessment: Principles and Practice", Springer, 2016.
3.	Mulder, K. F., "Sustainable Development for Engineers", Greenleaf Publishing, 2006.
Suggested Reference Books:	
1.	Curran, M. A., "Life Cycle Assessment Handbook: A Guide for Environmentally Sustainable Products", Wiley, 2012.
2.	Baumann, H., and Tillman, A. M., "The Hitchhiker's Guide to LCA", Studentlitteratur AB, 2004.
3	United Nations Environment Programme (UNEP), "Guidelines for Social Life Cycle Assessment of Products", 2009.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-I**					
Course Title	**:**	**Elective-I Municipal Solid Waste Management**			***Course Code*:**	**:**	ESTE13
Teaching Scheme (Hours)	**:**	Lecture :	3 Hrs/week		***Total Credits***	**:**	3
Evaluation Scheme (Marks)	**:**	ISE =40	ESE = 60	Grand Total=100	***Duration of ESE***	**:**	2 hrs
Revision:	**:**	Fourth			***Month***	**:**	July 2025

Pre-requisites *(if any)*	**:**	NILL
Course Domain	**:**	Environmental Engineering

Course Rationale: This course provides a comprehensive understanding of municipal solid waste (MSW) management, including its sources, characterization, collection, processing, treatment, disposal methods, and regulatory framework. It emphasizes sustainable waste management techniques and environmental impacts.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain the sources, types, and characterization of municipal solid waste.	**1.**	Identify sources, composition, and properties of municipal solid waste.
2.	Provide knowledge of waste generation rates, storage, collection, and transfer station design.	**2.**	Analyze waste generation rates and design waste collection and transfer station systems.
3.	Introduce waste processing techniques, material recovery, recycling, and energy recovery methods.	**3.**	Apply waste processing and resource recovery techniques, including recycling and energy generation.
4.	Develop an understanding of composting, vermicomposting, and anaerobic digestion for biological waste conversion.	**4.**	Evaluate biological waste treatment methods for compost and biogas production.
5.	Explain landfill design, leachate management, and rehabilitation of dumpsites.	**5.**	Design and manage landfills with proper leachate and gas control measures.
6.	Enable students to understand MSW regulations, government initiatives, and waste management strategies in India.	**6.**	Interpret MSW regulations, policies, and strategies for effective waste management.

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	2	2	1	1	2	2	3	3	1	1
CO 2	3	3	3	2	3	2	2	2	2	2	3	2	1
CO 3	3	3	3	3	3	2	2	2	2	3	1	3	3
CO 4	3	3	3	3	2	2	2	2	2	3	1	3	3
CO 5	3	3	3	3	3	2	3	2	2	3	2	1	3
CO6	3	2	2	2	2	2	2	3	3	3	2	1	3

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content	**Hours**
Unit I: Municipal Solid Waste Sources and Characterization Sources, types, and composition of municipal solid waste. Physical, chemical, and biological properties. Solid waste management objectives, functional elements, environmental impact of improper waste management, current scenario of MSW management in India.	7

Unit II: Solid Waste Generation Rate & Transfer Station Definition and typical values for Indian cities, factors affecting waste generation rates. Waste storage at source, collection components, types of collection systems, and their design. Waste transportation methods, vehicle routing. Transfer stations: need, types, capacity, location, and economic viability.	6
Unit III: Waste Processing Techniques & Material Recovery and Recycling Waste processing techniques: volume and size reduction, component separation. Material recovery and recycling: objectives, recycling program elements, commonly recycled materials and processes. Energy recovery: parameters affecting thermal processing, pyrolysis, incineration, refuse-derived fuels, case studies from India.	7
Unit IV: Recovery of Biological Conversion Products: Compost and Biogas Composting: benefits, processes, stages, and technologies. Factors affecting compost quality. Vermicomposting, mechanical composting, in-vessel composting, biomethanation.	6
Unit V: Landfills Dumpsites: associated problems, rehabilitation, and bio-mining. Sanitary landfills: site selection, types, principles, processes, landfilling methods, landfill design, liners, leachate and landfill gas management, closure and post-closure plans.	7
Unit VI: Overview of MSW Rules and Government Initiatives Waste management legislation in India, MSWM Rules 2016, role of CPCB and SPCB in waste management. Biomedical and construction & demolition (C&D) waste management: generation, sources, classification, management technologies, and legal framework.	7

Suggested list of Tutorials and Assignments: The tutorial consists of a set of minimum 8-10 Tutorials / Research Problems and based on the syllabus.	
Suggested Reference Books:	
1.	Diaz, L. F., Savage, G. M., and Eggerth, L. L., "Solid Waste Management: Principles and Practice", Springer, 2016.
2.	Pichtel, J., "Waste Management Practices: Municipal, Hazardous, and Industrial", CRC Press, 2014.
3.	CPCB, "Guidelines for Solid Waste Management", Central Pollution Control Board, India, 2016.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-I**				
Course Title	**:**	**Elective-II (Open Elective) Environmental Biotechnology**		***Course Code*:**	**:**	ESTOE21
Teaching Scheme	**:**	Lecture:	03 Hrs/week	***Total Credits***	**:**	03

(Hours)							
Evaluation Scheme (Marks)	**:**	ISE =40	ESE = 60	Grand Total=100	***Duration of ESE***	**:**	2 hrs
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	Environmental Engineering					
Course Domain	**:**	Elective-I					

Course Rationale: This course provides an understanding of biotechnological principles and their applications in environmental engineering. It covers microbial and enzymatic processes, bioremediation, bioenergy production, and environmental monitoring techniques for sustainable development.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain the fundamental concepts of biotechnology and its relevance to environmental engineering.	**1.**	Understand the fundamental principles of environmental biotechnology.
2.	Provide knowledge of microbial metabolism, genetic engineering, and biotechnological tools.	**2.**	Analyze microbial and enzymatic processes for waste treatment and pollution control.
3.	Introduce bioremediation techniques for pollution control and waste management.	**3.**	Apply bioremediationtechniques for environmental restoration.
4.	Develop an understanding of bioenergy production and bio-based treatment methods.	**4.**	Evaluate bioenergy production methods and their environmental benefits.
5.	Explore biosensors and biotechnological approaches for environmental monitoring.	**5.**	Utilize biosensors and microbial monitoring techniques for pollution assessment.
6.	Enable students to integrate biotechnology with environmental sustainability solutions.	**6.**	Integrate biotechnological solutions into environmental engineering practices.

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	2	2	1	1	2	2	2	3	3	2
CO 2	3	3	3	3	3	2	1	2	2	2	3	3	3
CO 3	3	3	3	3	3	2	2	2	2	3	3	3	3
CO 4	3	3	3	3	3	2	2	2	2	3	3	3	3
CO 5	3	3	2	3	3	2	2	2	2	3	3	3	3
CO6	3	3	3	3	3	3	3	3	3	3	3	3	3

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content	**Hours**

Unit I: Fundamentals of Environmental Biotechnology Basic principles of biotechnology, microbial diversity and metabolism, genetic engineering techniques, recombinant DNA technology, biosafety and ethical considerations.	07
Unit II: Microbial Processes in Environmental Engineering Role of microbes in wastewater treatment, biodegradation of organic and inorganic pollutants, microbial biofilms, bioaugmentation, microbial ecology in engineered systems.	07
Unit III: Bioremediation and Waste Treatment Bioremediation strategies (in situ and ex situ), phytoremediation, biotransformation of heavy metals, biodegradation of xenobiotics, application of fungi and bacteria in waste treatment.	04
Unit IV: Bioenergy and Biofuels Bioethanol, biodiesel, biogas production, microbial fuel cells, anaerobic digestion, algae- based biofuels, sustainability and environmental impact of bioenergy.	08
Unit V: Biosensors and Environmental Monitoring Types of biosensors, principles of microbial biosensors, bioindicators for pollution monitoring, detection of heavy metals, pesticides, and pathogens in the environment.	06
Unit VI: Emerging Biotechnological Applications Synthetic biology in environmental engineering, nanobiotechnology for pollution control, genetically modified organisms (GMOs) in environmental management, future trends in environmental biotechnology.	06

Suggested Text Books:	
1.	Rittmann, B. E., and McCarty, P. L., "Environmental Biotechnology: Principles and Applications", McGraw-Hill, 2020.
2.	Evans, G. M., and Furlong, J. C., "Environmental Biotechnology: Theory and Application", Wiley, 2011.
3.	Baker, K. H., and Herson, D. S., "Bioremediation", McGraw-Hill, 1994.
Suggested Reference Books:	
1.	Jordening, H.-J., and Winter, J., "Environmental Biotechnology: Concepts and Applications", Wiley, 2005
2.	Scragg, A., "Environmental Biotechnology", Oxford University Press, 2005.
3.	Glazer, A. N., and Nikaido, H., "Microbial Biotechnology: Fundamentals of Applied Microbiology", Cambridge University Press, 2007.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-I**					
Course Title	**:**	**Elective-II (Open Elective) Energy Efficient Buildings**			***Course Code*:**	**:**	ESTOE22
Teaching Scheme (Hours)	**:**	Lecture:	3 Hrs/week		***Total Credits***	**:**	3
Evaluation Scheme (Marks)	**:**	ISE =40	ESE = 60	Grand Total=100	***Duration of ESE***	**:**	2 hrs
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisite	**:**	NILL					
Course Domain	**:**	Environmental Engineering					
Course Rationale		This course provides an understanding of sustainable building materials, energy-efficient techniques, and the environmental impact of construction. It covers energy systems, renewable and conventional materials, green building strategies, and energy-efficient maintenance systems.					

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1.	Introduce the concepts of energy conservation, energy efficiency, and global energy challenges.	**1.**	Understand global energy challenges,classification and energy consumption patterns.
2.	Provide knowledge of conventional building materials, their properties, and sustainability considerations.	**2.**	Analyze the properties and energy implications of conventional building materials.
3.	Explain the environmental impact of energy use in buildings and the principles of green buildings.	**3.**	Evaluate the environmental impact of energy use in buildings and apply sustainability principles.
4.	Develop an understanding of and Sustainable masonry materials alternative roofing techniques.	**4.**	Implement sustainable masonry techniques and assess energy-efficient building materials.
5.	Introduce various energy-efficient roofing and construction techniques for reducing energy consumption.	**5.**	Design and compare alternative roofing systems for green buildings.
6	Enable students to analyze energy systems in building maintenance and design strategies for energy efficiency.	**6.**	Apply climate-responsive building design strategies and energy-efficient maintenance systems.

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	2	2	1	1	2	2	3	3	2	1
CO 2	3	3	3	2	2	2	1	2	2	2	2	2	2

CO 3	3	3	3	2	3	2	2	2	2	3	3	3	2
CO 4	3	3	3	3	3	2	2	2	2	3	3	3	3
CO5	3	3	3	3	3	2	3	2	2	3	2	3	3
CO6	3	3	3	3	3	2	3	3	3	3	3	3	3

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content	**Hours**
Unit I: Introduction to Energy Global warming, causes, energy considerations, energy conservation and efficiency, energy systems and spatial structures. Classification of energy: primary and secondary, commercial and non-commercial, renewable and nonrenewable. Global primary energy reserves, consumption, and distribution. Units of energy with examples.	07
Unit I: Conventional Materials and Techniques in Buildings Properties of building materials: physical, mechanical, chemical, and thermal characteristics. Introduction to structural and physical aspects of buildings. Case studies on conventional building materials, their energy consumption, and sustainability considerations.	06
Unit III: Energy and Environmental Issues in Buildings Energy resources and their environmental impact, energy use in the built environment. Sustainable buildings and objectives of green building design. Rating systems: LEED and GRIHA. Planning aspects, material strategies, design strategies, and environmental issues related to building materials.	07
Unit IV: Sustainable Materials and Techniques for Masonry Energy scenario in pre- and post-independent India, sustainability needs and approaches, green building materials. Appropriate materials and techniques for construction: stabilized mud blocks, fly ash-lime-gypsum (FALG) blocks, hollow concrete blocks, calcium silicate bricks. Energy estimation and comparison in masonry components.	07
Unit V: Roofing Alternatives in Green Buildings Structural inefficiencies in conventional roofing, sustainable roofing alternatives: thatch roofs, filler slab roofs, composite beam-panel roofs, hollow block roofs, ferrocement roofing, masonry domes, and vaults. Rainwater harvesting techniques.Energy consumption in roofing systems and embodied energy comparisons.	07
Unit VI: Energy Systems in Building Maintenance Elements of climate and factors influencing it. Human comfort and climate-responsive building design. Heat exchange in buildings. Concepts of active and passive energy systems in buildings. Role of modern energy-efficient technologies in reducing energy consumption.	07

