Kolhapur Institute of Technology's College of Engineering Kolhapur (Empowered Autonomous)

KOLHAPUR INSTITUTE OF TECHNOLOGY'S
COLLEGE OF ENGINEERING KOLHAPUR
(EMPOWERED AUTONOMOUS)

Department of Civil and Environmental Engineering

Curriculum and Syllabus for

M. Tech in Environmental Engineering
(As Per NEP, 2020)

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Kolhapur Institute of Technology's
College of Engineering (Autonomous), Kolhapur
GROUP – A: M. Tech Program in Environmental Engineering

Program Outcomes (POs)

The Graduates will be able to:

Element of the Descriptor	PO Statement
Knowledge and understanding	**PO1:** demonstrate the advanced knowledge and understanding of the research principles, methods, and techniques applicable to the field of Environmental Engineering or professional practice.
General, technical and professional skills required to perform and accomplish tasks	**PO2:** illustrate advanced cognitive and technical skills required for performing and accomplishing complex tasks related to the field of Environmental Engineering.
Application of knowledge and skills	**PO3:** apply advanced knowledge relating to research methods to carry out research and investigations to formulate evidence-based solutions to complex and unpredictable problems in the field of Environmental Engineering.
Generic learning outcomes	**PO4:** communicate, in a well-structured manner, technical information and explanations, and the findings of the research studies undertaken in the field of Environmental Engineering.
Constitutional, humanistic, ethical and moral values	**PO5:** embrace and practice constitutional, humanistic, ethical, and moral values in the field of Environmental Engineering and professional practice to address environmental protection and sustainable development issues.
Employability and job-ready skills, and entrepreneurship skills and capabilities/qualities and mindset	**PO6:** develop the knowledge and skills required for managing technology-assisted work involving technological developments, innovations and entrepreneurship.

Kolhapur Institute of Technology's
College of Engineering (Autonomous), Kolhapur
Teaching and Evaluation scheme for
GROUP – A: M. Tech Program in Environmental Engineering
Semester - I

Sr No.	Category	Course Code	Course	Teaching Scheme				Evaluation Scheme			
								Component	Marks		
				L	T	P	Credits		Max. Marks	Min. for Passing	
1	Program Core (PC)	MENPC0101	Air Pollution and Control	3	-	-	3	ISE1	10		40
								MSE	30		
								ISE2	10		
								ESE	50	20	
2	Program Core (PC)	MENPC0102	Physico-Chemical Processes for Water & Wastewater	3	1	-	4	ISE1	10		40
								MSE	30		
								ISE2	10		
								ESE	50	20	
3	Program Core (PC)	MENPC0103	Solid &Hazardous Waste Management	3	-	-	3	ISE1	10		40
								MSE	30		
								ISE2	10		
								ESE	50	20	
4	Programme Elective (PEC)	MENPE1***	Program Elective (PE-I)	3	-	-	3	ISE1	10		40
								MSE	30		
								ISE2	10		
								ESE	50	20	
5	Audit Course (AU)	MENAU0181	Applied Environmental Chemistry and Microbiology (AU-I)	2	-	-	0	ISE	100	40	40
6	Program Core (PC)	MENPC0131	Environmental Monitoring Lab. I	-	-	2	1	ISE	50	20	
7	Program Core (PC)	MENPC0132	Treatability Studies Lab. I	-	-	4	2	ISE	50	20	
8	Research Methodology	MENIL0171	Research Methodology	3	1	-	4	ESE	100	40	
Total:				**17**	**2**	**6**	**20**	**Total Marks: 700** **Total Credit: 20** **Total Contact Hours/Week: 25**			

List of Program Electives

Course Code	Program Elective – I
MENPE0111	Industrial Health and Safety (PE-I)
MENPE0112	Environmental Social Governance (PE-I)
MENPE0113	Operation and Maintenance of treatment Plants (PE-I)
MENPE0114	Green Buildings (PE-I)

Kolhapur Institute of Technology's
College of Engineering (Autonomous), Kolhapur
Teaching and Evaluation scheme for
GROUP – A: M. Tech Program in Environmental Engineering
Semester- II

Sr. No.	Category	Course Code	Course	Teaching Scheme				Evaluation Scheme			
								Component	Marks		
				L	T	P	Credits		Max. Marks	Min. for Passing	
1	Program Core (PC)	MENPC0201	Industrial Waste Treatment	3	1	-	4	ISE1	10		40
								MSE	30		
								ISE2	10		
								ESE	50	20	
2	Program Core (PC)	MENPC0202	Biological Wastewater Treatment	3	1	-	4	ISE1	10		40
								MSE	30		
								ISE2	10		
								ESE	50	20	
3	Program Core (PC)	MENPC0203	Environmental Impact Assessment & Legislation	3	1	-	4	ISE1	10		40
								MSE	30		
								ISE2	10		
								ESE	50	20	
4	Programme Elective (PEC)	MENPE12**	Program Elective (PE-II)	3	-	-	3	ISE1	10		40
								MSE	30		
								ISE2	10		
								ESE	50	20	
5	Audit Course (AU)	MENAU0281	Statistical Methods and Optimization (AU-II)	2	-	-	0	ISE	100	40	40
6	Program Core (PC)	MENPC0231	Environmental Monitoring Lab. II	-	-	2	1	ISE	50	20	20
7	Program Core (PC)	MENPC0232	Treatability Studies Lab. II	-	-	4	2	ISE	50	20	20
8	Project (PP)	MENIL0271	Mini Project	-	-	4	2	ISE	100	40	
			Total:	**14**	**3**	**10**	**20**	**Total Marks: 700** **Total Credit: 20** **Total Contact Hours/Week: 27**			

List of Program Electives

Course Code	Program Elective–II
MENPE0211	Environmental Modelling and Simulation (PE-II)
MENPE0212	Environmental Management System (PE-II)
MENPE0213	Environmental Geotechnology (PE-II)
MENPE0214	Watershed Management (PE-II)

Kolhapur Institute of Technology's
College of Engineering (Autonomous), Kolhapur
Teaching and Evaluation scheme for
GROUP – A: M. Tech Program in Environmental Engineering
Semester- III

Sr. No.	Category	Course Code	Course	Teaching Scheme				Evaluation Scheme		
								Component	Marks	
				L	T	P	Credits		Max. Marks	Min. for Passing
1	Internship/ On Job Training (OJT)	MENIL0371	Internship	-	-	20	10	ISE	100	40
2	Project (PP)	MENIL0372	Dissertation Phase I	-	-	20	10	ISE - I	25	10
				-	-			ISE – II	25	10
				-	-			ESE (OE)	100	40
Total:				-	-	**40**	**20**	**Total Marks: 250** **Total Credit: 20** **Total Contact Hours/Week: 40 hrs.**		

Kolhapur Institute of Technology's
College of Engineering (Autonomous), Kolhapur
Teaching and Evaluation scheme for
GROUP – A: M. Tech Program in Environmental Engineering
Semester- IV

Sr. No.	Category	Course Code	Course	Teaching Scheme				Evaluation Scheme		
								Component	Marks	
				L	T	P	Credits		Max. Marks	Min. for Passing
1	Project (PP)	MENIL0471	Dissertation Phase II	-	-	40	20	ISE – I	50	20
				-	-			ISE – II	50	20
				-	-			ESE (OE)	150	60
Total:				**-**	**-**	**40**	**20**	**Total Marks: 250** **Total Credit: 20** **Total Contact Hours/Week: 40 hrs.**		

Kolhapur Institute of Technology's
College of Engineering (Autonomous), Kolhapur
Teaching and Evaluation scheme for
GROUP – B: M. Tech Program in Environmental Engineering

Exit Courses after Semester – II

Sr. No.	Category	Course Code	Course	Teaching Scheme				Evaluation Scheme		
								Component	Marks	
				L	T	P	Credits		Max. Marks	Min. for Passing
1	Exit Course (EX)	MENEX0291	Exit Course – I Geospatial Technology	3	1	-	4	ISE	100	40
2	Exit Course (EX)	MENEX0292	Exit Course – II (Internship/ Training)	-	-	8	4	ISE	100	40
Total:				**3**	**1**	**8**	**8**	**Total Marks: 200** **Total Credit: 8** **Total Contact Hours/Week: 12 hrs.**		

Notes:

1. Workload for the course "**Mini Project**" shall be considered as 01 hour/ student/ week.
2. Workload for the course "**Internship**" shall be considered as 01 hour/ student/ week.
3. Workload for the courses "**Dissertation Phase – I**" and "**Dissertation Phase – II**" shall be considered as 05 hours/ student/ week.
4. PG Student is required to publish at least one research paper in a SCI/ SCIE/ SCOPUS/ Web of Science/ UGC CARE/ Peer-Reviewed Journal before Thesis Submission.

Class: F. Y. M. Tech. Environmental Engineering **Title of the Course:** Air Pollution and Control **Course Code:** MENPC0101	**L**	**T**	**P**	**Credit**
	3	**-**	**-**	**3**

Course Pre-Requisite: Students shall have the knowledge of

- Engineering mathematics
- Engineering Physics
- Environmental chemistry
- Fluid Mechanics

Course Description: As a comprehensive course, it introduces the sources of air pollution, physical and chemical behaviour of pollutants, the effects of air pollutants on human beings and the environment and dispersion in the atmosphere. Also, it covers legislation and regulation; control technologies and future trends toward preventing air pollution.

Course Objectives:

1. To interpret meteorological data for atmospheric stability, transportation and dispersion of air pollutants
2. To get an insight into the some of the most widely used commercial and freely available air quality dispersion models
3. To study the working principles and design of various control equipment various air pollutants
4. To understand the current air pollution control measures and policies at national and international levels

Course Learning Outcomes:

COs	**After the completion of the course the students will be able to**	Bloom's Cognitive level Descriptor
CO1	Apply knowledge of air pollution issues for research and development activities.	Cognitive (Applying) L3
CO2	Select appropriate measures for solution of problems associated with the design and operation of air pollution control equipments	Cognitive (Applying) L3
CO3	Analyze various policies and measures for control of air pollution	Cognitive (Analyzing) L-4
CO4	Recommend suitable measures for problems related to dispersion and control of air pollutants	Cognitive (Evaluating) L5

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO.1	2	2	2	1	1	1
CO.2	2	3	3	3	3	3

CO.3	2	1	1	2	3	2
CO.4	2	3	3	3	3	3

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	**Marks**
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three Units)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three Units) covered after MSE.

Course Contents:

Unit 1:---Introduction to Air pollution Scales of air pollution and current scenario at national and global level, Sources of air pollution, Classification of air pollutants, , criteria air pollutants and their effects, Ambient air quality standards, Measurement units	**6Hrs.**
Unit 2:---Meteorology and Air Pollution Structure and composition of atmosphere, Meteorological parameters, Wind circulation patterns , scale of motion, Wind rose diagram, Lapse rates, Stability of atmosphere, Inversion and its types, Plume behavior, Maximum Mixing Depth, Cyclones and anticyclones, Precipitation, types of humidity & its impact on air pollutants	**7 Hrs.**
Unit 3:---Dispersion of Air Pollutants Air quality dispersion models, Gaussian dispersion model for point sources and line sources, applications and limitations of Gaussian model, plume rise- causes and significance, Formulas for estimation of Plume Rise, Plume down wash, Stability classes, Box model , Street canyon model, Introduction to soft ware based models - CALINE, RAMS, AERMOD etc.	**10 Hrs.**
Unit 4:--- Air Quality management Control of air pollution from stationary and mobile sources, measures for effective control of air pollution in India, , Alternative fuels, Air quality index, National Air quality Monitoring Program, Legislative measures, International treaties for control and mitigation of air pollution, Continuous online monitoring for Ambient air and Stack emissions.	**6 Hrs**.

Unit 5:--- Control of Particulate Matter Sources of Suspended Particulate Matter, Particulate removal mechanisms, study of working principle and design, removal efficiency- block flow and mixed flow of Control Equipments for Particulate Matter : - Settling chamber, Cyclone separator, Fabric filter, Electrostatic precipitator, Wet collectors – spray towers, cyclonic scrubbers, Venture scrubber	**10Hrs.**
Unit 6: Control of Gaseous pollutants Sources and types of gaseous pollutants, Mechanisms for removal, Various techniques for control of gaseous pollutants - Principles suitability of absorption and adsorption, combustion/ incineration of gaseous pollutants, use of after burners, catalytic combustion, surface and direct condensation of air pollutants	**6 Hrs.**

Textbooks:

1) K. Wark, C.F. Warner & W.T. Davis Air Pollution Control: its Origin and Control, Addision-Wesley, (1998).
2) Stern A.C., "Air Pollution Vol. I and II", Allied Publishers Limited, 1st Edition, 1994.
3) Nevers N., "Air Pollution control Engineering" McGraw-Hill, New York, 2nd edition, 1995

References:

1. Martin Crawford, "Air Pollution and Control", Tata McGraw Hill Publication, 1st Edition, 1976.
2. Air Pollution and Control Technologies by Anjaneyulu, D", Allied Publishers, Mumbai, 2002
3. Environmental Pollution Control Engineering by Rao, C.S., Wiley Eastern Ltd., New Delhi, 1996
4. Industrial Air Pollution Control Systems by W.L.Heumann, McGraw-Hill, New York, 1997
5. Environmental Engineering by Peavy S.W., Rowe D.R. and Tchobanoglous G, McGraw Hill, New Delhi, 1985
6. Environmental Engineering Vol. II by Garg, S.K, Khanna Publishers, New Delhi
7. Fundamentals of Air Pollution by Richard W.Boubel, D.L.Fox, D.B.Turner& A.C.Stern, Reed Elsevier India Pvt. Ltd., New Delhi,

Unit wise Measurable students Learning Outcomes:
At the end of the course, the students will be able to

UO1 Summarize the various impacts of air pollution at national and global levels
UO2 Describe the role of various meteorological parameters in dispersion of air pollutants
UO3 Predict concentration of air pollutants using various dispersion models
UO4 Assess the air quality status with respect to legal standards , and suggest mitigative measures as per legal policies
UO5 Design control equipments for removal of particulate matter
UO6 Recommend measures for control of gaseous pollutants

Title of the Course: Physico- Chemical Processes for Water & Wastewater Treatment **Course Code:** MENPC0102	**L**	**T**	**P**	**Credit**
	3	**1**	**-**	**4**

Course Pre-Requisite:
Students must be aware of present water and wastewater pollution problems and their related environmental problems. The importance of treatment and the standards should be well known to students.

Course Description:
Students will understand the various treatments of water and wastewater such as Coagulation, Flocculation & Settling, Aeration, Reactors & Reaction Kinetics, Filtration, Membrane Processes, Adsorption, Ion exchange, Disinfection.