Suggested Text Books:	
1.	Jagadish, K. S., Venkatarama Reddy, B. V., and Nanjunda Rao, K. S., "Alternative Building` and Technologies", I.K. International Publishing House Pvt. Ltd.
2.	Jagadish, K. S. (Editor), "Sustainable Building Technologies", BMTPC, I.K. International Publishing House Pvt. Ltd.
3.	Koenigsberger, O. H., Ingersoll, T. G., Mayhew, A., and Szokolay, S. V., "Manual of Tropical Housing and Building – Climatic Design".
Suggested Reference Books	

1.	Boyle, G., "Renewable Energy: Power for a Sustainable Future", Oxford University Press, Third Edition.
2.	International Energy Agency, "World Energy Investment Outlook – Special Report", London, 2014.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-I**					
Course Title	**:**	**Elective-II (Open Elective) Operational Health and Safety Management**			***Course Code*:**	**:**	ESTOE23
Teaching Scheme (Hours)	**:**	Lecture:	3 Hrs/week		***Total Credits***	:	3
Evaluation Scheme (Marks)	**:**	ISE =40	ESE = 60	Grand Total=100	***Duration of ESE***	**:**	2 hrs
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites	**:**	NILL					
Course Domain	**:**	Environmental Engineering					

Course Rationale: This course provides a comprehensive understanding of environmental health and safety (EHS) principles, workplace hazards, risk assessment, safety management systems, accident prevention, and regulatory frameworks. It aims to equip students with the knowledge and skills to implement safety measures in industrial and environmental settings.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain different types of hazards and their impact on occupational safety.	**1.**	Identify different types of hazards and implement safety measures in industrial and construction environments.
2.	Introduce safety legislation, regulations, and industry standards for workplace safety.	**2.**	Interpret safety legislation, regulations, and codes of practice for workplace safety.
3.	Develop knowledge of safety precautions in various industrial and construction activities.	**3.**	Apply safety precautions in construction activities such as excavation, scaffolding, and demolition.
4.	Provide insights into occupational health and the use of personal protective equipment (PPE).	**4.**	Evaluate occupational hazards and implement PPE measures as per legal frameworks.
5	Explain accident prevention strategies, risk assessment, and safety management principles.	**5.**	Analyze accident prevention methods and conduct risk assessments using industry-standard techniques.
6.	Enable students to understand the role of education and training in improving workplace safety.	**6.**	Develop safety training programs and promote safety awareness in workplace settings.

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	2	**2**	**2**	**2**	**2**	**2**	**3**	3	**2**	**1**
CO 2	3	3	2	2	2	**2**	**2**	**3**	**2**	**3**	3	**2**	1
CO 3	3	3	3	2	3	**2**	**2**	**2**	**2**	**3**	3	**3**	2
CO 4	3	3	3	2	2	**2**	**2**	**2**	**2**	**3**	3	**3**	2
CO5	3	3	3	3	3	**2**	**2**	**2**	**2**	**3**	3	**3**	2
CO 6	3	3	2	2	2	**3**	**2**	**3**	**3**	**3**	3	**3**	3

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content	**Hours**
Unit I: Hazards and Causes of Accidents, Safety Measures Physical, chemical, biological, and ergonomic hazards. Industrial and electrical hazards, hazards in construction industries. Fire hazards and preventive measures. Need for EHS systems in workplaces. International safety initiatives, ergonomics in the workplace, safeuse of machines and tools.	**6**
Unit II: Safety Legislation and Standards Safety regulations for the construction industry, site management, safety manuals, and checklists Role of safety officers and committees, safety training and audits. Health and safety policies, risk assessment methods, accident investigation techniques, and principles of quality management in safety.	**7**
Unit III: Safety Precautions in Construction and Industry Safety practices in excavation, concreting, scaffolding, steel erection, and demolition. Organizational structure and responsibilities for safety, health, and environmental management. Role of safety committees and stress management in workplace safety.	**6**
Unit IV: Occupational Hazards and Personal Protective Equipment Legislative measures in industrial safety: Factories Act (1948), Workmen's Compensation Act (1943), Employees' State Insurance Act (1948), Mines Act, Air (Prevention and Control of Pollution) Act (1981), Water (Prevention and Control of Pollution) Act (1974), Boiler Vessels Act. Child labor and women employee regulations. ILO conventions and safety recommendations.	**8**
Unit V: Accident Management and Risk Assessment Definitions: incident, accident, injury, unsafe acts, hazards, errors, oversight, and risk factors. Theories and models of accident occurrence. Financial implications of accidents. Hazard identification methods: fault tree analysis, event tree analysis, failure modes and effects analysis (FMEA), HAZOP studies, job safety analysis. Safety inspection procedures and report generation.	**7**

Unit VI: Education and Training in Safety	**6**
Importance of safety education and training. Development of effective training programs. Methods for promoting safe practices: motivation, communication, role of government and private agencies. Safety awareness campaigns: posters, safety pledges, incentive schemes, safety competitions, and domestic safety training.	

Suggested Text Books/ Reference Books/Manual	
1	ILO, "Safety and Health in Construction", International Labour Organization, 1992.
2	R. Hudson and R. W. King, "Construction Hazard & Safety Handbook", Butterworths.
3	R.K. Jain and Sunil S. Rao, "Industrial Safety, Health and Environment Management Systems", Khanna Publishers, 2006.
Reference Books	
1	Slote L., "Handbook of Occupational Safety and Health", John Wiley & Sons, New York.
2	National Safety Council of India, "Industrial Safety Manual".
3	Frank P. Lees, "Loss Prevention in Process Industries", Vol. 1 & 2, Butterworth-Heinemann Ltd., London, 1991.
4	Heinrich H. W., "Industrial Accident Prevention", McGraw-Hill, New York, 1980.
5	Krishnan N.V., "Safety Management in Industry", Jaico Publishing House, Bombay, 1997.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-I**					
Course Title	**:**	**Seminar-I**			***Course Code*:**	**:**	ESTC14
Teaching Scheme (Hours)	**:**	Practical:	02 Hrs/week		***Total Credits***	**:**	1
Evaluation Scheme (Marks)	**:**	IOE= 50	EPE/EOE= NIL	Total= 50	***Duration of EPE***	**:**	----
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	Soft Skills					
Course Domain	**:**	Management					

Course Rationale: The course aims to emphasize the value and significance of the seminar in the M. Tech program, showcasing how it contributes to the overall learning experience and the professional growth of the students.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1.	Provide students with in-depth knowledge and understanding of a specific subject or research area within their field of study.	**1.**	Demonstrate the ability to perform close and critical readings.
2.	Enhance students' research skills, including critical analysis, literature review, data collection and analysis, experimental design, and problem-solving.	**2.**	Demonstrate the ability to consider critically the motives and methods of scholarship and the relationship between them.
3.	Help to improve students' ability to present technical information effectively, both orally and in writing, to an academic audience.	**3.**	Demonstrate the ability to distinguish opinions and beliefs from researched claims and evidence and recognize that kinds of evidence will vary from subject to subject.
4.	Promote collaboration and networking among students, faculty members, and experts in the field, fostering interdisciplinary discussions and potential research collaborations.	**4.**	Ask disciplinarily appropriate questions of the material and recognize when lines of inquiry fall outside of disciplinary boundaries.
5	Explore and discuss the latest trends, advancements, and challenges in the field.	**5.**	Evaluate, credit, and synthesize sources

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	2	2	2	1	2	2	2			
CO 2	3	3	3	3	2	2	1	2	2	3			
CO 3	3	3	2	3	2	2	1	3	2	3			
CO 4	3	3	3	3	2	3	1	2	2	3			

CO5	3	3	3	3	3	3	2	3	3	3			
CO 6													

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content
Seminar-I shall be delivered preferably on the topic of dissertation or at least the area of dissertation. The concepts must be clearly understood and presented by the student. All modern methods of presentation should be used by the student. Preparation and presentation of a seminar is intended to investigate an in-depth review of literature, prepare a critical review, and develop confidence to present the material by the student. The seminar-I shall be evaluated by a Department Committee constituted for this purpose, based on a report submitted by the candidate and a viva-voce conducted at the end of the semester. A hard copy of the report (25 to 30 pages A4 size, 12 fonts, Times New Roman, single spacing both sides printed, well formatted preferably in IEEE format) should be submitted to the Department before delivering the seminar. A PDF copy of the report in soft form must be submitted to the guide along with other details if any.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-I**					
Course Title	**:**	**Water Quality Analysis Lab**			***Course Code*:**	**:**	ESTC15
Teaching Scheme (Hours)	**:**	Practical :	2 Hrs/week		***Total Credits***	:	1
Evaluation Scheme (Marks)	**:**	IOE=50	EPE/EOE=Nil	Total= 50	----	**:**	----
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	Basic knowledge of Environmental Engineering					
Course Domain	**:**	Core					

Course Rationale: This laboratory course provides hands-on experience in analyzing the physical, chemical, and biological characteristics of water. It helps students understand water quality standards, pollution assessment, and treatment methodologies, essential for environmental protection and sustainable water management.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1.	Introduce students to water quality parameters and their significance.	**1.**	Analyze the physical, chemical, and biological parameters of water.
2.	Train students in the application of standard water analysis techniques.	**2.**	Determine the potability and pollution levels of various water sources.
3.	Develop analytical skills for assessing drinking water and wastewater quality.	**3.**	Perform standard laboratory tests for drinking water and wastewater analysis.
4.	Familiarize students with water pollution indicators and treatment efficiency.	**4.**	Assess the effectiveness of water treatment processes.
5	Enhance students' ability to interpret lab results for environmental applications.	**5.**	Interpret water quality data and apply it to environmental management.
6.	Encourage practical applications of water sustainability concepts.	**6.**	Prepare technical reports on water quality assessment.

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	2	2	2	1	2	2	2	3	2	1
CO 2	3	3	3	3	2	2	1	2	2	3	3	3	2
CO 3	3	2	3	3	3	2	1	2	2	2	3	3	2
CO 4	3	3	3	3	3	2	1	2	2	3	3	3	2
CO 5	3	3	3	3	3	2	1	3	2	3	3	3	3
CO6	3	2	2	2	2	2	1	3	2	2	3	3	3

Level of Mapping as: Low 1, Moderate 2, High 3

This lab consists of a set of minimum 8-10 Practical problems/ Tutorials /Research Problems and simulations based on the following topics:

List of Experiments

Sr. No.	
1.	**Determination of pH, Turbidity, and Electrical Conductivity of Water.**
2.	**Measurement of Alkalinity and Acidity in Water Samples.**
3.	**Estimation of Total Hardness (Calcium and Magnesium Hardness).**
4.	**Determination of Chloride Content using Argentometric Method.**

5.	**Analysis of Dissolved Oxygen (DO) in Surface and Groundwater.**
6.	**Biochemical Oxygen Demand (BOD) Test for Wastewater Samples.**
7.	**Chemical Oxygen Demand (COD) Test for Industrial and Domestic Effluents.**
8.	**Determination of Nitrate and Phosphate Concentrations in Water.**
9.	**Heavy Metal Analysis (Lead, Cadmium, and Arsenic) using Spectrophotometry.**
10.	**Microbiological Examination of Water Samples for Coliform Bacteria.**

Suggested Text Books/ Reference Books/Manual	
1.	APHA, "Standard Methods for the Examination of Water and Wastewater," 23rd Edition.
2.	Sawyer, C. N., McCarty, P. L., & Parkin, G. F., "Chemistry for Environmental Engineering and Science."
3.	Metcalf & Eddy, "Wastewater Engineering: Treatment and Reuse."
4.	Peavy, H. S., Rowe, D. R., & Tchobanoglous, G., "Environmental Engineering."

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-I**					
Course Title	**:**	**Remote Sensing and GIS Applications in Environmental Engineering Lab**			***Course Code*:**	**:**	ECTC16
Teaching Scheme (Hours)	**:**	Practical :	2 Hrs/week		***Total Credits***	:	1
Evaluation Scheme (Marks)	**:**	IOE=50	EOE=Nil	Total=50	3 Hrs	**:**	2 Hrs
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	Basic knowledge of Remote Sensing and GIS applications.					
Course Domain	**:**	Core					

Course Rationale: This laboratory course provides practical exposure to remote sensing and GIS ap for environmental engineering. It enables students to analyze spatial data, interpret satellite imagery, GIS techniques for environmental planning, resource management, and pollution control using open-ac

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1.	Introduce students to remote sensing fundamentals and GIS concepts.	**1.**	Acquire and process geospatial data using open-source tools.
2.	Train students in using open-source geospatial data and tools.	**2.**	Analyze satellite imagery for land use and land cover classification.
3.	Develop skills in satellite image interpretation and land cover classification.	**3.**	Apply GIS techniques for environmental monitoring and decision-making.
4	Familiarize students with GIS-based environmental analysis.	**4.**	Perform spatial analysis for pollution assessment and resource management.
5.	Enhance students' ability to perform spatial analysis	**5.**	Develop thematic maps and models for

	and mapping.		environmental applications.
6.	Encourage the use of open-access resources for environmental research.	**6.**	Use cloud-based GIS platforms for environmental planning.

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	2	3	2	3	2	1	2	2	2	3	2	1
CO 2	3	3	3	2	3	2	1	2	2	2	3	3	2
CO3	3	3	3	2	3	2	2	2	2	3	3	3	2
CO4	3	3	3	3	3	2	2	2	2	3	3	3	3
CO5	3	2	3	2	3	2	2	3	2	2	3	3	3
CO6	3	3	3	2	3	3	2	2	3	3	3	3	3

Level of Mapping as: Low 1, Moderate 2, High 3

List of Experiments	
Sr. No.	
1.	**Introduction to QGIS and Google Earth Engine (GEE).**
2.	**Downloading and processing Sentinel-2 and Landsat imagery.**
3.	**Geo-referencing and coordinate system transformations.**
4.	**Land Use and Land Cover Classification using supervised methods in QGIS.**
5.	**Mapping water bodies and vegetation health using NDVI analysis.**
6.	**Air and water quality assessment using remote sensing datasets.**
7.	**Flood risk mapping using Digital Elevation Models (DEMs).**
8.	**Application of GIS in waste management and urban planning.**
9.	**Cloud-based remote sensing data analysis with Google Earth Engine.**
10.	**Preparation of thematic maps for environmental applications.**

General Instructions: Students have to perform 8-10 practicals from the list.	
Suggested Text Books/ Reference Books/Manual	
1.	Open-access GIS tutorials from QGIS Documentation (https://docs.qgis.org/).
2.	Google Earth Engine Developers Guide (https://developers.google.com/earth-engine/).
3.	Remote Sensing Applications in Environmental Science, Open Source Edition.
4.	Free online courses from NASA Earth Data and ESA Copernicus.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-II**					
Course Title	**:**	**Intellectual Property Rights**			***Course Code*:**	**:**	ESTAE2
Teaching Scheme (Hours)	**:**	Lecture:	2 Hrs/week		***Total Credits***	**:**	2
Evaluation Scheme (Marks)	**:**	IOE=50	ESE = NIL	Grand Total=50	***Duration of ESE***	**:**	--
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	Basic Legal Awareness, Digital Literacy					
Course Domain	**:**	Audit Course					

Course Rationale: The course on Intellectual Property Rights (IPR) is designed to provide students with an in-depth understanding of the importance of intellectual property in fostering innovation, creativity, and economic development. As the global economy becomes increasingly knowledge-driven, protecting and managing intellectual property is critical for individuals, organizations, and nations.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1	Provide a comprehensive understanding of the concept, origin, and types of Intellectual Property Rights (IPR) and their significance in the global context.	**1**	Explain the fundamental concepts, origin, and significance of various types of Intellectual Property Rights (IPRs) in protecting innovations and creations.
2	Introduce the legal framework of IPR, including the TRIPS agreement and its relationship with the WTO.	**2**	Apply the knowledge of patent laws, registration procedures, and infringement remedies in the protection of inventions and technologies.
3	Familiarize students with the processes and laws related to patents, copyrights, and trademarks, along with their infringements and remedies.	**3**	Demonstrate an understanding of copyright laws, including software copyrights, piracy issues, and the remedies for infringement.
4	Understand the significance of designs, geographical indications, and layout designs, as well as their protection under international and national laws.	**4**	Analyze and manage issues related to trademarks, including registration, infringement, and offenses in cyberspace, such as domain name disputes.
5	Explore the legal provisions and ethical considerations related to the Information Technology Act, 2000, including cybercrime, e-commerce, and digital signatures.	**5**	Evaluate the legal framework for design protection, including the Semiconductor Integrated Circuits Layout Design Act and international conventions.
6	Develop the ability to identify, register, and manage intellectual property rights in various domains, including traditional knowledge and modern technologies.	**6**	Assess the implications of the Information Technology Act, 2000, particularly in the areas of e-governance, e-commerce, digital signatures, and combating cybercrime.

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	2	1	1	1	2	2	3			
CO 2	3	3	3	2	2	2	2	2	2	3			
CO 3	3	3	2	2	2	1	1	2	2	3			
CO 4	3	3	3	2	2	2	2	2	2	3			
CO 5	3	3	3	2	2	2	2	2	3	3			
CO6	3	3	3	2	2	2	2	2	3	3			

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content	**Hours**
Unit I Introduction to IPR: Meaning of property, Origin, Nature, Meaning of Intellectual Property Rights, Introduction to TRIPS and WTO, Kinds of Intellectual property rights—Copy Right, Patent, Trade Mark, Trade; Secret and trade dress, Design, Layout Design, Geographical Indication, Plant. Varieties and Traditional Knowledge.	5
Unit II Patent Rights and Copy Rights— Origin, Meaning of Patent, Types, Inventions which are not patentable, Registration Procedure, Rights and Duties of Patentee, Assignment and license, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties.	5
Unit III Copy Right—Origin, Definition &Types of Copy Right, Registration procedure, Assignment & license, Terms of Copy Right, Piracy, Infringement, Remedies, Copy rights with special reference to software.	4
Unit IV Trade Marks: Origin, Meaning & Nature of Trade Marks, Types, Registration of Trade Marks, Infringement & Remedies, Offences relating to Trade Marks, Passing Off, Penalties. Domain Names on cyber space.	4
Unit V Design- Meaning, Definition, Object, Registration of Design, Cancellation of Registration, International convention on design, functions of Design. Semiconductor Integrated circuits and layout design Act-2000.	4
Unit VI Basic Tenents Of Information Technology Act-2000, IT Act - Introduction, E-Commerce and legal provisions, E- Governance and legal provisions, Digital signature and Electronic Signature. Cybercrimes.	4

Suggested Text / Reference Books:	
1.	Intellectual Property Rights and the Law, Gogia Law Agency, by Dr. G.B. Reddy
2.	Law relating to Intellectual Property, Universal Law Publishing Co, by Dr. B.L.Wadehra
3.	IPR by P. Narayanan
4.	Law of Intellectual Property, Asian Law House, Dr. S. R. Myneni.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-II**					
Course Title	**:**	**Industrial Waste Treatment**			***Course Code*:**	**:**	ESTC21
Teaching Scheme (Hours)	**:**	Lecture :	3 Hrs/week		***Total Credits***	**:**	3
Evaluation Scheme (Marks)	**:**	ISE =40	ESE = 60	Grand Total=100	***Duration of ESE***	**:**	2 hrs
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	Basic knowledge about waste Management.					
Course Domain	**:**	Environmental Engineering					
Course Rationale: This course provides an in-depth understanding of industrial wastewater treatment processes, waste minimization techniques, and the design of effluent treatment plants. It covers wastewater management strategies for various industries, including agro-based, chemical, and engineering sectors, along with project report preparation for industrial wastewater management.							

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1	Introduce the classification of industries and their water requirements.	**1**	Analyze water requirements and quality issues in industrial processes.
2	Explain waste minimization techniques and industrial wastewater management strategies.	**2**	Apply waste minimization and recycling techniques in industrial wastewater management.
3	Provide knowledge of wastewater treatment methods for agro-based industries.	**3**	Design and evaluate treatment processes for agro-based industries.
4	Develop an understanding of wastewater treatment for chemical and engineering industries.	**4**	Develop treatment strategies for chemical and engineering industries.
5	Explain the concept, design, and operation of common effluent treatment plants.	**5**	Plan and design common effluent treatment plants (CETPs).
6	Enable students to prepare industrial wastewater treatment project reports.	**6**	Prepare feasibility and financial appraisal reports for industrial wastewater treatment projects.

Course Outcome and Program Outcome Mapping

Level of Mapping as: Low 1, Moderate 2, High 3

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	**3**	**3**	**2**	**2**	**1**	**1**	**2**	**2**	**2**	3	2	1
CO 2	3	**3**	3	2	2	**2**	**2**	**2**	**2**	**3**	3	3	2
CO 3	3	**3**	3	3	2	**2**	**2**	**2**	**2**	**3**	3	3	2
CO 4	3	**3**	3	3	2	**2**	**2**	**2**	**2**	**3**	3	3	2
CO 5	3	3	3	2	3	**2**	**3**	**2**	**2**	**3**	3	3	2
CO6	3	3	3	2	2	**2**	**3**	**3**	**2**	**3**	3	3	3

Curriculum Content	**Hours**
Unit I: Introduction to Industrial Water Requirements and Reuse Classification of industries, general water requirements, industrial water reuse. Cooling tower makeup water, water and salt balances in cooling towers. Common water quality problems in cooling tower systems, estimation of blow down water composition, analysis of scaling potential using Langlier and Ryzner indexes.	4
Unit II: Waste Minimization Techniques Concept of waste minimization, waste audits, volume and strength reduction techniques. Equalization: process, flow and quality, location, volume requirement, and design considerations. Reuse and recycling concepts, neutralization, and proportioning methods	5
Unit III: Industrial Wastewater Treatment for Agro-Based Industries Manufacturing processes, water usage, sources, quantities, and characteristics of effluents (process stream and combined), pollution effects, waste reduction, reclamation, by- product recovery, and alternative treatment and disposal methods for: • Sugar Industry • Distillery • Dairy • Pulp and Paper Mill and Textile Industry	10
Unit IV: Industrial Wastewater Treatment for Chemical and Engineering Industries Manufacturing processes, water usage, sources, quantities, and characteristics of effluents (process stream and combined), pollution effects, waste reduction, reclamation, by-product recovery, and alternative treatment and disposal methods for: • **Chemical Industries**: Pharmaceutical, Petroleum and Refineries, Fertilizer, Tannery. • **Engineering Industries**: Steel, Electroplating, Foundries, Sponge Iron Unit, Alumina/Aluminum Manufacturing Unit, Copper Smelter. **Thermal Power Plants**: Effluent characteristics and treatment methods.	10
Unit V: Common Effluent Treatment Plant (CETP) Concept , objectives ,methodology, - Benefit analysis ,design ,operation, and maintenance of CETPs.	3
Unit VI: Industrial Project Report Preparation Preparation of industrial waste treatment and disposal system project reports. Pre- feasibility, feasibility, and detailed project reports. Project financial appraisal and environmental impact assesment considerations.	8

Suggested Text Books:	
1.	Metcalf & Eddy, "Wastewater Engineering: Treatment and Resource Recovery", McGraw-Hill, 2017.
2.	Rao, M. N., and Datta, A. K., "Wastewater Treatment: Rational Methods of Design and Industrial Practices", Oxford & IBH, 2011.
3.	Eckenfelder, W. W., "Industrial Water Pollution Control", McGraw-Hill, 2000.
Suggested Reference Books:	
1.	Tchobanoglous, G., Burton, F. L., and Stensel, H. D., "Wastewater Engineering: Treatment and Reuse", McGraw-Hill, 2003.
2	Arceivala, S. J., and Asolekar, S. R., "Wastewater Treatment for Pollution Control and Reuse", Tata McGraw-Hill, 2006.
3	Frank Woodard, "Industrial Waste Treatment Handbook", Butterworth-Heinemann, 2001.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-II**					
Course Title	**:**	**Environmental Management Systems**			***Course Code*:**	**:**	ESTC22
Teaching Scheme (Hours)	**:**	Lecture :	3 Hrs/week		***Total Credits***	**:**	3
Evaluation Scheme (Marks)	**:**	ISE =40	ESE = 60	Grand Total=100	***Duration of ESE***	**:**	2 Hrs
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	NILL					
Course Domain	**:**	Environmental Engineering					

Course Rationale: This course provides a comprehensive understanding of environmental management systems (EMS), their principles, regulatory frameworks, and implementation strategies. It covers environmental impact assessments, ISO standards, sustainability planning, corporate environmental responsibility, and environmental auditing.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1	Introduce the fundamental concepts of Environmental management and sustainability.	**1**	Understand the fundamental principles of environmental management systems.
2	Provide knowledge of environmental regulations, policies, and compliance requirements.	**2**	Analyze environmental policies, regulations, and compliance frameworks.
3	Explain ISO 14001 standards and the framework for environmental management systems.	**3**	Implement EMS frameworks, including ISO 14001, for organizational sustainability.
4	Develop an understanding of environmental impact assessments (EIA) and life cycle analysis (LCA).	**4**	Conduct environmental impact assessments and apply LCA methodologies.
5	Introduce corporate environmental responsibility and sustainability reporting.	**5**	Develop corporate environmental responsibility strategies and sustainability reports.
6	Enable students to apply EMS principles to environmental auditing and risk assessment.	**6**	Perform environmental auditing and risk assessments in industrial and corporate settings.