Course Objectives:

1. To provide the necessary knowledge of physical and chemical processes used for water and wastewater treatment.
2. To impart technical skills for analysis, evaluation and design of physical & chemical treatment of water and wastewater.
3. To inculcate aptitude for research & consultancy.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Explain the concepts of unit operations & processes for physical and chemical processes used for water and wastewater treatment.	2	Understanding
CO2	Analyze the physical and chemical processes used for water and wastewater treatment	3	Analyzing
CO3	Evaluate the physical and chemical processes used for water and wastewater treatment	5	Evaluating
CO4	Design physical and chemical processes used for water and wastewater treatment	6	Creating

CO-PO Mapping

	CO1	**CO2**	**CO3**	**CO4**
PO1	**3**			
PO2		**3**	**3**	
PO3		**3**	**3**	**3**
PO4		**3**	**3**	**3**
PO5	**3**		**1**	**1**
PO6		**1**	**3**	**3**

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) have 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1: Reactors, Reaction Kinetics & Water Treatment: Aeration Types of reactions, reaction kinetics, Configurations of ideal and non-ideal reactors. **Aeration** Principles of aeration, Gas-liquid mass transfer, two film theory, Aeration in water and wastewater treatment, Types of aerators, Design of aeration systems	**7 Hrs.**
Unit 2: - Coagulation, Flocculation & Settling Coagulation processes, stability of colloids and destabilization, coagulants Flocculation theory, Orthokinetic and perikinetic, Design of slow and rapid mixers. Sedimentation, particle settling theory, types of settling and related theory, clarifiers, high-rate clarification, design of clarifiers, Design of grit chamber.	**8 Hrs.**
Unit 3: -Filtration Introduction to depth filtration, filtration processes, principal mechanisms of filtration, filter hydraulics, backwash hydraulics, Rate control patterns and methods, design and operation of rapid sand and dual media filters	7 **Hrs.**
Unit 4: -Membrane Processes Membrane Filtration: Terminology, Process Classification, Membrane configuration, Specific membrane problems such as fouling and its control, application of membranes, Reverse Osmosis (RO), Electrodialysis: Theory, Disposal of concentrated waste streams.	**7 Hrs.**
Unit 5: - Adsorption & Ion exchange Adsorption processes, causes and types of adsorptions, influencing factors, adsorption equilibria and development of adsorption isotherms, activated carbon adsorption kinetics, analysis and design of GAC and PAC contactors. **Ion exchange** Ion exchange, exchange materials, exchange capacity, ion exchange chemistry & reactions, applications for hardness & TDS removal, design of ion exchange softener.	**8 Hrs.**
Unit 6: - Disinfection Disinfection, modes of disinfection, mechanisms, factors influencing, ideal disinfectant, chemistry of chlorination, Disinfection with ozone: chemistry, modeling, estimation of ozone dosage. UV disinfection: system components, modeling, Estimation of UV dose Corrosion processes, electrochemical nature of corrosion, types of corrosion, methods of corrosion control. Concept of zero Liquid Discharge (ZLD)	**8 Hrs.**

Reference Books:

1. "Theory and Practice of Water and Wastewater Treatment", Droste, Ronald L., John Wiley & Sons Publication, 1997, 1st Edition.
2. "Environmental Engineering", Peavy, Rowe and Technologies.
3. "Physico-Chemical Processes of Water Purification", Weber.
4. "Wastewater Engineering Treatment and Reuse", Metcalf And Eddy, Tata McGraw Hill Publication, 1979, 2nd Edition.
5. Wastewater manual, CPHEEO, Government of India

Unit wise Measurable students Learning Outcomes: Students will

1. understand and apply the reaction kinetics of processes involved and study & design the aeration system of water treatment.
2. study & design settling tank, flocculation and grit chamber.
3. apply the filtration principles for filter design.
4. apply the advanced filtration principles for membrane filter design.
5. be able to select design GAC and PAC due to the understanding regarding its details and be able to select a proper process in case of Ion Exchange.
6. understand and apply the disinfection process as per requirement.

Class: F.Y. M. Tech. Environmental Engineering **Title of the Course:** Solid and Hazardous Waste Management **Course Code:** MENPC0103	L	-	-	Credits
	03 hours per week			3

Course Pre-Requisite:

Students shall have the knowledge of

- Sources of environmental pollution
- Causes of pollution which can identify various remedial measures. Various industrial operations and their waste generations
- Environmental chemistry

Course Description:

The course will provide knowledge of solid waste management and hazardous waste management according to rules and regulations. Respective sources of solid waste and hazardous wastes. Current problems due to mismanagement of waste. Remedial measures to control pollution. It also provides various legal provisions made for different types of wastes.

Course Objectives:

1. Understand various sources of solid and hazardous waste.
2. Learn respective legislations related to solid and hazardous wastes
3. Know various treatment methods for solid and hazardous wastes
4. Learn various disposal methods used for various solid and hazardous waste.

Course Learning Outcomes:

COs	**After the completion of the course the students will be able to**	**Bloom's Taxonomy Descriptor**
CO.1	Summarize Fundamentals of Municipal Waste and Hazardous waste Management	Cognitive (Understanding) L2
CO.2	Apply relevant waste management regulations and legislations	Cognitive (Applying) L3
CO.3	Analyze environmental risks associated with solid and hazardous waste management	Cognitive (Analyze) L4
CO.4	Design effective chemical and biological treatment processes for managing solid and hazardous waste.	Cognitive (Creating) L6

CO-PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO.1	1				1	1
CO.2	1				3	3
CO.3	2		2	2	1	1
CO.4	3	3	3	3	1	3

Assessments:

Assessment	Weightage (Marks)
ISE-1	10
MSE	30
ISE-2	10
ESE	50

- **ISE 1 and ISE 2** are based on assignment/declared test/quiz/seminar/Group Discussions etc.
- **MSE:** Assessment is based on 50% of course content (Normally first three Units)
- **ESE:** Assessment is based on 100% course content with60-70% weightage for course content (normally last three Units) covered after MSE.

Course Contents:

Unit 1: - Introduction of solid and hazardous wastes Sources; composition; generation rates; collection of waste; separation, transfer and transport of waste; treatment and disposal options. Characterization of waste, compatibility and flammability of chemicals, fate and transport of chemicals, health effects due to improper management of wastes. Concept of Extended producer responsibility (EPR) and Circular Economy	**6 Hrs.**
Unit 2: - Various Legislations in waste management Municipal solid waste management rules, hazardous waste management rules, biomedical waste management and handling rules fly ash rules, recycled plastics usage rules, batteries rules. Swachh Bharat Mission	**10 Hrs.**
Unit 3: - Risk and risk Assessment Defining risk and environmental risk, methods of risk assessment, case studies., measures, health effects; nuclear power plants and fuel production; waste generation from nuclear power plants; disposal options,	**7 Hrs.**
Unit 4: - Chemical treatments for solid and hazardous waste Chemical treatment processes for MSW (combustion, stabilization and solidification of hazardous wastes); physico-chemical processes for hazardous wastes (soil vapor extraction, air stripping, chemical oxidation); ground water contamination and remediation.	**8 Hrs.**
Unit 5: - Biological treatment methods for solid and hazardous waste Biochemistry of microbial metabolism; aerobic biodegradation of solid waste: composting and vermi-composting; anaerobic biodegradation of solid waste: waste to energy options, other methods; bioremediation - fundamentals.	**8 Hrs.**
Unit 6: Disposal of solid and hazardous waste Sanitary landfills and secured landfills. Site selection for landfills, design, operation, maintenance and precautions of landfill sites. Leachate and its control, control of contamination of ground water. Operation monitoring. Rehabilitation, Closure & end-use	**6 Hrs.**

Textbooks

1. Tchobanoglous G., Theisen H. and Vigil S.A., "Integrated Solid Waste Management",McGraw-Hill International editions.
2. Bhide A.D. and Sundaresan B.B., "Solid Waste Management, Collection, Processing and Disposal", Nagpur.

References:

1. Vesilind P.A., Worrell W. and Reinhart D.R., "Solid Waste Engineering", ThomsonBooks.
2. "Manual on Municipal Solid Waste Management", CPHEEO, Ministry of Urban Development, Government of India.
3. Management and Handling Rules for: municipal solid waste, biomedical waste,hazardous waste and radioactive wastes, Government of India Publications.
4. Solid Waste Management Handbook – Pavoni
5. Handbook and Solid Waste Disposal – George Tchobanoglous
6. Hazardous Waste Management - Charles Wentz

Unit wise Measurable students Learning Outcomes:

At the end of the course, the students will be able to

Unit 1- Able to recall & identify various sources of solid waste.

Unit 2- Choose & Make use of respective legislation related to solid waste.

Unit 3- Able to Identify & Demonstrate effects & risk associated with solid waste.

Unit 4- Able to Recall & Choose appropriate chemical treatments of solid waste.

Unit 5- Able to Recall & Choose biological treatments of solid waste.

Unit 6- Able to Compare & Choose disposal method for solid waste.

Class: F.Y. M. Tech. Environmental Engineering **Title of the Course:** Industrial Health and Safety **Course Code:** MENPE0111	**L**	**T**	**P**	**Credit**
	03 hours per week	-	-	3

Course Pre-Requisite:

Students shall have the knowledge of

- Students shall have a knowledge of physics and chemistry.
- Students shall have knowledge of industrial management, building bye laws.

Course Description:

The course is designed to train and provide expert human resource to safety management and expected to bring direct benefits to industry and society. The course develops entry level skills in industrial safety, health, and environmental awareness. Course will help the students to obtain work in a variety of safety-related fields to include accident investigation, monitoring and enforcement of codes, ergonomics, and Occupational Safety Health administration (OSHA) requirements.

Course Objectives:

1. Understand the importance of maintaining a safe workplace, safety standards compliance with regulatory requirements and within engineering limits.
2. Define the role of safety in the industry, organization and business community.
3. Recognize the effects of exposures to chemical, physical, biological and ergonomic agents in the workplace.
4. Know the policies, procedures and equipment's needed to deal with hazardous materials and situations.

Course Learning Outcomes:

COs	**After the completion of the course the students will be able to**	**Bloom's Taxonomy Descriptor**
CO.1	Identify the fundamental concepts of industrial health and safety.	Cognitive (Applying) L3
CO.2	Analyse various risk assessment and hazard evaluation techniques	Cognitive (Analysing) L4
CO.3	Inspect the effectiveness of safety measures, fire and electrical protection systems, and plant and machine layouts	Cognitive (Analysing) L4
CO.4	Develop comprehensive safety programs, health management plans for various industries considering safety legislations.	Cognitive (Applying) L3

CO-PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO.1	1				1	1
CO.2	2	1		3	2	2
CO.3	2	1		2	2	2
CO.4	2	1		2	2	2

Assessments:

Assessment	Weightage (Marks)
ISE-1	10
MSE	30
ISE-2	10
ESE	50

- **ISE 1 and ISE 2** are based on assignment/declared test/quiz/seminar/Group Discussions etc.
- **MSE:** Assessment is based on 50% of course content (Normally first three Units)
- **ESE:** Assessment is based on 100% course content with60-70% weightage for course content (normally last three Units) covered after MSE.

Course Contents:

Unit 1: Safety Audit History of Safety movement, Evolution of modern safety concept, Purpose and Overview of Audit Systems, Scope and Background, Intended Audience, Period of Applicability, Organization of the Document, Components of safety audit, types of audits, audit methodology, audit checklist and report, review of inspection, scrutiny of accident and safety records, check list, identification of unsafe acts of workers and unsafe conditions.	**7 Hrs.**
Unit 2: Accident Investigation and Reporting Concept of an accident, Accident causation, Reportable and non-reportable accidents, Principles of accident prevention, Theories of accidents, Accident investigation and analysis, Accident reporting, Domino sequence, Supervisory role, Role of safety committee, Cost of accident.	**8 Hrs.**
Unit 3: Hazard, Risk Issues and Hazard Assessment Hazard (physical, chemical, biological and ergonomic), Hazard monitoring, Risk issue, Approaches for establishing risk acceptance levels, Risk estimation, Checklist analysis, What-if analysis, Job Safety Analysis (JSA), Safety review, Preliminary hazard analysis (PHA), Human error analysis, Hazard operability studies (HAZOP), Permissible exposure limits, Safety warning systems, Methods of control, Training and education, Lockout- Tagout	**8 Hrs.**
Unit 4: Occupational Physiology Man as a system component, Allocation of functions, Efficiency, Occupational work capacity, Ergonomics, Evaluation of physiological requirements of jobs, Parameters of measurements, Categorization of job heaviness, Work organization, Stress, Strain, Fatigues, Shift work, Personal hygiene, Work permit, Confines spaces, Occupational Safety Health Administration (OSHA) requirements.	**7 Hrs.**
Unit 5: Fire Protection and Plant and Machine Layout Sources of ignition, Fire triangle, Principles of fire extinguishing, Active and passive fire protection systems, Various classes of fires (A, B, C, D, E), Types of fire extinguishers, Material Safety Data Sheets (MSDS), Classification of hazardous chemicals, Storage and handling of chemicals, Handling, Safety precautions, good housekeeping. Electrical safety. Plant and Machine layout, Site selection, Factors affecting, Lighting, Ventilation, Body dimensions, Passages, Staircases, Auxiliary facilities.	**8 Hrs.**
Unit 6: Occupational Health Problems in Different Types of Industries and Industrial safety legislations Health and safety considerations, Personal protective equipment, Construction, Textile, Steel, Food processing, Pharmaceutical, Occupational health and safety considerations in wastewater treatment plants. Environment, Safety Rules and Legislations	**8 Hrs.**

Textbooks

1. Blake, R. B., “Industrial Safety” Prentice Hall, Inc., New Jersey, 1973.
2. Colling D.A., “Industrial Safety Management and Technology”, Prentice Hall, New Jersey.
3. Goetsch, D. L., “Occupational Safety and Health for Technologists, Engineers and Managers”, Prentice Hall, New York.

References:

1. “Guidance on Technical Audits and Related Assessments for Environmental DataOperations”, EPA QA/G-7, US Environment Protection Agency, Washington, DC 20460
2. Heinrich, H.W., “Industrial Accident Prevention”, McGraw Hill Publication, New York.
3. Kausek, J., “The Management System Auditor's Handbook”, 2006.
4. National Safety Council and Associate (Data) Publishers Pvt. Ltd., “Industrial Safety and Pollution Control Handbook
5. Pain, S. W., “Safety, Health, and Environmental Auditing: A Practical Guide”, Published: April 26, 2010 by CRC Press.
6. Petersen, D., “Techniques of Safety Management”, McGraw-Hill Company, Tokyo, 1981.

Unit wise Measurable students Learning Outcomes:

At the end of the course, the students will be able to

1. Recognize the importance of safety audit including an outline of the legal system and hierarchy of legislation.
2. Apply the knowledge and principles of accident prevention techniques and practical skills required for prevention of injury in the workplace environment.
3. Develop theoretical and practical understanding of the recognition, evaluation and management of occupational hygiene and related safety hazards.
4. Apply logical and rational processes to critically analyze issues related to OHS and think creatively in the generation of solutions to problems.
5. Design safety discipline to safeguard against the fire and plant layout related hazards.
6. Carry out industry-based assessment and the development of novel ways of solving problems.

Class: M. Tech Environmental Engineering **Title of the Course:** Environmental Social Governance (PE-I) **Course No.: MENPE0112**	**L**	**T**	**P**	**Credit**
	03 hours per week	-	-	3

Course Pre-Requisite:

- Understanding of Environmental Systems
- Environmental Policy and Regulations
- Environmental Impact Assessment (EIA)
- Pollution Prevention and Control technologies.

Course Description:

This course offers M. Tech Environmental Engineering students a comprehensive exploration of Environmental Social Governance (ESG) and its pivotal role in sustainable development. The course delves into the integration of ESG principles within environmental engineering projects, focusing on the assessment and management of environmental impacts, social responsibilities, and ethical governance. Students will engage with contemporary ESG frameworks, regulatory standards, and best practices through case studies and practical applications relevant to the engineering sector.

Course Learning Objectives:

1. To identify key principles and frameworks of Environmental Social Governance (ESG) and their relevance to engineering practices.
2. To explain the impact of ESG factors on business decision-making and stakeholder relations in engineering projects.
3. To Apply ESG assessment tools and methodologies to evaluate the sustainability performance of engineering projects.
4. To analyse case studies of engineering projects to determine best practices and areas for improvement in ESG implementation.

Course Outcomes:

COs	**After the completion of the course the students will be able to**	**Bloom's Cognitive Descriptor**
CO.1	Identify key principles and frameworks of Environmental Social Governance (ESG) and their relevance to engineering practices.	Cognitive (Applying) L3
CO.2	Apply ESG assessment tools and methodologies to evaluate the sustainability performance of engineering projects.	Cognitive (Applying) L3
CO.3	Explain the impact of ESG factors on business decision-making and stakeholder relations in engineering projects.	Cognitive (Analysing) L4
CO.4	Analyse case studies of engineering projects to determine best practices and areas for improvement in ESG implementation.	Cognitive (Analysing) L4

CO-PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO.1	1	-	-	-	2	1
CO.2	2	3	1	2	1	3
CO.3	1	1	1	2	1	2
CO.4	1	-	1	2	2	3

Assessments:

Assessment	**Weightage (Marks)**
ISE-1	10
MSE	30
ISE-2	10

ESE	50

- **ISE-1 and ISE-2:** Assessment is based on Assignment/Declared Test/Quiz/Seminar/Group Discussions etc. (For each ISE two different tools are to be used).
- **MSE:** Assessment is based on 50% of course content (Normally first three Units)
- **ESE:** Assessment is based on 100% course content with 30% weightage for course content covered before MSE and 70% weightage for course content covered after MSE.

Course Contents:

Unit 1: Introduction to ESG Principles and Frameworks: Overview of Environmental, Social, and Governance (ESG) concepts, Importance of ESG in corporate sustainability and responsible investing, Evolution of ESG frameworks and standards (e.g., Global Reporting Initiative, Sustainability Accounting Standards Board), Principles of sustainable development and triple-bottom-line (TBL) accounting, Materiality assessment (what is materiality assessment, approach & methodology and outcome)	**07 Hrs.**
Unit 2: Environmental Aspects of ESG: Assessment and Management Environmental considerations within ESG frameworks, Methods for assessing environmental impacts (e.g., Life Cycle Assessment, Environmental Impact Assessment), Types of Footprints to measure the impacts of industries on Environment Environmental management approaches (e.g., pollution prevention, resource conservation, ecosystem restoration). Energy Management (ISO 50001), GHG emissions (Scope 1,2 and 3 emissions monitoring, reporting and calculation methodology, emission reduction goals/targets)	**08 Hrs.**
Unit 3: Social Dimensions of Sustainability: Equity, Diversity, and Community Engagement Social factors in ESG evaluations and reporting, Key social issues (e.g., human rights, labour practices, community relations), Strategies for promoting diversity, equity, and inclusion (DEI: DEI goals/targets, policy, gender representation across the organisation and Board of Directors, DEI initiatives, gender pay gap assessment) in organizations, Stakeholder engagement and community outreach in environmental projects.	**08 Hrs.**
Unit 4: Governance and Corporate Responsibility: Ethics, Transparency, and Accountability Governance principles in ESG frameworks, corporate governance structures and best practices, Ethical considerations in environmental engineering and business decision-making, Transparency, accountability, and anti-corruption measures. Supply chain management (supplier code of conduct, modern slavery policy, supplier due diligence, supplier audits) Community relations (initiatives/programs, donations, employee volunteering hours)	**09 Hrs.**
Unit 5: ESG Reporting and Disclosure: Standards and Guidelines ESG reporting frameworks and standards (e.g., SASB, TCFD, CDP, BRSR), Guidelines for ESG disclosure and reporting (e.g., Integrated Reporting, GRI Standards), ESG data collection, measurement, and reporting processes, Role of assurance and verification in ESG reporting.	**08 Hrs.**
Unit 6: Case Studies and Practical Applications of ESG Principles Real-world examples of ESG implementation in various sectors (e.g., energy, manufacturing, finance), Analysis of ESG performance metrics and indicators, Group projects or presentations on ESG initiatives and strategies, Discussion of emerging trends, challenges, and opportunities in ESG integration.	**06 Hrs.**

References:

1. Environmental Social and Governance (ESG) investing A Balanced analysis of the theory and Practice of a Sustainable Portfolio 1st Ed by Hill and John, Elsevier Feb 2020.
2. Environmental Social Governance: Managing Risk and Expectations by John Trudinger, Karlheinz Spitz, and Matthew Orr. CRC Press, 2022

Unit Learning Objectives:

Students will be able to

1. Make use of ESG Principles and Frameworks.
2. Explain Environmental Aspects of ESG.
3. Explain Social Dimensions of Sustainability: Equity, Diversity, and Community Engagement
4. Analyze governance and Corporate Responsibility.
5. Explain ESG reporting frameworks and standards and its guidelines.
6. Analyze case studies of engineering projects to determine best practices and areas for improvement in ESG implementation.

Class: F. Y. M. Tech. Environmental Engg.	**L**	**T**	**P**	**Credit**
Title of the Course: Operation and Maintenance of Treatment Plants (PE-1) **Course Code:** MENPE0113	**3**	**-**	**-**	**3**

Course Pre-Requisite:

- Students shall have knowledge of Water Supply Engineering.
- Students shall have knowledge of Wastewater Engineering.
- Students shall have knowledge of Air Pollution and Control.

Course Description:

Operation and Maintenance of Environmental Facilities deals with the operation of environmental facilities like water supply facilities, water treatment plants, water distribution systems, wastewater treatment plants, wastewater collection systems, air pollution control equipment and their maintenance.

Course Learning Objectives:

1. To know the necessity of maintenance of environmental facilities.
2. To study the different measures to avoid failures in pipe systems.
3. To understand the criteria of operation and its purpose for water treatment plants, wastewater treatment plants and air pollution control equipments.
4. To learn the importance of planning and scheduling in maintenance activities.

Course Outcomes:

CO	**After completion of course students will be able to**	**Blooms Cognit Descriptor**
CO1	Explain the types of maintenance and its requirements at treatment plants.	Cognitive L2 (Understanding)
CO2	Demonstrate use of different appurtenances in water distribution system, sewer network and treatment plants.	Cognitive L2 (Understanding)
CO3	Summarize the operation and maintenance requirements of air pollution control equipments.	Cognitive L2 (Understanding)
CO4	Identify the appropriate remedies for problems in water treatment plants and wastewater treatment plants.	Cognitive L3 (Applying)

CO-PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	-	-	2	1
CO2	2	3	-	2	1	3
CO3	1	1	-	2	1	2
CO4	1	-	-	2	2	2

Assessments:

Assessment	**Weightage (Marks)**
ISE-1	10
MSE	30
ISE-2	10
ESE	50

- **ISE-1 and ISE-2:** Assessment is based on Assignment/ Declared Test/ Quiz/ Seminar/ Group Discussions etc. (For each ISE two different tools are to be used).
- **MSE:** Assessment is based on 50% of course content (Normally first three Units)
- **ESE:** Assessment is based on 100% course content with 30% weightage for course content covered before MSE and 70% weightage for course content covered after MSE.

Course Contents:

Unit 1:- Introduction	**06 Hrs.**
Need of O and M, Types of Maintenance - Corrective and Preventive, Data: Detailed Plans, Drawings, Operation Manuals, Logbooks, Strategy for good O & M, O and M planning: Organizational Structure, Work Planning,	

Preparation and Scheduling, Inventory, Cost Estimates, TPM and TQM.	
Unit 2:--- Water Intakes O & M of Water Supply Facilities: Intakes, Pumps, Transmission Pipes and maintenance, Conventional Water Treatment Units Maintenance, Quantity and Quality Monitoring.	**08 Hrs.**
Unit 3:--- Water Distribution Systems Water Distribution System: Loss of Carrying Capacity of Pipes, Pipe Breaks & Leakages, Leak Detection, O and M of Appurtenances- Valves, Pipe Joints, WaterMeters, Water Audit, Energy Audit.	**08 Hrs.**
Unit 4:--- Wastewater Facilities O & M of Wastewater Facilities: Sewerage System and Appurtenances, InspectionMethods, Cleaning and Rehabilitation, Safety in Sewer Inspection, O and M of Wastewater Treatment Plant- Activated Sludge Process, Trickling Filters, Monitoring and Operational Problems, Corrective Measures.	**08 Hrs.**
Unit 5:--- Air Pollution Control Facilities Air Pollution Control Facilities: Regular Inspection of Devices, Operation and Maintenance of Particulate Matter Control Equipments, Gravity Settlers, Cyclone Separators, Bag Filters, Scrubbers, Electrostatic Precipitator.	**08 Hrs.**
Unit 6:--- Advanced Treatment Facilities Maintenance for Cartridge Filter, Ultra-filtration, Ion Exchange, Reverse Osmosis, Multi Effect Evaporators, MBBR, UASB, Incinerators, Use of Sensors, PLCs and SCADA.	**07 Hrs.**
Textbooks: 1. CPHEEO manual on Water Supply and Treatment 2. CPHEEO manual on Sewerage and Sewage Treatment 3. A manual on Operation and Maintenance of Water Supply Systems by CPHEEO 4. Wastewater Engineering: Treatment and Reuse by by Metcalf & Eddy, Inc., George Tchobanoglous , McGraw Hill Publications 5. Air Pollution M N Rao, H V N Rao	
References: 1. Industrial Air Pollution Control Systems – Neumann 2. O and M of Water treatment plant – Charles R Cox 3. Guidelines for Operation and Maintenance of Effluent Treatment Plants by MPCB	
Unit wise Measurable Students Learning Outcomes: **Unit Learning Objectives:** 1.To know the planning requirements of Maintenance works. 2.To learn the maintenance requirements of water intakes and treatment units. 3.To understand the use of various appurtenances in water distribution system. 4.To know the operational criteria and maintenance requirements of sewer network and STP. 5.To understand the operation and maintenance requirements of Air Pollution Control Equipments. 6.To understand the maintenance requirements of Advanced Treatment Facilities. **Unit Outcomes:** At the end of course students will be able to: 1.1 Explain the types of maintenance. CO1 1.2 Explain the planning requirements of maintenance. CO1 2.1 Identify the maintenance requirements of Water Intakes. CO4 2.2 Identify the operation and maintenance requirements of Water Treatment Plants. CO4 3.1 Demonstrate use of appurtenances in water distribution system. CO2 3.2 Identify the maintenance requirements of Reservoirs. CO4	

4.1 Demonstrate use of appurtenances in sewer network. CO2
4.2 Identify the operation and maintenance requirements of ASP and Trickling Filters. CO4
5.1 Summarize the operational requirements of Air Pollution Control Equipments. CO3
5.2 Summarize the remedial measures for the Air Pollution Control Equipments. CO3
6.1 Demonstrate use of Sensors and PLCs in treatment plants. CO2
6.2 Identify the remedies for problems in Advanced Treatment Facilities. CO4

Class: F.Y. M.Tech Environmental Engineering **Title of the Course: Green Building (PE-I)** **Course No.: MENPE0114**	**L**	**T**	**P**	**Credits**
	3	--	--	3

Course Pre-Requisite:

Students shall have the knowledge of:

- Basic Civil Engineering
- Building Material and Concrete Technology
- Building Planning and Design

Course Description:

The course is imparting fundamental knowledge of introduction to sustainable site selection, passive and active architecture, green rating of building, water efficiency, water efficient landscaping, indoor environmental quality, recycling of building materials.

Course Learning Objectives:

1. To understand the importance and necessity of green building.
2. To learn the various rating systems for green building.
3. To identify materials and technologies to improve energy efficiency of building.
4. To study a building on the norms available for green building.

Course Outcomes:

COs	**After the completion of the course the students will be able to**	**Bloom's Cognitive Descriptor**
CO.1	Explain the importance and necessity of green building.	Cognitive (Understanding) L2
CO.2	Interpret the various rating systems for green building.	Cognitive (Understanding) L2
CO.3	Choose materials and technologies to improve energy efficiency of building.	Cognitive (Applying) L3
CO.4	Identify the recent techniques of water and energy conservation in buildings.	Cognitive (Applying) L3

CO-PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO.1	1			1		
CO.2	2	3	2	2	1	2
CO.3	3	1	1		1	2
CO.4	1		2	2	1	3

Assessments:

Assessment	**Weightage (Marks)**
ISE-1	10
MSE	30
ISE-2	10
ESE	50

- **ISE-1 and ISE-2:** Assessment is based on Assignment/Declared Test/Quiz/Seminar/Group Discussions etc. (For each ISE two different tools are to be used).

- **MSE:** Assessment is based on 50% of course content (Normally first three Units)
- **ESE:** Assessment is based on 100% course content with 30% weightage for course content covered before MSE and 70% weightage for course content covered after MSE.

Course Contents:

Unit 1: **Introduction** Concept of green building, History of green building, Need of green building in present scenario, Importance of green building, merits and demerits. **Sustainable Site Selection:** Soil erosion and pollution control measures, alternate transportation strategies, storm water management, reduction of heat island effect, minimizing night sky pollution.	08 Hours
Unit 2: Concept of Passive and Active Architecture. Natural ventilation and air conditioning, Hybrid system of active and passive air conditioning. Indoor Environmental Quality for Occupant Comfort and Wellbeing: Day lighting, air ventilation, exhaust systems, low VOC paints and adhesives	07 Hours
Unit 3: **Alternate energy sources**: Significance and utilization of solar energy, wind energy, biomass and biofuel for Green rating system of building. Comparison of various lighting devices- electric tubes, incandescent lamps, CFL and LED lamps.	07 Hours
Unit 4: **Water conservation and efficiency** Water Efficient Landscaping –Rainwater harvesting, potable water and bore well recharging methods. Minimization of water use: Dual flush, waterless urinals, smart controlled water taps. **Segregation and treatment of wastewater:** Various treatment technologies, recycling of treated wastewater for different non potable purpose. Domestic solid waste – Segregation, earthworm composting and other options.	07 Hours
Unit 5: **Building materials:** Concept of Embodied Energy, Embodied energy of various common building materials, Thermal properties of building components, Thermal storage, emissivity, reflectivity. Selection of materials and surface treatment for improvement in thermal comfort with minimum energy input. Green building materials and products- Bamboo, Rice husk ash concrete, plastic bricks, Bagasse particle board etc Use of materials with recycled content such as blended cements, pozzolana cements, fly ash bricks, foundry sand, other inert solid wastes in buildings, Reuse of waste and salvaged materials	07 Hours
Unit 6: **Green Rating of building**: LEED India and GRIHA (Green Rating for Integrated Habitat Assessment), Introduction to IGBC (Indian Green Building Council) standard, Study of existing green buildings. Concept of CDM and Carbon trading, Energy audit and Water Audit of building, Concept of Life cycle analysis, Building Management System and net zero building	09 Hours

Textbooks:

1. Green Home Building: Money-Saving Strategies for an Affordable, Healthy, High-Performance Home by Miki Cook and Doug Garrett

2. Sustainable Construction: Green Building Design and Delivery by Charles J Kibert
3. Sustainable Energy System Engineering: The Complete Green Building Design Resource by Peter Gevorkian

Reference Books:

1. Handbook of Green Building Design and Construction: LEED, BREEAM and Green Globes by Sam Kubba
2. Integrated Life Cycle Design of Structures, SPON Press by Asko Sarja
3. Non-conventional Energy Resources, New Age International Publishers by D S Chauhan and S K Sreevasthava
4. Buildings How to Reduce Cost, Cost Ford by Laurie Backer

Class: F.Y. M. Tech. Environmental Engineering **Title of the Course:** Applied Environmental Chemistry and Microbiology **Course Code:** MENAU0181	**L**	**T**	**P**	**Credit**
	02 hours per week	-	-	0

Course Pre-Requisite:
Completion of introductory courses in chemistry and microbiology or equivalent foundational knowledge in these disciplines.