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	2	2	1	1	2	2	3	3	2	1
CO 2	3	3	2	2	2	2	2	2	2	3	3	3	1
CO 3	3	3	3	2	2	2	2	2	2	3	3	3	2
CO4	3	3	3	3	2	2	2	2	2	3	3	2	2

CO5	3	3	2	2	2	2	2	3	2	3	3	3	3
CO6	3	3	3	2	2	2	3	2	2	3	3	3	2

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content	**Hours**
Unit I: Introduction to Environmental Management Systems Definition, scope, and importance of environmental management systems. Evolution of environmental management, principles of sustainability, pollution prevention, and resource conservation. Overview of EMS models and best practices.	6
Unit II: Environmental Regulations and Policies National and international environmental laws and regulations. Environmental Protection Act, Water Act, Air Act, Hazardous Waste Rules. Role of regulatory bodies (CPCB, SPCBEPA). Compliance strategies and enforcement mechanisms	7
Unit III: ISO Standards and Environmental Management System ISO and ISO 14000 Series: Introduction, Areas covered in the series of standards, Necessity of ISO certification. Environmental management system: Evolution, Need, Elements, Benefits. ISO 14001 requirements, Steps in ISO 14001 certification, ISO 14001 and sustainable development. Integration with other systems (ISO 9000, TQM, Six Sigma), Benefits of integration.	7
Unit IV: Environmental Impact Assessment (EIA) and Life Cycle Analysis Concepts of EIA, objectives, stages, methodologies, and reporting. Strategic Environmental Assessment (SEA). Life Cycle Analysis (LCA) methodology, impact assessment, interpretation, and applications in decision-making.	6
Unit V: Corporate Environmental Responsibility and Sustainability Reporting Concepts of corporate social responsibility (CSR) and environmental governance. Global sustainability frameworks: GRI, UN SDGs, ESG reporting. Tools for sustainability performance evaluation and reporting.	7
Unit VI: Environmental Auditing and Risk Assessment Types and scope of environmental audits, auditing procedures, compliance audits, waste audits. Risk assessment methodologies, hazard identification, environmental risk management strategies, case studies.	7

Suggested Text Books:	
1.	ISO 14001:2015, "Environmental Management Systems – Requirements with Guidance for Use".
2.	Cunningham, W. P., and Cunningham, M. A., "Environmental Science: A Global Concern", McGraw-Hill, 2017.
3	Peavy, H. S., Rowe, D. R., and Tchobanoglous, G., "Environmental Engineering", McGraw-Hill, 2017.
	Suggested Reference Books
1.	Asit K. Biswas and S. B. Cordeiro, "Environmental Management for Sustainable Development", Routledge, 2015.
2.	Madu, C. N., "Environmental Planning and Management", Imperial College Press, 2007.
3.	Welford, R., "Corporate Environmental Management: Systems and Strategies", Earthscan, 2002.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-II**					
Course Title	**:**	**Advanced Water and Wastewater Treatment**			***Course***	**:**	ESTC23
Teaching Scheme (Hours)	**:**	Lecture :	03 Hrs/week		***Total Credits***	**:**	03
Evaluation Scheme (Marks)	**:**	ISE =40	ESE = 60	Grand Total=100	***Duration of ESE***	**:**	2 Hrs
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	NILL					
Course Domain	**:**	Environmental Engineering					

Course Rationale: This course provides an in-depth understanding of advanced water and wastewater treatment technologies. It covers conventional and emerging treatment methods, membrane processes, disinfection techniques, and the integration of sustainable approaches inwater and wastewater management.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1	Introduce advanced water and wastewater treatment technologies and their applications.	1	Analyze and compare advanced water and wastewater treatment technologies.
2	Provide knowledge of physical, chemical, and biological treatment methods.	2	Apply membrane filtration, adsorption, and ion exchange methods for water treatment.
3	Explain membrane filtration, adsorption, ion exchange, and emerging contaminant removal techniques.	3	Evaluate advanced oxidation and nutrient removal techniques in wastewater treatment.
4	Develop an understanding of advanced oxidation processes (AOPs) and nutrient removal strategies.	4	Integrate sustainable approaches into water and wastewater treatment processes.
5	Introduce sludge treatment and management practices for sustainable disposal.	5	Design sludge treatment and disposal strategies with environmental considerations.
6	Enable students to design and optimize advanced water and wastewater treatment systems.	6	Optimize treatment system performance through case studies and real-world applications.

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	2	2	1	1	2	2	2	3	2	1
CO 2	3	3	3	2	3	2	2	2	2	2	3	2	1
CO 3	3	3	3	3	2	2	2	2	2	2	3	3	2

CO 4	3	3	3	2	2	2	2	2	2	3	3	3	2
CO 5	3	3	3	2	2	2	3	2	2	3	2	3	2
CO6	3	3	3	3	3	2	2	3	2	3	2	3	3

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content	**Hours**
Unit I: Introduction to Advanced Water and Wastewater Treatment Overview of conventional and advanced treatment processes. Water quality parameters, contaminant characterization, and selection of treatment methods. Emerging contaminants in water and wastewater treatment.	6
Unit II: Gas Transfer and Membrane Filtration Gas transfer: Aeration systems, energy requirements, and design of aeration systems. Membrane filtration: Terminology, process classification, membrane configurations. Membrane operation for microfiltration, ultrafiltration, and reverse osmosis. Area requirement, membrane fouling and its control, application of membranes. Electrodialysis: Theory, area and power requirements, disposal of concentrate waste streams.	7
Unit III: Grit Removal, Flotation, and Chemical Precipitation Grit removal: Types of grit chambers, characteristics, quantities, processes, and disposal of grit. Design of grit chambers. Flotation: Objective, types of flotation systems, design considerations. Chemical precipitation for removal of phosphorous, heavy metals, and dissolved inorganic substances.	7
Unit IV: Biological Nutrient Removal and Microbial Growth Kinetics Microbial growth kinetics, modeling suspended and attached growth treatment processes. Suspended growth processes for biological nitrification and denitrification. Biological nitrogen and phosphorous removal techniques.	6
Unit V: Anaerobic Treatment and Sludge Management Anaerobic sludge blanket processes, design considerations for Upflow Anaerobic Sludge Blanket (UASB) process. Theory and design of sludge treatment, sludge thickening, sludge drying, incineration. Aerobic and anaerobic digestion of sludge.	7
Unit VI: Wetland and Aquatic Treatment Systems Wetland and aquatic treatment systems: Types, applications, treatment kinetics, and effluent variability in constructed wetlands and aquatic systems. Free water surface and subsurface constructed wetlands, floating plant systems (water hyacinths and duckweed), combination systems. Design procedures for constructed wetlands and management of wetland and aquatic systems.	7

	Suggested Text Books:
1.	Metcalf & Eddy, "Wastewater Engineering: Treatment and Resource Recovery", McGraw-Hill, 2017.
2.	Rittmann, B. E., and McCarty, P. L., "Environmental Biotechnology: Principles and Applications", McGraw-Hill, 2020.
3	AWWA, "Water Treatment Principles and Design", Wiley, 2012.
	Suggested Reference Books

1.	Tchobanoglous, G., Burton, F. L., and Stensel, H. D., "Wastewater Engineering: Treatment and Reuse", McGraw-Hill, 2003.
2.	Lazarova, V., Choo, K. H., and Cornel, P., "Water-Energy Interactions in Water Reuse", IWA Publishing, 2012.
3.	l Spellman, F. R., "Handbook of Water and Wastewater Treatment Plant Operations", CRC Press, 2013man, F. R., "Handbook of Water and Wastewater Treatment Plant Operations", CRC Press, 2013.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-II**					
Course Title	**:**	**Elective-III Environmental Modeling and Simulation**			***Course Code*:**	**:**	ESTE21
Teaching Scheme (Hours)	**:**	Lecture :	3 Hrs/week		***Total Credits***	**:**	3
Evaluation Scheme (Marks)	**:**	ISE =40	ESE = 60	Grand Total=100	***Duration of ESE***	**:**	2 Hrs
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	NILL					
Course Domain	**:**	Environmental Engineering					

Course Rationale: This course provides a comprehensive understanding of environmental modeling and simulation techniques. It covers mathematical modeling principles, simulation methods, and their applications in air, water, and soil pollution assessment and management.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1	Introduce the fundamental concepts of environmental modeling and simulation.	**1**	Understand the principles and importance of environmental modeling.
2	Provide knowledge of mathematical models for air, water, and soil pollution assessment.	**2**	Develop mathematical models for pollution control and environmental impact assessment.
3	Explain numerical modeling techniques and their applications in environmental systems.	**3**	Apply numerical techniques for solving environmental modeling problems.
4	Develop an understanding of hydrological and atmospheric models.	**4**	Use simulation tools for air, water, and soil pollution studies.
5	Introduce stochastic and deterministic modeling approaches.	**5**	Evaluate hydrological and atmospheric models for environmental prediction.
6	Enable students to apply simulation tools for environmental management and decision-making.	**6**	Integrate modeling techniques into environmental management strategies.

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	2	2	1	1	2	2	2	3	2	1
CO 2	3	3	3	3	2	2	2	2	2	2	3	3	2

CO 3	3	3	3	3	3	2	2	2	2	2	3	3	3
CO 4	3	3	3	2	3	2	2	2	2	2	3	3	3
CO 5	3	3	3	3	3	2	2	2	2	3	3	3	3
CO6	3	3	3	3	3	3	3	3	3	3	3	3	3

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content	**Hours**
Unit I: Introduction to Environmental Modeling and Simulation Definition and scope of environmental modeling. Types of environmental models: empirical, deterministic, and stochastic models. Role of simulation in environmental engineering.	6
Unit II: Air Pollution Modeling Mathematical models for air pollution dispersion: Gaussian plume model, Lagrangian and Eulerian models. Source characterization and meteorological factors affecting dispersion. Computational approaches in air quality modeling.	7
Unit III: Water Quality and Hydrological Modeling Surface water quality modeling: Streeter-Phelps equation for dissolved oxygen modeling, nutrient transport models. Groundwater flow and contaminant transport modeling: Darcy's Law, advection-dispersion equation. Hydrological models: SWAT, HEC-HMS applications	7
Unit IV: Soil and Waste Management Modeling Fate and transport modeling of contaminants in soil. Landfill leachate modeling. Solidwaste decomposition and methane generation models.Risk assessment using environmental models.	6
Unit V: Numerical Methods in Environmental Modeling Finite difference and finite element methods in environmental modeling. Monte Carlo simulations, sensitivity analysis, uncertainty analysis in environmental prediction. Application of MATLAB and GIS-based modeling tools.	7
Unit VI: Case Studies and Applications of Environmental Models Real-world applications of environmental models in pollution control and resource management. Case studies on air pollution dispersion, river water quality, and climate change modeling. Future trends in environmental modeling and simulation.	7

Suggested list of Tutorials and Assignments: Students have to perform 6-8 tutorials based on the curriculum.

Suggested Text Books:	
1.	Schnoor, J. L., "Environmental Modeling: Fate and Transport of Pollutants in Water, Air, and Soil", Wiley, 1996.
2.	Chapra, S. C., "Surface Water-Quality Modeling", Waveland Press, 2008.
3.	Zannetti, P., "Air Pollution Modeling: Theories, Computational Methods and Available Software", Springer, 1990.
Suggested Reference Books:	
1.	Thangaraj, P., "Computer Simulation and Modeling", SciTech Publications, 2006.
2.	Wang, L. K., Pereira, N. C., and Hung, Y.-T., "Environmental Modeling for Sustainable Development", CRC Press, 2016.
3.	Ramaswami, A., Milford, J. B., and Small, M. J., "Integrated Environmental Modeling: Pollutant Transport, Fate, and Risk in the Environment", Wiley, 2005.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-II**					
Course Title	**:**	**Elective-III** **Environmental, Social and Governance**			***Course Code*:**	**:**	ESTE22
Teaching Scheme (Hours)	**:**	Lecture :	3 Hrs/week		***Total Credits***	**:**	3
Evaluation Scheme (Marks)	**:**	ISE =40	ESE = 60	Grand Total=100	***Duration of ESE***	**:**	2 Hrs
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	NILL					
Course Domain	**:**	Environmental Engineering					

Course Rationale: This course provides an understanding of Environmental, Social, and Governance (ESG) principles and their role in sustainability. It covers regulatory frameworks, sustainable business strategies, ESG investing, and case studies from various industries.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1	Introduce the fundamental concepts of ESG and its role in sustainability.	**1**	Understand the principles and importance of ESG in business strategy.
2	Provide knowledge of global ESG frameworks and regulations.	**2**	Analyze environmental sustainability practices and regulatory compliance.
3	Explainenvironmental sustainability practices and reporting standards.	**3**	Evaluate social impact factors such as diversity, labor rights, and community development.
4	Develop an understanding of social responsibility, diversity, and labor practices.	**4**	Assess corporate governance structures, transparency, and ethical business conduct.
5	Introduce corporate governance structures and ethical business practices.	**5**	Interpret ESG investment strategies and their financial implications.
6	Enable students to analyze ESG investment strategies and industry best practices.	**6**	Apply ESG principles through case studies and industry best practices.

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	2	1	2	2	2	2	3	3	2	2
CO 2	3	3	2	3	2	2	2	2	2	3	3	3	2
CO 3	3	3	2	2	2	2	2	2	2	3	3	3	3
CO 4	3	3	2	2	1	3	2	2	2	3	3	2	3
CO 5	3	3	2	2	2	2	2	2	2	3	2	3	3
CO6	3	3	3	3	2	3	3	3	3	3	3	3	3

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content	**Hours**
Unit I: Introduction to ESG and Business Sustainability Definition of ESG: Environmental, Social, and Governance principles. Importance of ESG in business strategy, societal impact, and long-term value creation. Historical transition from CSR to ESG. Overview of international ESG frameworks (EU Taxonomy, SEC guidelines).Stakeholder engagement and ESG expectations.	6
Unit II: Environmental Pillars of ESG Climate change and carbon footprint: Assessing and reducing environmental impact. Sustainable resource use: Energy, water, raw materials, and waste management.Biodiversity and ecosystem preservation. Environmental reporting tools and standards (CDP, GRI). Regulatory compliance and environmental laws.	7
Unit III: Social Pillars of ESG Human rights and labor practices: Fair wages, working conditions, diversity, and inclusion. Community engagement and social development. Product safety and ethical production. Employee well-being, health, and work-life balance. Importance of DEI (Diversity, Equity, and Inclusion) in corporate practices.	7
Unit IV: Governance Pillars of ESG Corporate governance structures: Board composition, executive pay, and accountability. Ethical business practices, anti-corruption policies, and transparency. Risk management and compliance frameworks. Shareholder rights, activism, and governance reporting.	6
Unit V: ESG Investing Introduction to ESG investing: Sustainable and responsible investment strategies. ESG investment approaches: Impact investing, Socially Responsible Investing (SRI), and ESG integration. ESG rating agencies (MSCI, Sustainalytics) and metrics. Financial vs. ESG performance correlation. Regulatory considerations in ESG investing.	7
Unit VI: Case Studies and Best Practices in ESG and Business Sustainability Case studies on successful ESG implementation (e.g., Patagonia, Unilever). ESG failures and lessons learned (e.g., Volkswagen emissions scandal). Sustainability programs in various industries (tech, manufacturing, etc.). Future trends and emerging technologies in ESG.	7

Suggested Text Books:	
1.	Eccles, R. G., and Krzus, M. P., "The Integrated Reporting Movement: Meaning, Momentum, Motives, and Materiality", Wiley, 2014.
2.	Friede, G., Busch, T., and Bassen, A., "ESG and Financial Performance: Aggregated Evidence from More than 2000 Empirical Studies", Journal of Sustainable Finance & Investment, 2015.
3.	Krosinsky, C., and Robins, N., "Sustainable Investing: Revolutions in Theory and Practice", Routledge, 2012.
Suggested Reference Books:	

1.	GRI Standards, "Global Reporting Initiative (GRI) Sustainability Reporting Standards", 2020.
2.	CFA Institute, "ESG Investing: Principles CFA Institute, "ESG Investing: Principles, Practices, and Impact", 2021., Practices, and Impact", 2021.
3.	United Nations, "Principles for Responsible Investment (PRI)", 2015.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-II**					
Course Title	**:**	**Elective-III Environmental Policies and Legislation**			***Course Code*:**	**:**	ESTE23
Teaching Scheme (Hours)	**:**	Lecture:	03 Hrs/week		***Total Credits***	**:**	03
Evaluation Scheme (Marks)	**:**	ISE =40	ESE = 60	Grand Total=100	***Duration of ESE***	**:**	2 Hrs
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	NILL					
Course Domain	**:**	Environmental Engineering					
Course Rationale: This course provides an in-depth understanding of environmental laws, policies, and regulations. It covers national and international legal frameworks, pollution control legislations, and environmental ethics. The role of institutions, judiciary, and governance in environmental protection is also discussed.							

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1	Introduce historical developments and constitutional provisions for environmental protection.	1	Understand the evolution of environmental laws and policies in India.
2	Explain national policies for conservation, protection, and sustainable development.	2	Analyze national and international policies for environmental conservation.
3	Provide knowledge on pollution prevention, waste management laws, and regulatory frameworks.	3	Interpret pollution control regulations and their implementation.
4	Discussinternational environmental agreements and global policies.	4	Evaluate international environmental conventions and their impact on policy-making.
5	Analyze the role of common law, judicial interventions, and environmental litigation.	5	Examine landmark judicial cases, legal interpretations, and litigation procedures.
6	Explain environmental management strategies, certification procedures, and remediation measures.	6	Implement environmental management frameworks and ISO 14000 certification requirements.

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	2	1	2	1	2	2	3	3	2	2
CO 2	3	3	2	2	1	2	2	2	2	3	3	3	3
CO 3	3	3	2	2	2	2	2	2	2	3	3	3	3
CO 4	3	3	2	2	1	2	2	2	2	3	3	3	2
CO 5	3	3	2	2	1	2	1	3	2	3	3	3	2
CO6	3	3	3	2	2	2	3	2	3	3	3	3	3

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content	**Hours**
Unit I: Introduction to Environmental Laws and Policies Ancient Indian perspectives on environmental protection. Historical development of environmental legislations. Sustainable development pre- and post-independence. Indian Constitution and environmental protection. National environmental policies and institutional frameworks (SPCB/CPCB/MoEF). Overview of environmental agreements and protocols – Montreal Protocol, Kyoto Agreement, Rio Declaration. Environmental provisions in five-year plans. National and international perspectives on environmental policy.	8
Unit II: Environmental Policies and Conservation Strategies Policies for conservation and protection of natural resources – National Water Policy, Sustainable Developmental Policy, National Forest Policy. Conflict between environmental protection and development. Conservation strategies, management of natural resources. Evolution of principles like Precautionary Principle and Polluter Pays Principle. Concept of absolute liability in environmental protection.	7
Unit III: Pollution Prevention and Regulatory Frameworks Role of central and state governments in pollution control. Key legislations – Water Act (1974), Air Act (1981), Environment (Protection) Act (1986). Noise pollution control and related regulations. Waste disposal and management laws – Municipal Solid Waste Management Rules, Hazardous Waste Rules, Biomedical Waste Handling Rules. Responsibilities of waste generators and Pollution Control Boards. Coastal Zone Regulation, Wildlife Protection Act (1972), Forest Conservation Act (1980). Amendments and evaluation of the existing legal framework.	8
Unit IV: International Environmental Law and Governance Transboundary pollution hazards and international conventions shaping environmental laws. Development of international environmental policy from the Stockholm Conference to recent conventions. Role of IPCC, WHO, and other global environmental bodies. Functions and powers of the Ministry of Environment and Forests (MoEF) and Pollution	5

Control Boards at central and state levels.	
Unit V: Common Law and Environmental Protection Legal remedies under common law – IPC, CRPC, CPC. Public Liability Insurance Act. Public Interest Litigation (PIL) in environmental governance. Landmark Supreme Court judgments in environmental cases. Environmental ethics, the role of NGOs in environmental planning, education, and policy advocacy.	6
Unit VI: Judiciary, Environmental Management, and ISO 14000 Constitutional provisions and the role of the judiciary in environmental protection. Executive and legislative powers and their limitations. Interpretation of case laws, statutory provisions, and town planning laws. Environmental management plans, establishment of environmental management cells. Rehabilitation and remediation strategies. ISO 14000 – need, procedures for obtaining certification, and implications of ISO certification.	6

Suggested Text Books:	
1.	Divan, S., and Rosencranz, A., "Environmental Law and Policy in India", Oxford University Press, 2002.
2.	Leelakrishnan, P., "Environmental Law in India", Lexis Nexis, 2019.
3.	Shastri, S. C., "Environmental Law", Eastern Book Company, 2020.
Suggested Reference Books:	
1.	Birnie, P., Boyle, A., and Redgwell, C., "International Law and the Environment", Oxford University Press, 2009.
2.	Sands, P., "Principles of International Environmental Law", Cambridge University Press, 2018.
3.	MoEF&CC, "National Environmental Policy, Government of India", 2006.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-II**					
Course Title	**:**	**Elective- IV (Open Elective) Operation and Maintenance of Environmental Facilities**			***Course Code*:**	**:**	ESTOE41
Teaching Scheme (Hours)	**:**	Lecture :	03 Hrs/week		***Total Credits***	**:**	03
Evaluation Scheme (Marks)	**:**	ISE =40	ESE = 60	Grand Total=100	***Duration of ESE***	**:**	2 Hrs
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	NILL					
Course Domain	**:**	**Open Elective**					

Course Rationale: This course provides an in-depth understanding of the operation and maintenance (O&M) of environmental systems, including water supply, wastewater treatment, air pollution control, and infrastructure management. It covers best practices, safety protocols, and cost-effective strategies for sustainable environmental system management.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1	Introduce the importance of operation and maintenance in environmental engineering.	**1**	Understand the principles and importance of operation and maintenance in environmental systems.
2	Explain water supply system operations, treatment process control, and quality monitoring.	**2**	Analyze the operation and monitoring of water supply and distribution networks.
3	Provide knowledge of water distribution, sewerage system maintenance, and corrosion control.	**3**	Evaluate sewerage system inspection, maintenance, and rehabilitation techniques.
4	Develop an understanding of wastewater treatment plant operation, monitoring, and troubleshooting.	**4**	Optimize wastewater treatment plant performance and address operational challenges.
5	Explain air pollution control facility maintenance and troubleshooting of control devices.	**5**	Manage air pollution control facilities and implement preventive maintenance.
6	Enable students to plan, manage, and estimate costs for environmental system maintenance.	**6**	Develop work planning, scheduling, and cost estimation strategies for O&M activities.