Course Description:
Students will have acquired a comprehensive understanding of how chemical processes and microbial activities influence the quality and health of the environment and will be equipped with the knowledge and skills necessary to propose and implement effective solutions for environmental challenges.

Course Objectives:

1. Understand the fundamental principles of environmental chemistry and microbiology and their roles in shaping natural and engineered environments.
2. Identify and analyze environmental pollutants, their sources, behavior, and impacts on ecosystems and human health.
3. Evaluate bioremediation techniques and microbial processes for the mitigation of environmental pollution and the restoration of contaminated sites.
4. Explore the interactions between microorganisms and chemical compounds in water, soil, and air, and their implications for environmental quality.

Course Learning Outcomes:

COs	**After the completion of the course the students will be able to**	**Bloom's Taxonomy Descriptor**
CO.1	Demonstrate a thorough understanding of key chemical **principles** and their applications in environmental engineering.	Cognitive (Understanding) L2
CO.2	Apply knowledge of water treatment processes for efficient removal of contaminants.	Cognitive (Applying) L3
CO.3	Analyse ecological and microbiological concepts to assess environmental health and implement appropriate remediation strategies.	Cognitive (Analysing) L4
CO.4	Explain analytical techniques such as colorimetry, chromatography, and spectroscopy.	Cognitive (Analysing) L4

CO-PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO.1	3		3		1	1
CO.2	3	1	3	3	2	3
CO.3	3	1	3	3	2	3
CO.4	1	2		3		3

Assessments:

Assessment	**Weightage (Marks)**
ISE	100

ISE is based on four different tools like assignment/declared test/quiz/seminar/Group Discussions etc.

Course Contents:	
Unit1: Fundamentals of Chemistry in Environmental Engineering Importance of Environmental Chemistry, Type of reactions, Gas laws and their application in Environmental Engineering, Osmosis, Dialysis, Principles of solvent extraction, Amphoteric hydroxides, Electrochemistry, and its applications.	**4 Hrs.**
Unit2: Physical and equilibrium chemistry Concept of pH, and its application in Environmental Engineering, definitions and basic concepts of acids, bases and buffers, pE-pH diagram, Acidity, Alkalinity, Langelier index, Solubility diagram, Oxidation and Reduction equilibrium. **Colloidal chemistry** Properties of colloids, colloidal dispersions, stability of colloids and applications. Preparation and purification of colloidal systems: Kinetic properties: The motion of particles in liquid media; Brownian motion and translational diffusion, Molecular Thermodynamics of Hydrogen-Bonded Systems, Thermally Sensitive Particles: Preparation, Characterization, and Application, Basic concepts of carbohydrates, proteins, lipids, and enzymes.	**6 Hrs.**
Unit 3: Colorimetry Principles and applications, Lambert's law, Beer's law, Instruments of Colorimetry: Colorimeter, Spectrophotometer, Light, Vision and Photometry, Definition of Photometric Quantities, Photometric Units, Calculation of Colorimetric Values **Analytical Chemistry** Emission and absorption techniques, titrimetric, gravimetry, Solvent extraction, chromatography, gas chromatography, HPLC, GC-MS, atomic absorption spectroscopy, ICP-AES, flame photometry, electrophoresis, X-ray fluorescence, X-ray diffraction	**6 Hrs.**
Unit4: Water Treatment Processes Chemistry of water treatment processes like coagulation, disinfection, water softening, adsorption, and demineralization.	**4 Hrs.**
Unit5: Microbiology in Environmental Engineering Introduction to Microbiology, Haeckel's classification, Microorganisms of importance in air, water and soil environment, Morphology and structure of bacteria, nutritional requirement, and nutritional classification of bacteria, Principles and applications of microscopy, microscopic flora and fauna of importance, Growth of bacteria, Indicator bacteria, Multiple Tube Dilution (MTD) and Membrane Filter (MF) techniques, Definition and characteristics of viruses.	**5 Hrs.**
Unit6: Applied Microbiology Ecological interactions, Geochemical cycles, Metabolism and metabolic pathways, Bioconcentration, Biomagnification and Bioaccumulation, Biosphere, earth energy budget, Ecosystem, Uniformitarianism.	**5 Hrs.**

Textbooks

1. C. N. Sawyer and P. L. McCarty, Chemistry for Environmental Engineers, McGraw Hill, Latest.
2. Pelczar Reid & Chan, Microbiology Tata McGraw Hill, Latest.
3. Powar &Daginawala, General Microbiology Vol. I &II, Himalaya Publishing House, Latest
4. Dutt PK, Dutt PK (2000) General & Inorganic Chemistry, Latest.
5. Tortora GJ, Funke BR, and Case CL (2004) Microbiology: An Introduction. Pearson Education (Singapore), Latest.

References:

1. Tchobanoglous G., Burton F., and Stensel H.D., (2017), "Water and Wastewater Treatment Processes", 4th Edition, Metcalf & Eddy, McGraw Hill Education.
2. Stumm, W. and Morgan, J.J. (1996) Aquatic Chemistry, Chemical Equilibria and Rates in Natural Waters. 3rd Edition, John Wiley & Sons, Inc., New York.

Title of the Course: Environmental Monitoring Lab. I	**L**	**T**	**P**	**Credit**
Course Code: MENPC0131	**0**	**0**	**2**	**1**

Course Pre-Requisite:

- Environmental chemistry and instrumentation, solid waste management

Course Description:

The course is designed to develop sampling and analytical skills of the students which are required in environmental monitoring. Through this course, the students will be exposed to various standard protocols used in monitoring of air quality including meteorological parameters, noise levels and solid waste characteristics. During the course, students will be demonstrated with the use of equipment in laboratories and hands-on practice in the field.

Course Learning Objectives:

1. To understand the standards protocols and procedures to be followed for environmental monitoring
2. To develop sampling and analytical skills which are required in environmental monitoring

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	Analyze the results of experiments conducted .and conclude through application of modern engineering tools and techniques	4,5	Analyzing, Evaluating
CO2	Design and conduct experiments by applying the acquired knowledge on standard	6	Design

CO-PO Mapping:

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	3	3	2	2	2	3
CO2	3	3	3	2	2	3

Assessments:

Assessment	Marks
ISE	50

ISE is based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

Course Contents:

1. Monitoring of meteorological parameters- temperature, pressure, RH, Dew point, wind speed and direction (8 hrs.)
2. Ambient air monitoring for Respirable Suspended Particulate Matter, NOx, SOx (6 hrs.)
3. Demonstration of stack monitoring kit (2hrs.)
4. Ambient noise level measurements (4hrs.)
5. Sampling and characterization of MSW (6 hrs.)

Class: F. Y. M. Tech. Environmental Engineering Title of the Course: Treatability Studies Laboratory – I Course Code: MENPC0132	L	T	P	Credit
	0	0	4	2

Course Pre-Requisite:

Environmental chemistry, instrumentation and Unit Operations and Processes in Environmental Engineering

Course Description:

Students will be demonstrated with use of equipment's in laboratories and hands-on practice in the field for water quality monitoring

Course Objectives:

1. To provide exposure to the techniques and tools for the design and conduct of the experiments.
2. To provide an opportunity to contribute individually/in groups to the development of experimental set ups by applying the acquired technological knowledge.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	**Develop** experimental setups to carry out characterization, parameter estimation, and performance evaluation of water treatment.	3	Applying
CO2	**Analyse** experimental results through application of engineering tools	4	Analysing

CO-PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO.1	2	1	2	2	2	3
CO.2	3	3	3	3	1	3

Assessments:

Assessment	Marks
ISE	50

ISE is based on experimental work/performance in laboratory/Internal Oral etc.

Course Contents:

List of Experiments

1. Determination of overall mass/gas transfer coefficient (04 Hours)
2. Determination of order of reaction and reaction rate coefficient (04 Hours)
3. Jar test for determination of coagulant/s dose for the removal of turbidity (04 Hours)
4. Physical and chemical characteristics of sand as filter media (04 Hours)
5. Determination of head loss in depth filter (04 Hours)
6. Development of adsorption isotherm with activated carbon/natural adsorbent (04 Hours)
7. Determination of exchange capacity of resin (04 Hours)
8. Performance evaluation of resin for hardness removal (04 Hours)

Textbooks:

1. Peavy H, S, Rowe D, R, and Techobanoglous G, "Environmental Engineering", McGraw-Hill Book Company, International edition, 1985.
2. Metcalf and Eddy "Wastewater Engineering Treatment and Reuse", Tata McGraw Hill Publication, 6th Reprint. 2003,
3. "Manual on water supply and Treatment", CPHEEO, Ministry of Urban Development, GoI, New Delhi, 1999.

References:

1. Sincero A, P and Sincero G, A, "Environmental Engineering A Design approach", PHI learning private limited, 2004.
2. 2. Sawyer and McCarty, "Chemistry for Environmental Engineers", Tata McGraw Hill, Edition 5, 2003.
3. 3. Clesceri, L. S., Greenberg, A. E. and Eaton, A. D. (Eds), Standard Methods for the Examination of Water and Wastewater, Washington, D.C., 21st Ed., 2001.
4. 4. Quasim, S. R., "Water treatment plants planning, design and operation", CRC Press, 2nd Edition, 2010.

Class: F. Y. M. Tech. Environmental Engineering **Title of the Course: Research Methodology** **Course Code: MENIL0171**	**L**	**T**	**P**	**Credit**
	03	**01**	**-**	**04**

Course Pre-Requisite:

- Mathematics Proficiency
- Communication Skills

Course Description: The Research Methodology course for Master of Technology (M. Tech) students is designed to equip them with the essential tools and techniques for conducting rigorous scientific research. This course covers the fundamentals of research design, data collection and analysis, statistical methods, and the ethical considerations inherent in scholarly work. Students will learn to formulate research questions, develop hypotheses, and apply appropriate methodologies to investigate and solve complex engineering problems. Emphasis is placed on critical thinking, effective communication of research findings, and the practical application of advanced research tools, preparing students to contribute innovatively to their fields.

Course Learning Objectives:

1. Effectively impart the fundamental steps for the literature review to identify gaps in the research.
2. Make students familiar with the research process keeping in view testable hypotheses.
3. Make students to realize the concepts of reliability and validity of a data collection, measurement and scaling techniques.
4. Make students to understand the techniques of interpretations, characteristics of a good research report and importance of IPRs.

Course Outcomes:

COs	**After the completion of the course the students will be able to**	**Bloom's Cognitive Descriptor**
CO.1	Define a good research problem, hypothesis and objectives.	Cognitive (Understanding) L2
CO.2	Identify alternative research methodologies and analytical techniques for a chosen research question.	Cognitive (Applying) L3
CO.3	Analyse basic techniques of quantitative and qualitative data gathering.	Cognitive (Analysing) L4
CO.4	Summarize the purpose, process, methods and results in preparation of a research report and various forms of IPRs.	Cognitive (Evaluating) L5

CO-PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO.1	3		3		2	
CO.2	2	2	3			
CO.3	2	2	2			
CO.4	1		1	2	2	1

Assessments:

Assessment	**Weightage (Marks)**
ESE	100

- **ESE:** Assessment is based on 100% course content.

Course Contents:	
Unit 1: **Introduction to Research Methodology:** Meaning and Concept of Research, Research Process, Objectives, Motivation, Ethics in Research, Types of Research – Basic, Applied, Descriptive, Analytical, Conceptual, Empirical, Qualitative and Quantitative.	**06**
Unit 2: **Problem Identification & Formulation –** Introduction, Concept and Need of Research Problem, Literature Survey, hypothesis, characteristics of hypothesis, Steps of Defining a Research Problem, Characteristics of a Good Research Problem, Identifying and Formulating Research Problem.	**07**
Unit 3: **Measurement and Scaling Techniques –** Concept of Measurement, Measurement Scale, Developing Measurement Tools, Basic Criteria of Good Measurement Tools, Errors in Measurement, Concept of Scaling and Types of Scales.	**07**
Unit 4: **Methods of Data Collection –** Concept of Data Collection, Types of Data, Methods of Primary Data Collection, Methods of Secondary Data Collection, Selecting an Appropriate Method of Data Collection.	**07**
Unit 5 **Test of Significance:** Basic concepts, procedure of hypothesis testing, Tests for Hypotheses I and II, Important parameters, Limitations of the tests of Hypotheses, Parametric tests-chi square, t – Test, F Test, Z Test. Introduction to ANOVA, One way, Two way and three-way ANOVA classification.	**09**
Unit 6 **Intellectual Property Rights (IPRs) -** Intellectual Property-Importance and Protection of Intellectual Property Rights (IPRs)- A brief summary of: Patents, Copyrights, Trademarks, Industrial Designs, Geographical Indications. **Interpretation and Report Writing -** Techniques of interpretation, Structure and components of scientific reports, Layout, structure and language of the report, Illustrations and tables, References and Citations.	**09**
Tutorials:	
Tutorial 1: Carry out literature review using primary and secondary sources.	**3**
Tutorial 2: Formulate a research problem for your area of interest and prepare proposed objectives.	**2**
Tutorial 3: Develop a Research Methodology for the proposed problem.	**2**
Tutorial 4: Identify and develop effective data collection methodology.	**2**
Tutorial 5: Application of Statistical analysis and its interpretation of results.	**3**
Tutorial 6: Writing a Research Proposal in the format provided by various funding agencies.	**3**
Textbooks: 1. Books: C. R. Kothari, "Research Methodology", New Age international, 2004. 2. Deepak Chopra and Neena Sondhi, "Research Methodology: Concepts and cases", Vikas Publishing House, New Delhi, 2008.	

3. Ranjit Kumar, “Research Methodology: A Step-by-Step Guide for Beginners”, 2nd Edition, Sage Publisher, 2011.

References:

1. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi.
2. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
3. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
4. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications.
5. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
6. Intellectual Property Rights in the Global Economy: Keith Eugene Maskus, Institute for International Economics, Washington, DC, 2000.
7. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
8. Subbarau NR-Handbook on Intellectual Property Law and Practice-S Viswanathan Printers and Publishing Private Limited.1998
9. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
10. Wadehra, D. B. (2011). Law relating to intellectual property. Universal Law Publishing Co. Pvt. Ltd..

Class: F. Y. M. Tech. Environmental Engineering **Title of the Course:** Industrial Waste Treatment **Course Code:** MENPC0201	**L**	**T**	**P**	**Credit**
	3	**1**		**4**

Course Pre-Requisite: Environmental chemistry

Course Description:

The course is designed to provide an understanding of the alternate processes available to treat wastewater from industrial activities prior to its disposal as well as for potential reuse and recycling. As the characteristics of wastewater differ from industry to industry, knowledge of manufacturing process is necessary to understand specific treatment needed to meet the stipulated standards as per the consent. The common effluent treatment plants are very useful to ensure full-fledged treatment of wastewater from small scale industries with potential reuse and recycling

Course Objectives:

1. To learn the manufacturing process, water requirement and pollution aspects of various industries
2. To understand the benefits and techniques of waste minimization in industries
3. To study the various options for treatment of industrial waste
4. To learn the concept of common effluent treatment plant and project report

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Utilize knowledge of manufacturing process and pollution aspects of industries for treatment and disposal of waste	3	Applying
CO2	Apply concepts of pollution prevention and waste minimization in industries	3	Applying
CO3	Analyze issues related to treatment and disposal of waste in industries	4	Analyzing
CO4	Select alternative treatment for industrial waste to meet disposal standards	5	Evaluating

CO-PO Mapping:

CO	PO					
	1	2	3	4	5	6
CO1	2	1	2	1	3	2
CO2	2	3	2	3	2	3
CO3	3	2	3	2	2	2
CO4	2	2	1	1	3	3

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) have 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc. MSE: Assessment is based on 50% of course content (Normally first three Units) ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three Units) covered after MSE.	
Course Contents:	
Unit 1:---Sources, Characteristics and Effects of Industrial Waste Classification of Industries, General water requirements in industry, Sources and characteristics of industrial wastewater, Effects of untreated industrial wastewater, Effluent standards, Benefits of treatment of wastewater	**5Hrs.**
Unit -2:--- Waste Minimization and Treatment options Techniques of waste volume and strength reduction, Waste minimization - 4 R concepts, Zero discharge concepts , Classification of treatment, Treatment flow sheet development, Pre treatment of wastewater- Neutralization, Equalization, Proportioning	**5Hrs.**
Unit -3 Agro-based Industries Manufacturing processes, Water usage, Sources, quantities and characteristics of effluents (process stream and combined), Pollution effects, Waste Reduction/Reclamation/Byproduct recovery, Utilization, Alternative methods of treatment, and disposal for various Agro-based industries: Sugar, Distillery, Dairy, Pulp and paper mill, Textile	**12Hrs.**
Unit-4 Chemical industries Manufacturing processes, Water usage, Sources, quantities and characteristics of effluents (process stream and combined), Pollution effects, Alternative methods of treatment, Waste Reduction/Byproduct recovery, and disposal for various Chemical Industries: Fertilizers, Tannery, Petroleum and Oil refineries	**10 Hrs.**
Unit 5: **Engineering industries** Manufacturing processes, Water usage, Sources, quantities and characteristics of effluents (process stream and combined), Pollution effects, Alternative methods of treatment, Waste Reduction/Byproduct recovery, and disposal for Engineering industries : Steel, Foundries, Battery manufacturing	**8 Hrs.**
Unit 6:--- Treatment and Disposal System Joint treatment of industrial wastewater and sewage, Concept of Common Effluent Treatment Plant- Objectives, Design, benefits, Introduction to Project report preparation for waste treatment and disposal system of industries, Prefeasibility, feasibility and detailed project reports	**5Hrs.**
Textbooks: 1. "Theories and Practices of Industrial Waste Treatment", Nelson Nemerow, Wiley Publication Company, 2. Industrial Waste Treatment contemporary practice an vision for future", Nelson Nemerow Elsevier Science & Technology Books, 2006	
References: 1. W .W. Eckenfelder Jr., "Industrial Water Pollution Control", McGraw-Hill Book Company, New Delhi, 2000. 2. Industrial Waste Treatment by A.D Patwardhan 3. "Wastewater Engineering Treatment and Reuse", Metcalf And Eddy, Tata	

McGraw Hill Publication
4. A Handbook of Effluent treatnment plant by Mehajabin Shaikh, Enviro Media
5. MOEF standards Guide for Treatment and Disposal of Waste from Various Industries".
6. H.M.Freeman, "Industrial Pollution Prevention Hand Book", McGraw-Hill Inc., New Delhi,
7. "Pollution Prevention: Fundamental & Practice", Bishop, P.L.,McGraw-Hill, 2000.
8. "Industrial Pollution Prevention", T.T.Shen, Springer, 1999.
9. "Industrial Wastewater Systems Hand book", R.L.Stephenson and J.B.Blackburn, Jr., Lewis Publisher, New Yark, 1998
10. Lee, C.C. and Shun dar Lin. Handbook of Environmental Engineering Calculations, Mc Graw Hill, New York, 1999.
11. Casey T.J., Unit Treatment Processes in Water and Wastewater Engineering, John Wileys Sons, London, 1993.
12. David W.Hendricks, „Water Treatment Unit Processes: Physical and Chemical", CRC Press, Boca Raton, 2006.

Class: F. Y. M. Tech. Environmental Engineering **Title of the Course:** Biological Wastewater Treatment **Course Code: MENPE0202**	**L**	**T**	**P**	**Credit**
	3	**1**	**-**	**4**

Course Pre-Requisite:

- Wastewater treatment at graduate level and Unit Operations and Processes in environmental Engineering.

Course Description:

This course develops the fundamentals and applications of aerobic and anaerobic biological unit processes for the treatment of municipal and industrial wastewater. The principles of activated sludge, aeration and clarifier design, fixed film reactors, anaerobic treatment, solids handling, and treatment, land treatment, and nutrient removal are presented. This course uses concepts from microbiology and the basic principles of stoichiometry, energetics, and microbial kinetics are used to support the design of biological unit processes.

Course Objectives:

The course objectives are to:

1. To provide in-depth knowledge for the analysis and evaluation of biological and natural treatment processes of wastewater treatment critically.
2. To enhance the technical competency to apply the acquired knowledge for conduct of research and addressing the problems of industry/society related biological wastewater treatment.
3. To inculcate the qualities of critical thinking and independent judgement to e**valuate** and **design** biological wastewater treatment facilities.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	**Explain** the various biological and natural wastewater treatment processes.	2	Understanding
CO2	**Analyse** the performance of biological and natural wastewater treatment facilities.	3	Analysing
CO3	Evaluate the performance of biological and natural wastewater treatment facilities.	5	Evaluating
CO4	**Design** the biological wastewater treatment processes and natural treatment systems.	6	Creating

CO-PO Mapping:

	CO1	**CO2**	**CO3**	**CO4**
PO1	**3**			
PO2		**3**	**3**	
PO3		**3**	**3**	**3**
PO4		**3**	**3**	**3**
PO5	**3**	**1**	**1**	**1**
PO6		**1**	**3**	**3**

Assessment:

Assessment	Marks
ISE 1	10

MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three Units)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three Units) covered after MSE.

Course Contents:

Unit 1: Objectives and fundamentals of biological treatment Objectives and fundamentals of biological treatment, types of biological treatment processes, Microbial growth kinetics	**5 Hrs.**
Unit 2: Modeling suspended growth treatment processes Modeling suspended growth treatment processes Activated Sludge Process (ASP): Configurations and variations, Cyclic ASP, Process design and operating parameters, Operational problems, Evaluation of Biokinetic Parameters. Biological nitrification and denitrification. Design and operation of aerated lagoon, oxidation ditch, and facultative waste stabilization pond, Membrane bioreactor.	**10 Hrs.**
Unit 3: Modeling attached growth treatment processes Modeling substrate removal in attached growth treatment processes. Process, design considerations and operational problems for attached Growth aerobic biological treatment systems: Trickling filters and rotating biological contactors. Secondary clarification	**7 Hrs.**
Unit 4: Anaerobic processes Anaerobic processes, Process fundamentals, Growth kinetics, General design considerations, Types of anaerobic reactors. Process, design and operation of anaerobic lagoon, anaerobic filter and Upflow anaerobic sludge blanket systems	**7 Hrs.**
Unit 5: Sludge treatment and disposal Sludge treatment and disposal – characteristics, thickening, Sludge Digestion (anaerobic and aerobic), and disposal, Types of anaerobic digester and their selection, Design and operation of digesters. Stream and Effluent standards. Wastewater reclamation and reuse, Application of treated wastewater on land for irrigation, Effect of dissolved solids	**8 Hrs.**
Unit 6: Wetland and aquatic treatment systems Wetland and aquatic treatment systems: Types, application, Treatment kinetics and effluent variability in constructed wetlands and aquatic systems, Free water surface and subsurface constructed wetlands, Floating plants (water hyacinths and duckweed), Combination systems, Design procedures for constructed wetlands, Management of constructed wetlands and aquatic systems	**8 Hrs.**

Textbooks:

1. Wastewater Engineering Treatment and Reuse, Metcalf And Eddy, Tata McGraw Hill Publication, 1979, 4th Edition.
2. Manual on design of Constructed Wetland, US EPA
3. Manual on Sewerage and Sewage Treatment Systems, Part A (Engineering), Third Edition, Published by CPHEEO in collaboration with JICA

References:

1. "Theory and Practice of Water and Wastewater Treatment", Droste, Ronald L., John Wiley & Sons Publication, 1997, 1st Edition.
2. "Environmental Engineering", Peavy, Rowe and Technologous MGH.

3. "Environmental Engineering", Sincero. A.P. And Sincero. G.A., Prentice Hall of India Private Limited, 1996, 1st Edition.
4. "Wastewater Treatment for Pollution Control and Reuse", Arceivala S.J. and Asolekar, Tata McGraw Hill Publication, 2002, 2nd Edition.

Unit wise Measurable students Learning Outcomes:

At the end of course students will be able to

1. **Understand concepts of** biological treatment processes.
2. Understand and apply modeling, simulation and design of suspended growth biological wastewater treatment processes for conventional and specific pollutants
3. Understand and apply modeling, simulation and design of attached growth biological wastewater treatment processes
4. Understand and apply modeling, simulation and design of anaerobic biological wastewater treatment processes
5. Apply fundamental scientific concepts for treatment of sludge.
6. Apply fundamental scientific concepts and detailed technical understanding of the constructed wetland for domestic wastewater treatment.

Class: F.Y. M. Tech. Environmental Engineering **Title of the Course:** Environmental Impact Assessment & Legislation **Course Code:** MENPC0203	**L**	**T**	**P**	**Credit**
	03 hours per week	01 hours per week	-	4

Course Pre-Requisite:
Study of environmental pollutions and various treatment technologies and alternatives.

Course Description:
Students will study the predictions of impacts on various environmental resources and various legal provisions for protection of environment.

Course Objectives:
The course objectives are to:
1. To train the students regarding various aspects of Environmental Impact Assessment.
2. To understand various methodologies for assessing impact of a project.
3. To study various EIA case studies.
4. To understand various national policies and programs regarding environment.
5. To study provisions of various environmental acts rules and notifications regarding environmental protection.
6. To study various global and legal aspects of environmental pollution

Course Learning Outcomes:

COs	**After the completion of the course the students will be able to**	**Bloom's Taxonomy Descriptor**
CO.1	Explain the scope, methodologies, and public participation in EIA.	Cognitive (Analysing) L4
CO.2	Explain the objectives, types, and procedures of conducting EIA, including its limitations.	Cognitive (Analysing) L4
CO.3	Examine EIA knowledge to case studies in sectors like power plants, mining, and construction.	Cognitive (Analysing) L4
CO.4	Analyse environmental policies, pollution laws, and international conventions.	Cognitive (Analyzing) L4

CO-PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO.1		1	2	2	1	2
CO.2		1	1	3	1	3
CO.3	2	2	2	2	3	2
CO.4	3	1	2	3	2	2

Assessments:

Assessment	**Weightage (Marks)**
ISE-1	10
MSE	30
ISE-2	10
ESE	50

- **ISE 1 and ISE 2** are based on assignment/declared test/quiz/seminar/Group Discussions etc.

- **MSE:** Assessment is based on 50% of course content (Normally first three Units)
- **ESE:** Assessment is based on 100% course content with60-70% weightage for course content (normally last three Units) covered after MSE.

Course Contents:

Unit 1: Framework of Impact Assessment Scope, contents and types of EIA, Methodologies and techniques of EIA. Attributes, Standards and Value functions. EIA Notification history & present scope, public participation in EIA. Classification of EIA like Terrestrial, Marine etc.	**6 Hrs.**
Unit 2: Environmental Impact Assessment Definition, Objectives, Types– Rapid and Comprehensive EIA, EIS, FONSI. Step-by-step procedure for conducting EIA and Limitations of EIA, Prevention of Significant Deterioration Programme. Environmental clearance for Building sector, Building Energy Modelling, Traffic Management Plan and Carbon Footprint.	**6 Hrs.**
Unit 3: Various EIA case studies Thermal Power Plant, Mining, Fertilizer, Construction Projects, Airport, Water and Wastewater Treatment Plants.	**10 Hrs.**
Unit 4: Study of Environmental Policies Pre & Post Independence Period; From Stockholm to Johannesburg Declaration (Rio) and Role of Government –NITI Ayog and the functioning. Forest Policy – Conservation strategy Water Policy, Conservation of Natural Resources and its Management; NGT & its provisions.	**8 Hrs.**
Unit 5: **Prevention and Control of Pollution** Pollution of Water, Sources, Legal Control, The Water (P & CP) Act, 1974 The Water Cess Act Pollution of Air: The Air (P & CP) Act, 1981 Environment Protection Act,1986 and various rules under EPA.	**8 Hrs.**
Unit 6: International Laws and Environmental Protection International conventions in the development of Environmental Laws and its Policy - From Stockholm to recent conventions (Special Emphasis on Major conventions & Protocols) - Control on Marine Pollution; Common Law aspects of Environmental Protection; Various supreme court judgments regarding environmental protection.	**7 Hrs.**

Textbooks

1. Armin Rosencranz -Environmental Law and Its Policy in India.
2. P. Leelakrishnan-Environmental Law in India/Cases.
3. Lal's commentaries on Water and Air Pollution laws along with Environment (Protection) Act and Rules, 1986.
4. Canter L.(1995),"Environmental Impact Assessment", Mc Graw Hill.
5. Jain R.K., Urban L.V. Stacey G.S.,(1977),"Environmental Impact Analysis–A New Dimension in Decision Making", Van Nostrand Reinhold Co.
6. ClarkB.C.BisettandTomlinsonP,(1985),"PerspectiveonEnvironmentalImpact Assessment", Allied Publishers.