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	2	1	2	2	2	2	3	3	2	1
CO 2	3	3	3	2	2	2	2	2	2	3	3	3	2
CO 3	3	3	3	2	2	2	2	2	2	3	3	3	2
CO 4	3	3	3	2	3	2	2	2	3	3	3	3	3
CO 5	3	3	3	2	3	2	2	2	3	3	3	2	2
CO6	3	3	3	2	2	2	3	2	3	3	3	3	2

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content	**Hours**
Unit I: Introduction Need for Operation and Maintenance (O&M), basic principles, corrective and preventive maintenance, detailed plans, drawings, operation manuals, computer usage in O&M.	6
Unit II: Water Supply System Operation and maintenance of intakes, pumps, transmission pipes, water treatment process control, quantity and quality monitoring of drinking water supply systems.	6
Unit III: Water Distribution and Sewerage System Water distribution system: Loss of carrying capacity, pipe breaks, leakages, and leak detection. Record keeping and O&M of appurtenances. Use of network models in distribution system O&M. Corrosion control in pipelines. Sewerage system: Inspection methods (manual, television), cleaning, rehabilitation, and safety measures in sewerinspection.	7
Unit IV: Wastewater Treatment Plant Operational aspects of wastewater treatment plants. Monitoring and troubleshooting operational problems. Corrective measures for performance enhancement, need for plant upgradation, process reliability, and odor management.	6
Unit V: Air Pollution Control Facilities Inspection and maintenance of air pollution control devices. Maintenance of particulate matter control equipment: Gravity settlers, cyclone separators, bag filters, scrubbers, and electrostatic precipitators. Gaseous pollutant control devices, incinerators, and troubleshooting strategies.	6
Unit VI: Planning and Management Organizational structure for O&M management. Work planning, preparation, and scheduling. Cost estimation, budgeting, and financial management of environmental systems maintenance.	6

Suggested Text Books:	
1.	Manual on Water Supply and Treatment, Central Public Health and Environmental Engineering Organization (CPHEEO), Ministry of Housing and Urban Affairs, Government of India.
2.	Metcalf & Eddy, "Wastewater Engineering: Treatment and Resource Recovery", McGraw-Hill, 2017.
3.	National Research Council, "Operation and Maintenance of Wastewater Collection Systems", Water Environment Federation, 2013.
	Suggested Reference Books
1.	Davis, M. L., "Water and Wastewater Engineering", McGraw-Hill, 2010.
2.	Spellman, F. R., "Handbook of Water and Wastewater Treatment Plant Operations", CRC Press, 2013.
3.	Peavy, H. S., Rowe, D. R., and Tchobanoglous, G., "Environmental Engineering", McGraw-Hill, 2017.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-II**					
Course Title	**:**	**Elective-IV (Open Elective)** **Rural Water Supply and Sanitation**			***Course Code*:**	**:**	ESTOE42
Teaching Scheme (Hours)	**:**	Lecture :	3 Hrs/week		***Total Credits***	**:**	3
Evaluation Scheme (Marks)	**:**	ISE =40	ESE = 60	Grand Total=100	***Duration of ESE***	**:**	2 Hrs
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	NILL					
Course Domain	**:**	**Open Elective**					

Course Rationale: This course provides an understanding of rural water supply and sanitation systems, their design, implementation, and management. It covers drinking water sources, quality assessment, sanitation practices, and public health aspects in rural areas.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1	Introduce the concept of rural water supply and sanitation, along with its significance.	**1**	Analyze the magnitude and scope of rural water supply and sanitation challenges.
2	Provide knowledge on the selection and development of appropriate water sources.	**2**	Assess and design appropriate water supply systems for rural areas.
3	Explain specific problems and appropriate treatment techniques for rural water supply.	**3**	Identify and mitigate specific challenges related to rural water treatment.
4	Develop an understanding of wastewater treatment and disposal techniques for rural areas.	**4**	Implement wastewater treatment and disposal techniques for sustainable rural sanitation.
5	Discuss solid waste disposal methods and their environmental impacts.	**5**	Evaluate solid waste management practices and their impacts on rural health.
6	Enable students to explore sustainable solutions, including biogas plants and sanitation strategies.	**6**	Design and promote biogas plants and other sustainable sanitation solutions.

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	2	1	2	2	2	2	3	3	2	1
CO 2	3	3	3	2	2	2	3	2	2	3	3	2	2

CO 3	3	3	3	2	2	2	2	2	2	3	3	3	2
CO 4	3	3	3	2	2	2	2	2	2	3	3	3	2
CO 5	3	3	3	2	1	2	2	2	2	3	3	2	2
CO6	3	3	3	2	2	2	2	2	3	3	3	3	3

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content	**Hours**
Unit I: Introduction to Rural Water Supply and Sanitation Concept of environment and scope of sanitation in rural areas. Magnitude of rural water supply and sanitation challenges. Population to be covered, difficulties in implementation.National policies on rural water supply and sanitation.	5
Unit II: Planning of Rural Water Supply Systems Design population and demand loads. Various approaches to planning water supply schemes in rural areas. Selection and development of preferred water sources such assprings, wells, infiltration wells, radial wells, and infiltration galleries. Collection of raw water from surface sources.	7
Unit III: Specific Practices and Challenges in Rural Water Supply Common issues in rural water supply, including sustainability, water quality, and operation and maintenance. Rainwater harvesting and groundwater recharge techniques. Low-cost treatment methods and appropriate technologies for water supply and sanitation. Compact treatment systems, such as multi-bottom settlers (MBS), diatomaceous earth filters, cloth filters, slow sand filters, and chlorine diffusion cartridges.Water supply challenges during fairs, festivals, and emergencies.	7
Unit IV: Treatment and Disposal of Wastewater/Sullage Community latrines – types, design, and location. Various methods of collection and disposal of night soil. Simple wastewater treatment units and systems in rural areas, such as stabilization ponds, septic tanks, Imhoff tanks, and soak pits. Disposal of wastewater through soak pits and trenches.	8
Unit V: Solid Waste Management in Rural Areas Disposal of solid wastes through composting, landfilling, and incineration. Impact of solid waste mismanagement on rural health. Issues and challenges in rural sanitation. Sustainable approaches to rural solid waste disposal and management.	7
Unit VI: Biogas Plants and Sustainable Sanitation Concept, objectives, methodology, and construction of biogas plants. Operation and maintenance of biogas plants. Economic analysis, benefits, and shortcomings of biogas technology. Role of biogas plants in sustainable rural sanitation.	7

Suggested Text Books:
Bhatia, R., "Rural Water Supply and Sanitation", World Bank Publications, 2004.
Tchobanoglous, G., "Environmental Engineering and Sanitation", McGraw-Hill, 2014.
WHO, "Guidelines for Drinking Water Quality", World Health Organization, 2017.
Suggested Reference Books:
Ministry of Jal Shakti, "Operational Guidelines for Rural Water and Sanitation", Government of India, 2020.
UNICEF, "Water, Sanitation and Hygiene (WASH) in Rural Areas", 2019.
Cairncross, S., "Environmental Health Engineering in the Tropics", Routledge, 2005.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-II**					
Course Title	**:**	**Elective-IV (Open Elective) Emerging Technologies in Water and Wastewater Treatment**			***Course Code*:**	**:**	ESTOE43
Teaching Scheme (Hours)	**:**	Lecture :	3 Hrs/week		***Total Credits***	**:**	3
Evaluation Scheme (Marks)	**:**	ISE =40	ESE = 60	Grand Total=100	***Duration of ESE***	**:**	2 Hrs
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	Basic knowledge of waste water treatment processes.					
Course Domain	**:**	**Open Elective**					

Course Rationale: This course provides a comprehensive understanding of emerging treatment technologies in water and wastewater management. It covers emerging separation techniques, hybrid treatment processes, decentralized treatment approaches, and applications of automation and nanotechnology in environmental engineering.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1.	Introduce high-rate solid separation techniques and their applications in water and wastewater treatment.	1.	Analyze and apply high-rate solid separation techniques in treatment processes.
2.	Provide knowledge of advanced chemical and biological methods for organic and inorganic matter removal.	2.	Evaluate chemical and biological approaches for removing contaminants from wastewater.
3.	Explain hybrid treatment technologies, including membrane separation and biofilm processes.	3.	Design and assess hybrid wastewater treatment systems.
4.	Develop an understanding of decentralized and sustainable wastewater treatment systems.	4.	Implement treatment applications.
5.	Introduce vermitechnology and its applications in sludge management.	5.	Utilize vermitechnology for wastewater and sludge management.
6.	Enable students to explore automation and nanotechnology applications in environmental treatment.	6.	Apply automation and nanotechnology in water and wastewater treatment.

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	3	**3**	2	**2**	**2**	**2**	**2**	**2**	**3**	3	**2**	**2**
CO 2	3	3	**3**	2	**2**	**2**	**2**	**2**	**2**	**3**	3	**3**	**2**
CO 3	3	3	3	2	2	**2**	**3**	**2**	**2**	**3**	3	**3**	**3**
CO 4	3	3	3	**2**	2	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**
CO 5	3	3	3	**2**	2	**2**	**2**	**2**	**2**	**3**	**3**	**2**	**2**
CO6	3	3	3	2	3	**2**	**2**	**1**	**3**	**3**	3	**2**	**3**

Curriculum Content	**Hours**
Unit I: Solids Separation High-rate clarification, enhanced particle flocculation, analysis of ballasted flocculation and settling, dense-sludge process, swirl and vortex separation, enhanced coagulation. Applications in water and wastewater treatment.	5
Unit II: Organic and Inorganic Matter Removal Chemical oxidation for BOD, COD, ammonia, and non-biodegradable organic compounds.Advanced oxidation processes. Biological removal of phosphorus, heavy metals, toxic and recalcitrant organic compounds. Biological-Chemical Phosphorus and Nitrogen Removal(BCFS) Process. Gas stripping for ammonia and VOC removal, analysis, and design of stripping towers	5
Unit III: Hybrid Treatment Biological treatment with membrane separation, combined aerobic treatment processes, Integrated Fixed-film Activated Sludge (IFAS) Systems, aerobic granular biomass wastewater treatment, submerged attached growth processes, denitrification with attached growth systems, moving bed bioreactor, combination natural and mechanized treatment systems, vertical flow constructed wetlands, aerated constructed wetlands.	10
Unit IV: Decentralized and Sustainable Wastewater Treatment Limitations of conventional centralized wastewater systems, concept of sustainability in wastewater treatment. Decentralized treatment: Concept, significance, applications, and elements of decentralized wastewater treatment, technologies for decentralized wastewater treatment, on-site treatment systems, greywater treatment.	8
Unit V: Vermitechnology Concept of vermitechnology, worm species, and worm action. Applications of vermitechnology: Vermifilter and vegetated vermifilter in biological treatment of wastewater, vermistabilization of sludge, vermicomposting.	6

Unit VI: Introduction to Automation and Nanotechnology Introduction to automatic process control, energy efficiency in wastewater treatment, upgrading wastewater treatment plant performance. Nanotechnology in treatment: Introduction to nanotechnology in water and wastewater treatment, drinking water decontamination using nanotechnology, application of Nano TiO2 catalyst in wastewater treatment, disinfection by nanoparticles.	6

Level of Mapping as: Low 1, Moderate 2, High 3

Suggested Text Books:	
1.	Metcalf & Eddy, "Wastewater Engineering: Treatment and Resource Recovery", McGraw-Hill, 2017.
2.	Lazarova, V., Choo, K. H., and Cornel, P., "Water-Energy Interactions in Water Reuse", IWA Publishing, 2012.
3	Spellman, F. R., "Handbook of Water and Wastewater Treatment Plant Operations", CRC Press, 2013.
Suggested Reference Books:	
1.	Tchobanoglous, G., Burton, F. L., and Stensel, H. D., "Wastewater Engineering: Treatment and Reuse", McGraw-Hill, 2003.
2.	Rittmann, B. E., and McCarty, P. L., "Environmental Biotechnology: Principles and Applications", McGraw-Hill, 2020.
3.	AWWA, "Water Treatment Principles and Design", Wiley, 2012.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-II**					
Course Title	**:**	**Seminar-II**			***Course Code*:**	**:**	ESTC24
Teaching Scheme (Hours)	**:**	Practical :	2 Hrs/week		***Total Credits***	**:**	01
Evaluation Scheme (Marks)	**:**	IOE= 50	EPE/EOE= NIL	Total= 50	***Duration of EPE***	**:**	----
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	Soft Skills					
Course Domain	**:**	Management					

Course Rationale: The course aims to emphasize the value and significance of the seminar in the M.Tech program, showcasing how it contributes to the overall learning experience and the professional growth of the students.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1.	Provide students with in-depth knowledge and understanding of a specific subject or research area within their field of study.	1.	Acquire a comprehensive understanding of the seminar topic, its theoretical foundations, and its practical applications within their field of study.
2.	Enhance students' research skills, including critical analysis, literature review, data collection and analysis, experimental design, and problem-solving.	2.	Develop improved research skills, including the ability to critically analyze existing literature, design experiments or investigations, collect and analyze data, and draw meaningful conclusions.
3.	Help to improve students' ability to present technical information effectively, both orally and in writing, to an academic audience.	3.	Effectively present and communicate their research findings, ideas, and arguments through oral presentations and written reports.
4.	Promote collaboration and networking among students, faculty members, and experts in the field, fostering interdisciplinary discussions and potential research collaborations.	4.	Interact and establish connections with experts, professionals, and fellow researchers in the field, potentially
5.	Explore and discuss the latest trends, advancements, and challenges in the field, providing students with exposure to cutting-edge research and industry practices.	5.	Develop critical thinking skills and the ability to identify and solve complex problems within their area of specialization.
		6.	Gain knowledge on latest developments, trends, and challenges within their field, enabling them to contribute to the advancement of knowledge and industry practices.