References:

1. Simon Ball Stuart Bell-EnvironmentalLaw.
2. Sanjay Upadhyay and Videh Upadhyay -Handbook on Environmental Laws.
3. S. Shantha Kumar-Introduction to EnvironmentalLaw.
4. Relevant Bare Acts/Notifications.

Class: F.Y. M. Tech. Environmental Engineering **Title of the Course:** Environmental Modelling and Simulation **Course Code:** MENPE0211	L	-	-	Credits
	03 hours per week			3

Course Pre-Requisite:

Students must have knowledge about numerical and mathematical rules and its use in solvingproblems by correlating constants and parameters with each other. Also students must be aware of concept and units for preparing mathematical model and correlated concepts of Environmental engineering.

Course Description:

Students will understand the importance of formulation of mathematical model for various applications in the environmental processes. They will study the pollution caused by disposal of waste in surface, sub surface water as well as on ground. The syllabus also includes Ph model, BOD model, and Modelling of Toxicity.

Course Objectives:

The course objectives are to:

1. Understand the concepts of modeling and simulation in Environmental engineering.
2. Study the concepts of various mathematical models of physical systems related towater quality.
3. Learn to correlate parameters for modeling in surface water quality of rivers, streams,lakes, reservoirs.
4. Understand modeling for underground water quality, pH modeling and transport ofcontaminants in ground water.
5. Acquire the knowledge of developing mathematical model for various environmentalsystems.

Course Learning Outcomes:

COs	**After the completion of the course the students will be able to**	**Bloom's Taxonomy Descriptor**
CO.1	Explain fundamental concepts in environmental modeling and simulation	Cognitive (Understanding) L2
CO.2	Analyze various mathematical models of physical systems and apply these models to real-world environmental scenarios.	Cognitive (Analyzing) L4
CO.3	Evaluate water quality data using appropriate modelling techniques, synthesize information from different models, and assess the impacts of various pollutants on water quality in rivers, lakes, and reservoirs.	Cognitive (Assessing) L5
CO 4	Develop comprehensive environmental models for various ecosystems.	Cognitive (Creating) L6

CO-PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO.1	2				2	1
CO.2	3	3	2	3		1
CO.3	3	3	3	2		1
CO 4	3	3	3	2		1

Assessments:

Assessment	**Weightage (Marks)**
ISE-1	10
MSE	30
ISE-2	10

ESE	50

- **ISE 1 and ISE 2** are based on assignment/declared test/quiz/seminar/Group Discussions etc.
- **MSE:** Assessment is based on 50% of course content (Normally first three Units)
- **ESE:** Assessment is based on 100% course content with60-70% weightage for course content (normally last three Units) covered after MSE.

Course Contents:

Unit 1: Fundamentals & Mathematical model of physical systems Fundamentals: Mass balance principle, Reaction kinetics (types of reaction, rate and order of reaction, Effect of temperature), Analysis of experimental data, Determination of rate constants Mathematical model of physical systems- Hydraulic models of natural systems (Types of reactors), CFSTR, PFR Models, Ideal flow models, Mass balance applications	**9 Hrs.**
Unit 2: Modelling Water quality in Environment Modelling Water quality in Environment: Transport phenomena, Advection, diffusion, dispersion, Dispersion and mixing in streams, Air/water interface, Gas transfer (agitated and stagnant), pH modelling.	**7 Hrs.**
Unit 3: Surface water quality modelling Surface water quality modelling-, Water quality in rivers & streams, Point and non-point sources, BOD model, Point source Streeter –Phelp equation, Nitrogenous BOD modelling, Sediment oxygen demand, Stream quality modeling QUAL2E	**7 Hrs.**
Unit 4: Water quality of lakes & reservoirs Water quality of lakes & reservoirs- Hydraulic behaviour, Effect of physical processes on Water quality, Modelling of lakes & reservoirs, 1D model, Vertical modelling, Ecological modelling, Significance, Eutrophication in flowing water.	**8 Hrs.**
Unit 5: Subsurface water quality modelling Subsurface water quality modeling, Transport of non-reactive& reactivecontaminant in Ground water, Gaussian plume model	**7 Hrs.**
Unit 6: Microbe / Substrate modelling and pH modelling Microbe / Substrate modelling: bacteria growth, substrate utilization, Microbial kinetics, batch and CSTR, toxicant modelling in flowing water. pH modelling, Toxics substance model in CSTR, Bio-concentration andBioaccumulation model.	**7 Hrs.**

Textbooks

1. Surface water quality modelling - Steven Chopra, McGraw hill
2. Water quality modelling; modification - Tchobanoglous (Addision& WesleyEdward Schroedar)
3. Environmental Engineering - Sincero and Sincero
4. USEPA: www.epa.gov.in QUAL2E model
5. Metcalf & Eddy. Waste Water Engg. Treatment & Disposal,Tata McGraw - Hill Pub.

References:

Water Quality Modelling by Muler

Unit wise Measurable students Learning Outcomes: Students will..

- **Unit-1** Explain significance of mass balance principle in reactor design and. Hydraulic models of natural systems.
- **Unit-2** Demonstrate model of water quality in Environment, Transport phenomena andideal flow models.
- **Unit-3** Apply concepts of Surface water quality for rivers & streams, Point and non-pointsources, BOD model.
- **Unit-4** Develop the mathematical model for water quality of lakes and reservoirs, BOD model, stream quality modelling.
- **Unit-5** Analyze and design the subsurface water quality model for transport of contaminant in Ground water.
- **Unit-6** Develop toxicant model of water, pH modelling and Bio-concentration andBioaccumulation model.

Class: F. Y. M. Tech. Environmental Engineering **Title of the Course:** Environmental Management System **Course No.:** MENPE0212	**L**	**T**	**P**	**Credits**
	03	---	---	03

Course Pre-Requisite:

Students shall have the knowledge of:

- Environmental legislations
- Activities related to environment in industries
- Best practices for environmental management

Course Description:

Environmental Management Systems course deals with the implementation of effective environmental management system in organizations managing the various environmental aspects. The course underlines on learning the requirements of the various elements of EMS to be established. The course emphasizes on the different tasks to be performed under EMS.

Course Learning Objectives:

1. To understand the requirements of ISO 14001: 2015 Environmental Management System standard.
2. To learn the different tasks to be performed for the implementation of EMS.
3. To understand the processes and requirements of EMS audit.

Course Outcomes:

COs	**After the completion of the course the students will be able to**	**Bloom's Cognitive Descriptor**
CO1	Interpret the terms used in ISO 14001 and ISO 19011 standards with respect to EMS.	Cognitive (Understanding) L2
CO2	Illustrate the requirements of planning, implementation, support & operation and performance evaluation of EMS.	Cognitive (Understanding) L2
CO3	Summarize the requirements of EMS Audit as per ISO 19011.	Cognitive (Understanding) L2
CO4	Develop the documented information and checklists for EMS.	Cognitive (Applying) L3

CO-PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2			1		
CO2	1	1		1	2	1
CO3	1	1		1	2	
CO4	1	2	3	1	1	3

Assessments:

Assessment	**Weightage (Marks)**
ISE-1	10
MSE	30
ISE-2	10
ESE	50

- **ISE-1 and ISE-2:** Assessment is based on Assignment/Declared Test/Quiz/Seminar/Group Discussions etc. (For each ISE two different tools are to be used).
- **MSE:** Assessment is based on 50% of course content (Normally first three Units)
- **ESE:** Assessment is based on 100% course content with 30% weightage for course content covered before MSE and 70% weightage for course content covered after MSE.

Course Contents:

Unit 1:	07 Hours
Introduction to EMS and ISO standards, History of ISO, Benefits of ISO	

Standards, Standard Development Process at ISO, Environmental Management System (EMS) and Sustainable Development, Application of Life Cycle Analysis under EMS, Aim of EMS, Deming's PDCA Cycle, Terms and Definitions, Scope of ISO 14001:2015 Standard, Deciding the Context of Organization for EMS.	
Unit 2: Leadership and Commitment, Environmental Policy, Organizational Roles, Responsibilities and Authorities, Planning, Actions to address Risks and Opportunities, General Requirements, Aspects – Impacts Analysis for EMS, Compliance Obligations, Environmental Objectives, Planning Actions to achieve Environmental Objectives, Preparation of Aspect Impact Register, Preparation of Action Plan.	08 Hours
Unit 3: Support – Resources, Competence, Awareness, Communication – Internal and External Communication, Documented Information – Creating and Updating, Control of Documented Information, Operation – Operational Planning and Control, Emergency Preparedness and Response, Evaluation of Documented Information – Procedures used under EMS, Evaluation of Emergency Response Plan.	08 Hours
Unit 4: Performance Evaluation – Monitoring, Measurement, Analysis and Evaluation, Evaluation of Compliance, Calibration and Records, Standard Operating Procedures, Work Instructions, Preparation of Legal Requirements Register, Preparation of Checklists for Performance Evaluation.	08 Hours
Unit 5: Internal Audit, Internal Audit Programme, Terms and Definitions, Principles of Auditing, Managing an Audit Programme, Audit Activities, Audit Checklists and Reports, Competence and Evaluation of Auditors, Preparation of Checklists for Audit, Evaluation of an Audit Report.	08 Hours
Unit 6: Management Review - Need, Role of Management Representative, Role of Top Management, Improvement, Nonconformity and Corrective Action, Continual Improvement, Need of Brainstorming for Corrective Action, Preparation of Plan for Continual Improvement, Sustainability Assurance	06 Hours

Textbooks:

1. International Standard ISO 14001:2015 – Environmental Management Systems – Requirements withGuidance for Use
2. International Standard ISO 14004:2016 - Environmental Management Systems - General guidelineson implementation
3. International Standard ISO 19011:2018 – Guidelines for Environmental Management System auditing.

Reference Books:

1. Environmental Management Systems Auditors Course Manual by Confederation of Indian Industries.

Unit wise Measurable Students Learning Outcomes:

Unit Learning Objectives:

1. To know the application of ISO 14001 standard.
2. To learn the methodologies for Aspect Impact Analysis.
3. To understand the elements of establishment of EMS.
4. To know the approaches used for performance evaluation of EMS.
5. To understand the types of Audits and requirements.
6. To learn the importance of Continual Improvement n EMS.

Unit Outcomes:

At the end of course students will be able to:

1.1 Interpret the different term used in EMS. CO1
1.2 Illustrate the requirements of Context of Organization. CO2
2.1 Illustrate the planning requirements of EMS. CO2
2.2 Develop the Aspect Impact Register. CO4
3.1 Illustrate the requirements of Support and Operation. CO2
3.2 Develop the documented information of an element of EMS. CO4
4.1 Illustrate the requirements of Performance Evaluation in EMS. CO2
4.2 Develop the checklist to be used for Performance Evaluation. CO4
5.1 Interpret the different terms used with reference to EMS Audit. CO1
5.2 Summarize the Audit Activities of EMS. CO3
6.1 Illustrate the requirements of Management Review. CO2
6.2 Illustrate the requirements of Continual Improvement. CO2

Class: F. Y. M. Tech Environmental Engineering **Title of the Course:** Environmental Geotechnology **Course No.:** MENPE0213	**L**	**T**	**P**	**Credit**
	03 hours per week	-	-	3

Course Pre-Requisite:

Students shall have the knowledge of:

- Engineering Physics and Chemistry
- Geotechnical Engineering.
- Solid Waste Treatment

Course Description:

The course imparts knowledge of geotechnical aspects relevant to Environmental Geotechnology, starting with an introduction and exploration of its scope. It delves into the crucial role of soil in various geoenvironmental applications and highlights the multidisciplinary nature of Geo-environmental Engineering. The syllabus addresses problematic soils and rocks, emphasizing guidelines and care necessary for handling such materials. Environmental geotechnical problems are scrutinized, including the effects of pollution on soil behaviour, environmental integrity. It also covers waste containment systems and landfill design. Critical aspects such as landfill stability, compaction, and slope stability are thoroughly explored. Also contaminated site characterization and risk assessment are addressed.

Course Learning Objectives:

1. To study geotechnical/geo environmental parameters and its relevance
2. To understand environmental geotechnical problems.
3. To study soil pollution interaction.
4. To understand waste control systems and applications of geosynthetics.

Course Outcomes:

COs	**After the completion of the course the students will be able to**	**Bloom's Cognitive Descriptor**
CO.1	Explain significant aspects of Environmental Geo-technology.	Cognitive (Understanding) L2
CO.2	Apply concepts of stability analysis to evaluate the safety and effectiveness of landfill design	Cognitive (Apply) L3
CO.3	Assess the advantages and limitations of different geo-synthetic materials and methods in soil remediation.	Cognitive (Evaluating) L5
CO.4	Design suitable waste control system to avoid soil pollution.	Cognitive (Create) L6

CO-PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO.1	1					2
CO.2				2	1	2
CO.3	1		1	1		2
CO.4	1	2	1	3	1	2

Assessments :

Assessment	**Weightage (Marks)**
ISE-1	10
MSE	30
ISE-2	10
ESE	50

- **ISE-1 and ISE-2:** Assessment is based on Assignment/Declared Test/Quiz/Seminar/Group Discussions

etc. (For each ISE two different tools are to be used).

- **MSE:** Assessment is based on 50% of course content (Normally first three Units)
- **ESE:** Assessment is based on 100% course content with 30% weightage for course content covered before MSE and 70% weightage for course content covered after MSE.

Course Contents:

Unit 1: **Introduction to environmental geotechnology:** Introduction and Scope of Environmental Geotechnology, Role of soil in Geo environmental applications, Multidisciplinary aspects of Geo environmental Engineering, Sources and types of ground contamination, Impact of ground contamination on geo environment.	**06 Hrs.**
Unit 2: **Soil & Rocks:** Problematic soils and rocks, guidelines and care to be exercised for such soils, Environmental geotechnical problems. Pollution effect on soil behavior, environment and public concerns	**06 Hrs.**
Unit 3: **Soil Interaction:** Environmental cycles and their interaction, Soil mineralogy, Soil-Water-Contaminant interactions and its Implications, Pollution process and soil pollution interaction, Waste Containment System, Landfills, Methods for landfill site selection, Design concepts of landfills. Role of soil in engineered landfill.	**06 Hrs.**
Unit 4: **Landfill:** Disposal of solid and liquid waste in soil, stability of refuse landfill, problems of land fill sites, compaction of landfill, slope stability of landfills, stability of garbage in decomposed stage.	**06 Hrs.**
Unit 5: **Waste Control System:** Design of waste control systems, their components, structures of control system components.	**06 Hrs.**
Unit 6: **Contaminated Site Remediation:** Contaminated Site Characterization and Risk Assessment, Selection and planning of remediation methods for soil and groundwater, Physico-chemicaland other methods. Types and configurations of Geosynthetics / geotextiles, applications in Environmental Engineering and pollution control.	**06 Hrs.**

Textbooks:

1. Introduction to Environmental Geotechnology by Hsai Pang Fang,CRC press, Boca Raton New york
2. Geoenvironmental Engineering by Sharma and Redd
3. Fundamentals of Soil Behavior Mitchell, J. K and Soga, K, John Wiley and Sons Inc.,2005

References:

1. Geotechnical Practice for Waste Disposal Daniel, D.E, , Chapman, and Hall, 1993.
2. Barrier Systems for Waste Disposal Facilities Rowe, R.K., Quigley, R.M. and Booker,Clay, J.R., E and FN Spon, 1995.
3. Geotechnical and Geoenvironmental Engineering Handbook Rowe, R. K., Kluwer Academic publishers, 2001.
4. Geoenvironmental Engineering – Principles and Applications Reddi, L. N. and Inyang, H. F, Marcel Dekker Inc, 2000.
5. Waste Containment Systems, Waste Stabilization and Landfills: Design and Evaluation Sharma, H.D, and Lewis, S.P, , John Wiley and Sons Inc., Geotechnical Engineering (2002): D.P. Coduto, Pearson Education

Unit wise Measurable Students Learning Outcomes:

Unit Learning Objectives:

1. To understand the scope, role of environmental geotechnology, including sources, types, and impacts of ground contamination.
2. To identify problematic soils, geotechnical issues, and pollution impacts.