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	2	2	1	1	2	2	2			
CO 2	3	3	3	3	2	1	1	2	3	2			
CO 3	2	2	2	2	1	2	1	3	2	2			
CO 4	2	2	2	2	1	3	2	2	2	2			
CO 5	3	3	3	2	2	2	1	2	3	2			
CO6	3	3	2	2	2	2	1	2	3	2			

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content
Seminar-II shall be delivered preferably on the topic of dissertation or at least the area of dissertation. The concepts must be clearly understood and presented by the student. All modern methods of presentation should be used by the student. Preparation and presentation of a seminar is intended to investigate an in-depth review of literature, prepare a critical review, and develop confidence to present the material by the student. The seminar-II shall be evaluated by a Department Committee constituted for this purpose, based on a report submitted by the candidate and a viva-voce conducted at the end of the semester. A hard copy of the report (25 to 30 pages A4 size, 12 fonts, Times New Roman, single spacing both side printed, well formatted preferably in IEEE format) should be submitted to the Department before delivering the seminar. A PDF copy of the report in soft form must be submitted to the guide along with other details if any.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-II**					
Course Title	**:**	**Wastewater Characterization Lab**			***Course Code*:**	**:**	ESTC25
Teaching Scheme (Hours)	**:**	Practical :	2 Hrs/week		***Total Credits***	**:**	1
Evaluation Scheme (Marks)	**:**	IOE=50	EOE=Nil	Total=50	***Duration of EPE***	**:**	----
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	Basic Knowledge of Wastewater management Subject					
Course Domain	**:**	Core					

Course Rationale: This laboratory course provides hands-on experience in analyzing wastewater characteristics and evaluating its impact on the environment. It enables students to understand key physicochemical and biological parameters essential for wastewater treatment and environmental monitoring.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1.	Train students in sampling and analysis of wastewater.	**1**	Perform wastewater sampling and preservation techniques.
2.	Introduce standard laboratory techniques for wastewater characterization.	**2**	Analyze physicochemical characteristics of wastewater.
3.	Familiarize students with important water quality parameters.	**3**	Determine biological parameters affecting wastewater treatment.
4.	Develop skills in interpreting wastewater analysis results for treatment processes.	**4**	Assess the efficiency of primary, secondary, and tertiary treatment processes.
5	Encourage students to use open-access analytical methods where applicable.	**5**	Interpret experimental results for real-world wastewater treatment applications.
6.	Equip students with knowledge of wastewater treatment standards and regulatory compliance.	**6**	Understand regulatory standards for wastewater discharge.

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	2	2	1		2	2	2	3	2	2
CO 2	3	3	3	2	2	2	1	2	2	2	3	3	2
CO 3	3	2	2	2	2	2	1	2	2	2	3	3	3
CO 4	3	3	3	2	3	1	2	2	2	2	3	3	3
CO 5	3	3	3	2	2	2	2	2	3	3	3	3	3
CO6	3	3	3	3	3	3	3	2	3	3	3	3	

Level of Mapping as: Low 1, Moderate 2, High 3

List of Experiments	
Sr. No.	
1.	**Determination of pH, temperature, and electrical conductivity of wastewater.**
2.	**Estimation of total solids, suspended solids, and dissolved solids.**
3.	**Measurement of biochemical oxygen demand (BOD).**
4.	**Determination of chemical oxygen demand (COD).**
5.	**Analysis of dissolved oxygen (DO) in wastewater samples.**
6.	**Estimation of chlorides and sulfates in wastewater.**
7.	**Measurement of nitrogen species (ammonia, nitrates, nitrites).**
8.	**Determination of phosphorus content in wastewater.**
9.	**Heavy metal analysis using spectrophotometry.**
10.	**Microbial examination of wastewater (coliform count).**
General Instructions: List of Submission: Minimum 6 experiments	
Suggested Text Books/ Reference Books/Manual	
1.	Open-access GIS tutorials from QGIS Documentation (https://docs.qgis.org/).
2.	Google Earth Engine Developers Guide (https://developers.google.com/earth-engine/).
3.	Remote Sensing Applications in Environmental Science, Open Source Edition.
4.	Free online courses from NASA Earth Data and ESA Copernicus.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part I, Sem-II**					
Course Title	**:**	**Specific Treatment Lab**			***Course Code*:**	**:**	ESTC26
Teaching Scheme (Hours)	**:**	Practical :	02 Hrs/week		***Total Credits***	**:**	01
Evaluation Scheme (Marks)	**:**	IOE=50	EOE= Nil	Total=50	***Duration of EPE***	**:**	----
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	Basic knowledge of subject Wastewater Engineering.					
Course Domain	**:**	Core					

Course Rationale: This laboratory course provides hands-on experience in analyzing wastewater characteristics and evaluating its impact on the environment. It enables students to understand key physicochemical and biological parameters essential for wastewater treatment and environmental monitoring.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1.	Train students in sampling and analysis of wastewater.	**1.**	Perform wastewater sampling and preservation techniques.
2.	Introduce standard laboratory techniques for wastewater characterization.	**2.**	Analyze physicochemical characteristics of wastewater.
3.	Familiarize students with important water quality parameters.	**3.**	Determine biological parameters affecting wastewater treatment.
4.	Develop skills in interpreting wastewater analysis results for treatment processes.	**4.**	Assess the efficiency of primary, secondary, and tertiary treatment processes.
5.	Encourage students to use open-access analytical methods where applicable.	**5.**	Interpret experimental results for real-world wastewater treatment applications.
6.	Equip students with knowledge of wastewater treatment standards and regulatory compliance.	**6.**	Understand regulatory standards for wastewater discharge.

Course Outcome and Program Outcome Mapping

PO→ CO ↓	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO1	3	2	3	2	2	2	1	2	2	2	3	2	1
CO2	3	3	3	3	3	1	1	2	2	2	3	2	3
CO3	3	3	3	3	2	1	1	2	2	2	3	3	3
CO4	3	3	3	3	2	2	2	2	2	2	3	3	2
CO5	3	3	3	3	2	2	2	2	2	2	3	3	2
CO6	3	2	2	2	1	1	2	2	2	3	2	2	1

(1-low, 2-medium, 3-high, 0-No correlation)

List of Experiments	
Sr. No.	
1.	**Determination of pH, temperature, and electrical conductivity of wastewater.**
2.	**Estimation of total solids, suspended solids, and dissolved solids.**
3.	**Measurement of biochemical oxygen demand (BOD).**
4.	**Determination of chemical oxygen demand (COD).**
5.	**Analysis of dissolved oxygen (DO) in wastewater samples.**
6.	**Estimation of chlorides and sulfates in wastewater.**
7.	**Measurement of nitrogen species (ammonia, nitrates, nitrites).**
8.	**Determination of phosphorus content in wastewater.**
9.	**Heavy metal analysis using spectrophotometry.**
10.	**Microbial examination of wastewater (coliform count).**
Suggested Text Books/ Reference Books/Manual	
1.	Open-access GIS tutorials from QGIS Documentation (https://docs.qgis.org/).
2.	Google Earth Engine Developers Guide (https://developers.google.com/earth-engine/).
3.	Remote Sensing Applications in Environmental Science, Open Source Edition.
4.	Free online courses from NASA Earth Data and ESA Copernicus.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part II, Sem-III**

Course Title	**:**	**Industrial Training**			***Course Code*:**	**:**	ESTC31
Teaching Scheme (Hours)	**:**	Practical :	2 Hrs/week		***Total Credits***	**:**	5
Evaluation Scheme (Marks)	**:**	IOE= 50	EOE= 50	Total= 100	***Duration of EPE***	**:**	----
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	Technical Knowledge and Skills, Communication and Interpersonal Skills					
Course Domain	**:**	Core					

Course Rationale: By including industrial training in the curriculum, students can gain practical experience, industry exposure, and relevant skills that prepare them for successful careers in their chosen field. Industrial training enhances their employability, facilitates networking, and cultivates the necessary attributes for professional growth and development.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1.	Provide students with an opportunity to apply the theoretical knowledge gained during their coursework to a real-world software development project	1.	Apply the theoretical concepts and skills learned during their training to develop a software project
2.	Offer students hands-on experience in various aspects of software development, including requirements gathering, system design, coding, testing, and documentation.	2.	Gain hands-on experience in various aspects of software development
3.	Develop students' collaborative and professional skills	3.	Learn to collaborate effectively with team members, communicate their ideas, and participate in project discussions
4.	Enhance students' problem-solving abilities by exposing them to complex real-world problems	4.	Analyze complex problems, break them down into manageable tasks, and develop innovative solutions
5	Develop students' project management skills by engaging in a software development project	5.	Practice project management skills, including task planning, time management, and resource allocation
6.	Enhance students' technical writing and presentation skills	6.	Submit a comprehensive report of their development work

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3

CO 1	3	3	3	2	3	2	2	2	2	2			2
CO 2	3	3	3	2	3	2	2	2	2	2			3
CO 3	2	2	3	1	2	3	2	3	2	2			3
CO 4	3	3	3	2	2	2	2	2	3	2			3
CO 5	2	2	2	1	2	2	3	2	2	2			3
CO6	2	2	2	1	2	2	2	3	2	2			3

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content

The student shall undertake software development project at any of the industry/research organization/software company under the guidance of internal guide and a suitable Co-guide from that industry/research organization/software company for duration of eight weeks at the end of first year (during summer). The report of the development work is to be submitted to the University in the first week of semester III.

(Student is expected to submit Industrial Training report in Latex/Microsoft word in the standard format style file available in the department)

Industrial Training of Eight weeks at the end of First Year

OR

Industrial training will be split in two slots of four weeks during semester III

Evaluation at end of III semester on the basis given report and Presentation to concern Guide.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part II, Sem-III**					
Course Title	**:**	**Dissertation Phase-I**			***Course Code*:**	**:**	ESTC32
Teaching Scheme (Hours)	**:**	Practical :	2 Hrs/week		***Total Credits***	**:**	15
Evaluation Scheme (Marks)	**:**	IOE= 100	EOE= 100	Total= 200	***Duration of EPE***	**:**	----
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	Research Skills and Methodology, Domain-Specific Knowledge					
Course Domain	**:**	Core					

Course Rationale: This course develop essential research skills, demonstrate their ability to formulate research questions and proposals, and gain a comprehensive understanding of the research process. The rationale behind this course is to prepare students for the subsequent stages of their dissertation, ensuring they have the necessary knowledge, skills, and tools to undertake rigorous and meaningful research.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1.	Develop students' research competence by providing them with the opportunity to engage in independent research.	1.	Develop research skills through conducting a literature survey, critically analyzing existing literature, identifying research gaps, and proposing a dissertation topic.
2.	Enable students to prepare and deliver effective research proposals.	2.	Gain proficiency in preparing and delivering a presentation to propose a dissertation title.
3.	Equip students with project planning and execution skills.	3.	Demonstrate the ability to plan and execute a research project by preparing a synopsis, outlining research objectives, methodology, and expected outcomes
4.	Foster students' ability to monitor and report their research progress effectively.	4.	Develop skills in monitoring and documenting their research progress by submitting monthly progress reports
5	Enhance students' research presentation and communication skills.	5.	Develop effective presentation and communication skills by delivering an end-of-semester presentation summarizing the progress of their dissertation work
6.	Assess students' research work and their ability to defend their findings.	6.	Gain valuable research experience, contribute to their chosen field of study, and develop essential skills for future academic and professional

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	2	1	1	2	2	2	2			3
CO 2	2	2	2	1	1	1	3	3	2	2			3
CO 3	3	3	3	2	1	3	2	2	3	2			3
CO 4	2	2	2	2	1	2	2	2	2	2			3
CO 5	2	2	2	1	1	1	3	3	2	2			3
CO6	3	3	3	2	2	2	2	2	3	2			3

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content

The dissertation title should be identified on the basis of the literature survey and a presentation be delivered. The synopsis of the dissertation be prepared and submitted to the University for its Approval.