3. To understand soil interactions, landfill design, and soil's role in waste containment.
4. To learn landfill waste disposal, ensuring stability and addressing site issues.
5. To design effective waste control systems with structured components and structures.
6. To characterize contaminated sites, plan and implement soil and groundwater remediation.

Class: F.Y. M. Tech. Environmental Engineering **Title of the Course:** Watershed Management **Course Code:** MENPE0214	L	-	-	Credits
	03 hours per week			3

Course Pre-Requisite:
Students must have knowledge about natural resources available and the environmental impact of disaster and famine. Accordingly, students must be aware of utilization of water, soil, air andsurroundings towards approach of greenery.

Course Description:
Students will understand the importance of utilization of natural resources for better living ofhuman being. They will study the basic techniques of sustainable development. The course also includes advanced methods of watershed development in accordance with water storage and utilization, soil and land development, water harvesting methods and modern techniquesof farming.

Course Objectives:
The course objectives are to:

1. Understand the significance, concept, necessity& scope of watershed Managementand sustainable management practices.
2. Study general, scientific &engineering approaches regarding proper planning &utilization of water.
3. Learn Socio – Economic Aspects of Watershed Management.
4. Acquire the knowledge of standard watershed model based on standard modeling approaches and classifications.
5. Study storm water drainage system design, flood routing, flood control and reservoiroperation, Drought assessment and mitigation planning.

Course Learning Outcomes:

COs	**After the completion of the course the students will be able to**	**Bloom's Taxonomy Descriptor**
CO.1	Explain the basic concepts of watershed management.	Cognitive (Understanding) L2
CO.2	Apply integrated watershed management techniques.	Cognitive (Applying) L3
CO.3	Evaluate the socio-economic and institutional aspects of watershed management, including community participation, private sector involvement, water legislation, and the role of NGOs and international agencies.	Cognitive (Assessing) L5
CO 4	Determine comprehensive watershed models using advanced techniques.	Cognitive (Assessing) L5

CO-PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO.1	2				2	
CO.2	3		2	3	3	1
CO.3					3	
CO 4	3	3	3	1		2

Assessments:

Assessment	**Weightage (Marks)**
ISE-1	10
MSE	30
ISE-2	10

ESE	50

- **ISE 1 and ISE 2** are based on assignment/declared test/quiz/seminar/Group Discussions etc.
- **MSE:** Assessment is based on 50% of course content (Normally first three Units)
- **ESE:** Assessment is based on 100% course content with60-70% weightage for course content (normally last three Units) covered after MSE.

Course Contents:

Unit 1: Introduction to Watershed Management Concept of watershed, Introduction to watershed management, Watershed management policies and decision making, Place in environment, Global effects, Status in India, Historical background **Sustainable Watershed Management Practices** Sustainable integrated watershed management, Natural resources management, agricultural practices, Integrated farming, Soil erosion and conservation, Reclamation of saline soils, Watershed Management Practices in different Regions, Short term and long-term strategic planning	**9 Hrs.**
Unit 2: Integrated Approach of Watershed Management Introduction, Integrated water resources management, conjunctive use of water resources, rainwater harvesting; roof catchment system, Groundwater - potential & harvesting, well construction.	**7 Hrs.**
Unit 3: Socio – Economic Aspect of Watershed Management Community participation, Private sector participation, Institutional issues, Socio-economy, Integrated development, Water legislation and implementations, Role of NGOs and International agencies	**7 Hrs.**
Unit 4: Modeling of Watershed Standard modeling approaches and classifications, Concept for watershed modeling, overall description of different hydrologic processes, modeling of rainfall- runoff process, subsurface flows and groundwater flows. **Management of Water Quality:** Water quality and pollution, Types and sources of pollution**,** Water quality modeling, Environmental guidelines for water quality	**9 Hrs.**
Unit 5: Storm Water, Flood and Drought Management Storm water management, design of drainage system, flood routing through channels and reservoir, flood control and reservoir operation, Drought assessment and classification, drought analysis techniques, drought mitigation planning.	**7 Hrs.**
Unit 6: Advanced Techniques in Watershed Management Applications of Geographical Information System (GIS) and Remote Sensing in Watershed Management, Modeling of watershed using software.	**6 Hrs.**

Textbooks

1. Murty, J.V.S. "Watershed Management", New Age Intl., New Delhi 1998
2. Murthy, J.V.S., Watershed Management in India, Wiley Eastern, New Delhi, 1994
3. Purandare, A.P., Jaiswal A.K., Waterhed Development in India, NIRD, Hyderabad,1995
4. Vir Singh, Raj , Watershed Planning and Management, Yash Publishing House,Bikaner, 2000
5. Hydrology & Soil Conservation Engineering - GhanshamDas , Prentice Hall ofIndia
6. Manual of Soil & Water Conservation Practices - Gurumal Singh, Oxford & IBHPublishing Company
7. Soil & Water Conservation Engineering - R. Suresh, Standard Publishers

References:

Report of Watershed Management for Badri Village of Bihar

Class: F.Y.M.Tech Environmental Engineering **Title of the Course:** Audit Course – II: Statistical Methods and Optimization **Course Code:** MENAU0281	**L**	**T**	**P**	**Credit**
	02 hours per week	-	-	00

Course Pre-Requisite:

Students shall have knowledge of

- Mathematics, Algebra and Statistics.
- Computer and Microsoft office tools.

Course Description:

The objective of the course is to introduce students to computational methods for solving problems in Environmental Engineering (both for modeling and experimental work). The idea has been to impart insight into various statistical tools, that too without resort to undue technicality and verbosity. The course provides students with the necessary background to enable them to implement various statistical inferential approaches. It also helps them to develop an ability to analyze and apply some basic stochastic processes for solving real life situations through systematic logical thought process.

Course Learning Objectives:

1. Impart the fundamental understanding of the methods based on concepts previously acquired in mathematics and algebra.
2. Make students familiar with the computer as an engineering tool and to improve logical and analytical skills.
3. Encourage students to focus on the core ideas of the traditional statistical techniques used to solve engineering problems.
4. Present the techniques and applications of linear optimization models in simple manner.

Course Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Taxonomy Descriptor**
CO1	Summarize patterns and trends in data including outliers and anomalies to visualize and interpret data distribution.	Cognitive (Understanding) L2
CO2	Apply appropriate statistical measures and data analysis techniques for grouped and ungrouped data cases.	Cognitive (Applying) L3
CO3	Analyze the results of bivariate and multivariate regression and correlation analysis for linear and non-linear models.	Cognitive (Analyzing) L4
CO4	Determine the feasible solutions to given problems using linear optimization models.	Cognitive (Evaluating) L5

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		3		2		
CO2		3		2		
CO3		3	2	2		
CO4		3	2	2		

Assessments:

Assessment	**Marks**
ISE	100

Course Contents:

Unit 1: Database Design and Presentation Spreadsheet tools, features and functions, formulas and functions, data storing, data analysis, types of charts, graphs and other features, classification, objectives, rules, modes of classification, tabulation, objectives, components of table, requisites of a good statistical table, types of tables.	7 Hours
Unit 2: Statistical Techniques Frequency distribution, grouped frequency distribution, cumulative frequency distribution, bivariate frequency distribution, measure of central tendency, mean, median, mode, geometric mean, harmonic mean, measure of dispersion, range, quartile deviation, mean deviation, standard deviation, variance, coefficient of dispersion, coefficient of variation.	8 Hours
Unit 3: Regional Statistical Analysis Joint and marginal distribution, curve fitting, least-square method, covariance, correlation, regression, simple correlation, linear and non-linear correlation, multiple regression analysis, stepwise regression analysis, use of computers in correlation and regression analysis.	7 Hours
Unit 4: Linear Optimization Models Objective function and constraints, Formulation of linear optimization models, Graphical method, Simplex method, Big M method, Two phase method, Transportation model, Assignment model, Variants.	8 Hours

Textbooks:

1. Grewal, B. S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 2008.
2. Gupta, S. C., and Kapoor, V. K., "Fundamentals of Applied Statistics", Sultan Chand and Sons, New Delhi.
3. Sancheti, D. C., and Kapoor, V. K., "Statistics (Theory, Methods and Applications", Sultan Chand & Sons, New Delhi.

Reference Books:

1. Freund, J., "John E. Freund's Mathematical Statistical with Applications" Pearson Education, Asia.
2. Freund, J.E., and Miller, I.R., "Probability and Statistics for Engineers", Prentice – Hall of India, New Delhi.
3. Holder, R. L., "Multiple Regression in Hydrology", A Book by Institute of Hydrology, ISBN: 09485-40001.
4. Montgomery, D. C., and Runger, G. C., "Applied Statistics and Probability for Engineers", Wiley India.
5. Mood, A.M. Graybill, F.A. and Boes, D.C., "Introduction to the Theory of Statistics", 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
6. Mukhopadhyay, P., "Applied Statistics", New Central Book Agency.

Unit Learning Objectives:

Make students to

1. Understand the concept of organizing data using classification and tabulation techniques.
2. Recognize the perceptions of measure of central tendency and measure of dispersion.
3. Understand the concepts of simple and multiple correlation and regression analysis.
4. Learn the basic principles of linear optimization models to solve an LPP using various methods.

Unit Outcomes:

After completion of the unit, students will be able to,

1. Illustrate the use of spreadsheets to analyze and present the data. (CO1)
2. Apply fundamental concepts of statistical properties to compare two or more series with regard to their variability to trace precise relationships. (CO2)

3. Measure the degree or extent to which two or more variables fluctuate with reference to one another. (CO3)
4. Formulate the LPP and give the solution for the problem using suitable optimization models. (CO4)

Title of the Course: **ENVIRONMENTAL MONITORING LAB II** Course Code: MENPC0231	L	T	P	Credit
	0	0	2	1

Course Pre-Requisite:

- Environmental chemistry and Microbiology
- Basic knowledge of analytical instrumentation

Course Description:

Students will be demonstrated with use of equipment's in laboratories and hands-on practice in the field for water quality monitoring

Course Objectives:

1. To provide hands-on practice for analysing the water and wastewater by physical, chemical and instrumental methods.
2. To provide fundamental knowledge of laboratory skills.
3. To impart knowledge of microbiology and bacterial identification.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive Descriptor
CO1	**A**pply the principles and procedures of physico-chemical and microbiological analysis of water and wastewater.	Cognitive (Applying) L3
CO2	E**valuate** water and wastewater samples using instrumental methods, including the calibration and operation of advanced analytical instruments.	Cognitive (Evaluating) L5

Assessments:

Assessment	Marks
ISE	50

ISE is based on experimental work/performance in laboratory/assignment/declared test/internal oral etc.

CO-PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO.1	2	1	2	2	2	3
CO.2	3	3	3	3	1	3

Course Contents:

List of Experiments

i. Physico-chemical analysis of water & wastewater:
   a. pH
   b. Hardness and Alkalinity
   c. Conductivity
   d. Solids
   e. Dissolved oxygen
   f. Chlorides
   g. Residual chlorine and free chlorine
   h. BOD and COD
   i. Fluoride
   j. Iron and Manganese

ii. Microbiology
   a. Cell Types – Eukaryotic and Prokaryotic
   b. Gram staining
   c. Bacterial cultures
   d. MPN

iii. Instrumental Methods: Calibration and Operation of Flame photometer, Spectrophotometer, Atomic Absorption Spectrophotometer and Colorimeter

Textbooks:

1. Peavy H, S, Rowe D, R, and Tchobanoglous G, *"Environmental Engineering",* McGraw-Hill book company, , International edition, 1985.
2. Pelczar, Jr, M.J., E.C.S., Krieg, R.Noel., and PelczarMerna Foss. "Microbiology", Tata McGraw Hill Publishing Company Limited, 5_{th} edition., 1996.
3. Sawyer. C.N. And McCarty. P.L., *"Chemistry for Environmental Engineers",* Tata McGraw-Hill Publishing Company Limited, 5_{th} Edition, 2003.

References:

1. Standard Methods for the Examination of Water and Wastewater, Washington, D.C., 21st Ed., 2001.
2. Metcalf and Eddy *"Wastewater Engineering Treatment and Reuse",* Tata McGraw Hill Publication, 6_{th} Reprint. 2003.

Title of the Course: Treatability Studies Laboratory- II Course Code: MENPC0232	L	T	P	Credit
	0	0	4	2

Course Pre-Requisite:

Environmental chemistry, instrumentation and Unit Operations and Processes in Environmental Engineering

Course Objectives:

1. To develop skills to extract information pertinent to plan, design and conduct experiments.
2. To impart knowledge of modern engineering and IT tools for prediction, analysis, design and modelling of complex environmental systems.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	**Develop** the methods for evaluation of parameters and systems related to wastewater treatment using appropriate techniques and tools.	6	Creating
CO2	**Analyse** results of experimental studies of performance evaluation and characterization studies.	4	Analysing

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO.1	2	1	2	2	2	3
CO.2	3	3	3	3	1	3

Assessments:

Assessment	Marks
ISE	50

ISE is based on experimental work/performance in laboratory/assignment/declared test/etc.

Course Contents:

List of Experiments

i. Determination of BOD rate constant for domestic and industrial wastewater
ii. Development of laboratory scale Activated Sludge Process (ASP) and Determination of MLSS, MLVSS and sludge volume index
iii. Evaluation of bio-kinetic parameters for aerobic treatment
iv. Performance evaluation of aerobic sequential batch reactor for treating domestic wastewater
v. Evaluation of effluent quality for land application
vi. Evaluation of impact of effluent disposal on soil
vii. Study on characterization of raw and processed sludge
viii. Development and operation of anaerobic reactor for wastewater / sludge treatment

ix. Study and application of SEWERCAD/SEWERGEM for simple case studies.

x. Development of spreadsheet-based simulation/analysis/design modules for water/wastewater treatment system/solid waste processing units/air quality modelling.