The student shall carry work related to the dissertation with the consent of the guide. This work shall include related hardware/software assignments, field work (if required) as decided by the guide.

The student shall be allowed to submit the dissertation phase I report only after the completion of minimum 50% work of the total project with intermediate /partial results of the dissertation project to the concern guide. The student shall deliver a presentation at the end of Semester III submitting the progress of the work done. The work is to be jointly assessed for oral examinations by internal (guide) and external examiners appointed by the University.

(Student is expected to submit dissertation report in Latex/Microsoft word in the standard format style file available in the department)

Students are expected to do self-study for two hours as per the guidance given by the Project Guide and report to the department once in a week. Hence contact hours to be taken as two for the calculation of contact hours.

Class, Part & Semester	**:**	**First Year M. Tech (Environmental Science and Technology), Part II, Sem-IV**					
Course Title	**:**	**Dissertation Phase-II**			***Course Code*:**	**:**	ESTC41
Teaching Scheme (Hours)	**:**	Practical :	4 Hrs/week		***Total Credits***	**:**	20
Evaluation Scheme (Marks)	**:**	IOE= 100	EOE= 200	Total= 300	***Duration of EPE***	**:**	----
Revision:	**:**	Fourth			***Month***	**:**	July 2025
Pre-requisites *(if any)*	**:**	Research Skills and Methodology, Domain-Specific Knowledge Research Ethics, Research Methods or Analysis					
Course Domain	**:**	Core					

Course Rationale: The course rationale is to provide students with a comprehensive learning experience that combines theoretical knowledge with practical application, enabling them to become proficient researchers capable of conducting rigorous research, producing high-quality academic writing, delivering effective presentations, and publishing their work in reputable outlets.

Course Objectives: The Course teacher will		***Course Outcomes:*** Students will be able to	
1.	Enable students to acquire the necessary skills and knowledge to conduct high-quality research in their chosen field of study.	1.	Develop research skills by conducting a comprehensive study, collecting relevant data, and analyzing findings to contribute to the field of study.
2.	Foster the ability to produce well-structured and coherent written reports, including monthly progress reports.	2.	Enhance presentation skills by delivering a comprehensive presentation of the dissertation work at the end of Semester IV
3.	Help to develop effective oral communication and presentation skills.	3.	Gain experience in publishing research work by submitting a paper on the thesis work to either National or International Conference proceedings
4.	Encourage students to contribute to the academic community by publishing their thesis work in conference proceedings.	4.	Develop proficiency in using LaTeX or Microsoft Word to create dissertation reports in the standard format style file provided by the department.
5	Help to develop proficiency in using LaTeX or Microsoft Word for the creation of seminar reports	5.	Cultivate effective time management skills by submitting monthly progress reports
6.	Help to cultivate effective time management skills by submitting monthly progress reports	6.	Acquire proficiency in technical writing by preparing monthly progress reports,

Course Outcome and Program Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	2	2	2	2	3	3			3
CO 2	2	2	2	2	1	2	1	3	2	2			3
CO 3	3	3	2	3	2	2	1	3	3	2			3
CO 4	2	2	2	2	3	1	1	2	2	2			3
CO 5	2	2	2	2	1	1	3	2	3	2			3
CO6	2	2	2	2	2	1	2	3	3	2			3

Level of Mapping as: Low 1, Moderate 2, High 3

Curriculum Content

The student shall submit monthly progress report to the department and shall deliver a presentation of the work at the end of Semester IV submitting the report on the dissertation work.

A publication of a paper on the thesis work in a National/International Conference proceedings with presentation certificate **OR** a paper on the thesis work be communicated to a National/International Journal & accepted for publication for the submission of thesis at the end of IVth semester is mandatory.

The student shall be allowed to submit the dissertation phase II report only after the full-fledge demonstration of his /her work to the concerned guide. A pair of referees, as appointed by the University, one of which will be the guide and the other – external examiner will access the dissertation work during the oral examination.

(Student is expected to submit dissertation phase- II report in Latex/Microsoft word in the standard format style file available in the department)

Students are expected to do self-study for four hours as per the guidance given by the Project Guide and report to the department once in a week. Hence contact hours to be taken as four for the calculation of contact hours.

Equivalence of M. Tech (Environmental Science and Technology)

The above detailed syllabus is a revised version of the M. Tech (Environment Science and Technology) course being conducted by the Shivaji University at the Technology Department of the University. This syllabus is to be implemented from June 2025-26.

The Equivalence for the subjects of Environmental Science and Technology at M. Tech Semester I and II pre-revised course under the faculty of Engineering and Technology is as follows.

M. Tech (Environmental Science and Technology) Part-I Semester I

Sr. No	M. Tech (Environmental Science and Technology) Semester I Pre-revised syllabus	M. Tech (Environmental Science and Technology) Semester I Revised syllabus	Remark
1.	Research Methodology (Audit)	Research Methodology	Two Credits assigned
2.	Physico-chemical and Biological Treatment processes	---	Subject Removed
3.	---	Unit Operations and processes in water and waste water treatment.	New subject Introduced
4.	Remote sensing and GIS Application in Environmental Engineering	Remote sensing and GIS Application in Environmental Engineering	No Change
5.	Solid and Hazardous waste Management.	---	Subject Removed
6.	---	Air Pollution and Control.	New Subject Introduced.
7.	Elective-I Environmental Chemistry and microbiology.	Elective-I Environmental Chemistry and microbiology.	No Change
8.	Elective-I Environmental Toxicology	---	Subject Removed
9.	Elective-I Environmental Toxicology	---	Subject Removed
10.	---	Elective-I Sustainable Engineering Concepts and Life Cycle Analysis	New subject introduced
11.	---	Elective-I Municipal Solid Waste Management	No Subject Introduced
12.	Elective-II (Open Elective) Optimization Techniques	---	Subject Removed

13.	Elective-II (Open Elective) Design of Energy Efficient Building	Elective-II (Open Elective) Energy Efficient Building	Name Changed. Content modified
14.	Elective-II (Open Elective) Operational Health and Safety Management.	Elective-II (Open Elective) Operational Health and Safety Management.	No Change
15.	---	Elective-II (Open Elective) Environmental Biotechnology	New Subject Introduced
16.	Solid and Hazardous waste Management Lab	Solid and Hazardous waste Management Lab	Lab Removed
17.	Water Quality Analysis Lab	Water Quality Analysis Lab	No Change
18.	Remote sensing and GIS Application in Environmental Engineering Lab	Remote sensing and GIS Application in Environmental Engineering Lab	No Change
19.	Seminar-I	Seminar-I	No Change

M. Tech (Environmental Science and Technology)-I Semester II

Sr. No	M. Tech (Environmental Science and Technology) Semester II Pre-revised syllabus	M. Tech (Environmental Science and Technology) Semester II Revised syllabus	Remark
1.	----	Intellectual Property Rights	New subject introduced
2.	Air Pollution and Control	---	Subject Removed
3.	---	Industrial Waste Treatment	New Subject Introduced
4.	Environment Management Systems	Environment Management Systems	No Change
5.	Advanced water and waste water treatment.	Advanced water and waste water treatment	No Change
6.	Elective-III Industrial Waste Treatment	---	Subject Removed
7.	Elective-III Environmental Sanitation	---	Subject Removed
8.	Elective-III Environmental Policies and Legislation	Elective-III Environmental Policies and Legislation	No Change
9.	---	Elective-III Environmental Modeling and	New Subject Introduced

		Simulation	
10.	---	Elective-III Environmental Social and Governance	New Subject Introduced
11.	Air pollution and control Lab	---	Lab Removed
12.	Wastewater Characterization Lab	Wastewater Characterization Lab	No Change
13.	Specific Treatment Lab	Specific Treatment Lab	No Change
14.	Elective- IV Operation and Maintenance of Environmental facilities	Elective- IV Operation and Maintenance of Environmental facilities	No Change
15.	Elective- IV Rural Water Supply and Sanitation.	Elective- IV Rural Water Supply and Sanitation.	No Change
16.	Elective- IV Environmental Biotechnology	Elective- IV Environmental Biotechnology	No Change
17.	Seminar-II	Seminar-II	No Change

M. Tech (Environment Science and Technology) Part-II Semester III

Sr. No	**M. Tech (Environment Science and Technology) Semester III Pre-revised syllabus**	**M. Tech (Environment Science and Technology) Semester III Revised syllabus**	**Remark**
1	Industrial Training	Industrial Training	No Change
2	Dissertation Phase-I	Dissertation Phase-I	No Change

M. Tech (Environment Science and Technology) Part-II Semester IV

Sr. No	**M. Tech (Environment Science and Technology) Semester IV Pre-revised syllabus**	**M. Tech (Environment Science and Technology) Semester IV Revised syllabus**	**Remark**
1	Dissertation Phase – II	Dissertation Phase-II	No Change

VISION:

To be a centre of academic excellence and research in the field of Computer Science and Technology by imparting knowledge to students and facilitating research activities that cater the needs of industries and society.

MISSION:

1. To provide a learning environment that help students to enhance problem solving skills, be successful in their professional career and to prepare students to be lifelong learners by offering theoretical foundation in Computer Science and Technology.
2. To prepare students in developing research, design, entrepreneur skills and employability capabilities.
3. To establish Industry Institute Interaction to make students ready for industrial environment.
4. To educate students about their professional and ethical responsibilities.

Program Educational Objectives (PEOs):	
PEO1	**Advanced Knowledge and Research Competence** Graduates will acquire in-depth knowledge of environmental science and technology, equipping them to pursue advanced research, innovative solutions, and sustainable technologies for addressing complex environmental challenges.
PEO2	**Professional Excellence and Leadership** Graduates will establish themselves as competent professionals, consultants, or leaders in academia, industry, government, or research organizations by applying technical expertise, analytical skills, and ethical practices in environmental management and technology development.
PEO3	**Sustainable Solutions and Societal Contribution** Graduates will contribute to sustainable development by designing and implementing eco-friendly, energy-efficient, and resource-conserving technologies that safeguard human health, natural ecosystems, and environmental quality.
PEO4	**Lifelong Learning and Global Engagement** Graduates will engage in lifelong learning, professional development, and global collaborations to adapt to emerging technologies, environmental policies, and evolving societal needs.
Program Outcomes (POs)	
PO1	**Scholarship of Knowledge:** The ability to acquire and synthesize in-depth, specialized knowledge, including a global perspective, to enhance one's understanding of the discipline.

PO2	**Critical Thinking:** The ability to critically analyse complex engineering problems and apply independent judgment to make intellectual and creative advances in a broader theoretical, practical, and policy context.
PO3	**Problem Solving:** The ability to think laterally and originally to solve engineering problems. This involves evaluating a wide range of solutions, while considering public health and safety, societal, and environmental factors.
PO4	**Research Skill:** The ability to use literature surveys and experiments to extract information, apply appropriate methodologies and tools, and analyze data to contribute to scientific and technological knowledge.
PO5	**Usage of Modern Tools:** The ability to select and apply modern engineering and IT tools, including modelling and prediction, with an understanding of their limitations.
PO6	**Collaborative and Multidisciplinary Work:** A knowledge of group dynamics and the capacity for self-management, teamwork, and decision-making to contribute positively to multidisciplinary research and achieve common goals.
PO7	**Project Management and Finance:** The ability to apply engineering and management principles to manage projects efficiently in a multidisciplinary environment, considering financial and economic factors.
PO8	**Communication:** The ability to communicate complex engineering activities confidently and effectively with both the engineering community and society. This includes writing reports, giving presentations, and giving clear instructions.
PO9	**Life-long Learning:** A recognition of the need for, and the ability to engage in, independent and continuous life-long learning to improve competence.
PO10	**Ethical Practices and Social Responsibility:** Professional and intellectual integrity, a commitment to a code of conduct and ethics of research, and an understanding of the impact of research outcomes on the community and sustainable development.
PSO1	**Environmental Analysis and Assessment** Graduates will be able to analyze, monitor, and interpret environmental quality using advanced scientific tools, modeling techniques, and laboratory/field investigations for effective decision-making.
PSO2	**Sustainable Technology and Resource Management** Graduates will design, develop, and implement sustainable technologies for water, wastewater, solid waste, air quality, and renewable energy management with a focus on resource efficiency and circular economy principles.
PSO3	**Policy, Research, and Innovation** Graduates will integrate scientific knowledge with environmental policies, conduct impactful research, and develop innovative solutions for addressing global and local environmental challenges.