Textbooks:

1. Hammer M, J and Hammer M, J, "Water and Wastewater Technology", PHI learning private limited, 6th Edition, 2008.
2. Metcalf and Eddy "Wastewater Engineering Treatment and Reuse", Tata McGraw Hill Publication, 6th Reprint. 2003,
3. Lee C, C and Lin S, D, "Handbook of environmental engineering calculations", McGraw Hill Publication, 2nd Edition. 2007

References:

1. Sawyer and McCarty, "Chemistry for Environmental Engineers", Tata McGraw Hill, Edition 5, 2003.
2. Clesceri, L. S., Greenberg, A. E. and Eaton, A. D. (Eds), Standard Methods for the Examination of Water and Wastewater, Washington, D.C., 21st Ed., 2001.
3. Quasim, S. R., "Wastewater treatment plants planning, design and operation", CRC Press, 2nd Edition, 2010.
4. User manuals of EPANET, WATERCAD, WATERGEMS, SEWERCAD, Qual2e, MODFLOW etc.

Class: F. Y. M. Tech Environmental Engineering **Title of the Course: Mini Project** **Course No.: MENIL0271**	**L**	**T**	**P**	**Credits**
	---	**---**	04 hours per week	02

Course Pre-Requisite:

Students shall have the knowledge of:

- **Basic Sciences**
- **Engineering Sciences**
- **Mathematics**
- **Research Methodology**

Course Description:

This course provides hands-on experience in addressing real-world environmental engineering challenges through a focused mini project. Students will select a relevant topic, conduct literature reviews, design experiments or simulations, and apply engineering principles to solve the problem. The course emphasizes project planning, data analysis, and effective communication of results. It culminates in a final report and presentation, demonstrating the practical application of theoretical knowledge gained during the program.

Course Learning Objectives:

1. To apply advanced environmental engineering concepts and methodologies to identify, analyze, and develop solutions for specific problems in the field of environmental engineering.
2. To enhance students' ability to conduct comprehensive research, analyze data, and effectively communicate their findings through written reports and oral presentations.

Course Outcomes:

COs	**After the completion of the course the students will be able to**	**Bloom's Taxonomy Descriptor**
CO.1	Apply advanced environmental engineering concepts and methodologies to identify and develop practical solutions for environmental issues.	Psychomotor (Readiness to Act) L3
CO.2	Establish the findings for describing the work undertaken, results, and conclusions within the specified time frame.	Psychomotor (Ability to Perform) L5

CO-PO Mapping:

CO	**1**	**2**	**3**	**4**	**5**	**6**
CO1	1	2	3	3	1	1
CO2	1	2	3	3	2	1

Assessments:

Assessment	**Weightage (Marks)**
ISE	100

- **ISE:** Assessment is based on the efforts of the students for formulating the problem, developing design solutions, testing and validating the solution and presentation.

Course Contents:

Students are expected to carry out independent research work on the selected topic. It is expected that the students formulate the research problem, develop/fabricate of experimental set-up (if any) and test and analysis of results thus obtained. The students are required to submit the report of mini project work and present their findings during the oral presentations.

Class: F. Y. M. Tech. Environmental Engineering	**L**	**T**	**P**	**Credits**
Title of the Course: Internship **Course No.:** MENIL0371	---	---	20	10

Course Pre-Requisite:

Students shall have the knowledge of:

- Environmental Protection and Pollution Prevention Measures, Environmental Management
- Use of tools and applications in various domains of Civil and Environmental Engineering

Course Description:

Internship course has been included in the curriculum to provide the candidates the exposure to professional practices followed in the field of Environmental Engineering. Internship provides an opportunity to the students to learn the various aspects of Environmental Engineering in Industries and other organizations.

Course Learning Objectives:

1. To understand the professional practices followed in the field of Environmental Engineering.
2. To advance with reference to skills to be used in the Environmental Engineering field.

Course Outcomes:

COs	**After the completion of the course the students will be able to**	**Bloom's Cognitive Descriptor**
CO1	Build the knowledge base with reference to practices and measures followed in the field with reference to Environmental Engineering Domains.	Cognitive (Applying) L3
CO2	Determine the solutions to the field problems by using different approaches, tools and techniques.	Cognitive (Evaluating) L5

CO-PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	2	-	-	2	-
CO2	-	3	2	2	-	2

Assessments:

Assessment	**Weightage (Marks)**
ISE	100

- **ISE:** Assessment is based on Presentation and Report related to Internship.

Course Contents:

This internship course is designed to provide M. Tech Environmental Engineering students with hands-on, practical experience in a professional setting in terms of working as an intern in organisations. Students will apply theoretical knowledge gained during their coursework to real-world environmental engineering projects, enhancing their technical skills, professional development, and industry readiness.

Class: S. Y. M. Tech Environmental Engineering **Title of the Course: Dissertation Phase I** **Course No.: MENIL0372**	**L**	**T**	**P**	**Credits**
	---	**---**	20 hours per week	10

Course Pre-Requisite:

Students shall have the knowledge of:

- **Core Courses of Environmental Engineering**
- **Research Methodology Course**
- **Mini Project Course**

Course Description:

In this initial phase, students identify a research problem, conduct a comprehensive literature review, and formulate a research proposal. Emphasis is placed on developing a clear research plan, including objectives, methodology, and expected outcomes. Students begin preliminary data collection and analysis, laying the groundwork for their final dissertation.

Course Learning Objectives:

1. To enable students to identify a significant environmental engineering research problem, conduct a thorough literature review, and develop a well-structured research proposal with clear objectives and methodology.
2. To equip students with the skills to design a comprehensive research plan, including selecting appropriate research methods, tools, and techniques for preliminary data collection and analysis.
3. To develop students' abilities to document their research progress effectively and present their initial findings and research plan to a faculty committee for constructive feedback and guidance.

Course Outcomes:

COs	**After the completion of the course the students will be able to**	**Bloom's Taxonomy Descriptor**
CO.1	Develop and submit a detailed research proposal that identifies a significant environmental engineering problem, includes a thorough literature review, and outlines clear research objectives and methodology.	Applying L3
CO.2	Design a robust research plan, selecting appropriate methods and tools for preliminary data collection and analysis, thereby laying a strong foundation for their research.	Creating L6

CO-PO Mapping:

CO	**1**	**2**	**3**	**4**	**5**	**6**
CO1	2	1	2		1	1
CO2	2	1	2	2		1

Assessments:

Assessment	**Weightage (Marks)**
ISE 1	25
ISE 2	25
ESE (OE)	100

- **ISE 1 & 2:** For dissertation phase I, these ISEs should be based on the efforts by the student for synopsis preparation. It shall be evaluated using the parameters extent of literature review, scope defined, objectives, fundamental concepts, quality of presentation, and interaction during presentation, effort/work done, quality of report and interaction with guide.

- **ESE:** Shall be conducted at the end of semester by a duly constituted examination panel composed of Chairman, internal examiner (guide) and external examiner.

Course Contents:

The third semester is completely devoted to dissertation work which is defined based on the interest of the students to specialize in a particular area. Students are expected to carry out independent research work on the chosen topic. In this semester it is expected that the student has carried out substantial research work including exhaustive literature survey, formulation of the research problem, development/fabrication of experimental set-up (if any/required) and testing, and analysis of initial results thus obtained.

Class: S. Y. M. Tech Environmental Engineering	**L**	**T**	**P**	**Credits**
Title of the Course: Dissertation Phase II **Course No.: MENIL0471**	**---**	**---**	40 hours per week	20

Course Pre-Requisite:

Students shall have the knowledge of:

- **Core Courses of Environmental Engineering**
- **Research Methodology Course**
- **Mini Project Course**
- **Dissertation Phase I Course**

Course Description:

Building on the groundwork completed in Dissertation Phase 1, students complete their data collection and conduct in-depth analysis. This phase focuses on interpreting results, drawing conclusions, and making recommendations based on the research findings. Students are required to compile their work into a detailed dissertation, demonstrating their ability to conduct significant, independent research. The phase culminates in a final defense, where students present and defend their research before a Expert evaluators panel.

Course Learning Objectives:

1. To enable students to perform comprehensive data analysis, interpret the results accurately, and draw meaningful conclusions related to their research problem in environmental engineering.
2. To equip students with the skills to compile their research findings, methodology, and analysis into a well-organized, detailed dissertation that adheres to academic standards and effectively communicates their research.
3. To prepare students to confidently present and defend their research findings before a faculty panel, demonstrating a thorough understanding of their work and its implications in the field of environmental engineering.

Course Outcomes:

COs	**After the completion of the course the students will be able to**	**Bloom's Taxonomy Descriptor**
CO.1	Interpret complex data, its significance, and determine insightful conclusions relevant to their research topic.	Evaluating L5
CO.2	Create a detailed and well-structured dissertation, effectively documenting their research methodology, analysis, and results in accordance with academic standards.	Creating L6

CO-PO Mapping:

CO	**1**	**2**	**3**	**4**	**5**	**6**
CO1	3	3	3	3	1	3
CO2	1		1	2	1	3

Assessments:

Assessment	**Weightage (Marks)**
ISE 1	50
ISE 2	50
ESE (OE)	150

- **ISE 1 & 2:** Evaluation is based on the work done during the semester four and the reports submitted by the students. It shall be evaluated through progress seminars at mid and then at the end of the semester. The parameters for evaluation include extent of work done, results and discussion/publication efforts, quality of presentation, quality of report, interaction during presentation and interaction with guide.
- **ESE:** Shall be conducted at the end of semester by a duly constituted examination panel composed of Chairman, internal examiner (guide) and external examiner.

Course Contents:

In fourth semester, the students continue their dissertation work. It is expected that the student has completed most of the experimental/computation works and analyzed the results so obtained as proposed in the synopsis. The work should be completed in all respects in this semester. The students are required to submit the dissertation work in the form of report as per the institute rules and regulations.

Class: F.Y.M.Tech Environmental Engineering **Title of the Course:** Geospatial Technology (Exit Course-I) **Course Code.:** MENEX0291	**L**	**T**	**P**	**Credits**
	03	1	-	**04**

Course Description:

This course offers an opportunity for the students to understand the basics of geospatial technology for developing an interest in the principles, practical uses, and resources related to geospatial technologies. This course will enable the students to get an insight into the diverse geospatial database concepts, creating and implementing of the same, GIS theory and spatial analysis, supplemented by extensive practical exercises. Also, it will help the students to acquire skills for further studies and to enter the professional world.

Course Learning Objectives:

1. To impart the basic knowledge to students to compile, analyze, and present geospatial data.
2. To develop creative thinking among students for solving real problems commonly addressed with Geospatial Technology.

Course Outcomes:

COs	**After the completion of the course the students will be able to**	**Bloom's Taxonomy Descriptor**
CO.1	Classify the maps, coordinate systems and projections to process spatial and attribute data.	Cognitive (Analyzing) L4
CO.2	Create maps and other geographic representations to extract, analyze, interpret and present spatial information.	Cognitive (Creating) L6

CO-PO Mapping:

CO	**1**	**2**	**3**	**4**	**5**	**6**
CO1	3	3			3	
CO2	3	2		2	2	

COs	**PSO1**	**PSO2**
CO1		
CO2		2

Assessments:

Assessment	**Marks**
ISE	100

ISE: ISE is based on four different tools like assignment/declared test/quiz/seminar/Group Discussions etc.

Course Contents:

Introduction to GIS: - Definition and Overview - History and Evolution - Basic Concepts and Terminology **GIS Data:** - Types of GIS Data (Vector, Raster) - Data Sources and Formats - Data Quality and Accuracy **GIS Software and Tools:** - Overview of Popular GIS Software (e.g. ArcGIS, QGIS, Google Earth) - Basic Functionality and Tools (e.g. Mapping, Editing, Analysis)	60 Hours (45 lecture + 15 Tutorials)

Coordinate Systems and Projections: - Coordinate Systems - Map Projections and Distortions **Mapping and Visualization:** - Basic Principles - Map Types - Creating maps with GIS software - Symbolization and Visualization Techniques - Basic Spatial Analysis Techniques **GIS Data Management:** - Data Storage and Retrieval - Data Editing and Manipulation - Data Export and Import	

Text Books:

1. Jensen, J.R. (2006): Remote Sensing of the Environment: An Earth Resource Perspective (2nd Ed.), Prentice Hall, New Jersey.
2. Lillesand, T.M., Kiefer, R.W., and Chipman, J.W. (2007): Remote Sensing and Image Interpretation (6th Ed.). Wiley, New Jersey.
3. Reddy, M.A. (2008): Textbook of Remote Sensing and Geographical Information System (3rd Ed.), BS Publications, Hyderabad.

Reference Books:

1. Nair, N. B. (1996): Encyclopaedia of Surveying, Mapping and Remote Sensing. Rawat Publications., Jaipur and New Delhi.
2. Bernhardensen, Tor. 1999. Geographic Information Systems: An Introduction. Toronto: John Wiley and Sons, Inc.

Websites:

1. Indian institute of remote sensing, (IIRS). India: https://www.iirs.gov.in/
2. National Remote Sensing Centre (NRSC), India: http://www.nrsc.gov.in
3. Bhuvan:http://www.bhuvan.nrsc.gov.in
4. National Aeronautics and Space Administration (NASA), USA: http://www.nasa.gov
5. United States Geological Survey (USGS), USA: http://www.usgs.gov
6. International Society for Photogrammetry and Remote Sensing (ISPRS): http://www.isprs.org

Class: F. Y. M. Tech. Environmental Engineering	**L**	**T**	**P**	**Credits**
Title of the Course: Internship/Training (EXIT COURSE) **Course No.:** MENEX0292	---	---	08	04

Course Pre-Requisite:

Students shall have the knowledge of:

- Environmental Protection and Pollution Prevention Measures, Environmental Management
- Use of tools and applications in various domains of Civil and Environmental Engineering

Course Description:

The Internship/Training Lab course is designed for M. Tech Environmental Engineering students who have completed their first year and are considering exiting the program. This course provides practical, hands-on experience in a professional environmental engineering setting, allowing students to apply their academic knowledge to real-world projects. Through this internship or training experience, students will gain valuable industry exposure, develop technical and professional skills, and enhance their understanding of environmental engineering practices.

Course Learning Objectives:

1. To gain practical experience in the field of environmental engineering.
2. To apply theoretical knowledge to real-world environmental engineering projects.
3. To reflect on personal and professional growth through the internship or training experience.

Course Outcomes:

COs	**After the completion of the course the students will be able to**	**Bloom's Cognitive Descriptor**
CO1	Apply theoretical knowledge to real-world environmental engineering projects.	Cognitive (Applying) L3
CO2	Develop professional skills, including teamwork, communication, and project management	Cognitive (Creating) L6

CO-PO Mapping:

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2	-	-	2	-
CO2	1	3	2	2	-	2

Assessments:

Assessment	**Weightage (Marks)**
ISE	100

• **ISE:** Assessment is based on Presentation and Report related to Internship/training.

Course Contents:

- Participation in day-to-day operations and projects at the host organization.
- Application of environmental engineering principles to practical tasks.
- Data collection, analysis, and reporting on environmental projects.
- Development of technical and professional skills through hands-on experience.
- Preparation of a comprehensive internship report documenting experiences and learning outcomes.

120 Hours