1st Semester

DEPARTMENT OF ENVIRONMENTAL ENGINEERING						
Course Code: 26MTEV110		**Course Title: Water Treatment and Distribution Systems**				
Total Credits: 05		**SDGs addressed: 6, 13, 14**		**Course Category: PCC**	**Course Type: Theory Integrated with Laboratory**	
Teaching Learning Process		**Total Contact Hours/semester**	**Assessment Weightage and Marks**			
	Lecture	**60**		**CIE**	**SEE**	**Total**
	Tutorial	**-**	**Weightage %**	**40**	**60**	**100**
	Practical	**30**	**Maximum Marks**	**40**	**60**	**100**
	Self-learning and Term work	**60**	**Minimum Marks**	**20**	**25**	**45***
	Total	**150**				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Objective: To impart comprehensive knowledge of water supply, treatment, distribution, advanced technologies, and residue management, enabling students to analyze, design, and evaluate sustainable water systems in urban and rural contexts.

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcomes	Highest Level of Cognitive Domain
CO1	Apply knowledge of water quality standards, pipe hydraulics, intake and pumping system design, and hydraulic equations to analyze and design sustainable water supply systems.	L3
CO2	Apply relevant norms, design principles, and treatment technologies to analyze and design sustainable water treatment systems for urban and rural water supply facilities.	L3
CO3	Evaluate advanced clarifiers, disinfection kinetics, and miscellaneous treatment technologies for the design of sustainable water treatment systems.	L5
CO4	Apply engineering principles to analyze and design water supply and distribution systems, including appurtenances, reservoirs, network analysis, chlorine boosting, biofilm control, and corrosion prevention.	L3
CO5	Apply appropriate engineering principles to analyze and design water treatment plant residue management systems, smart water supply systems, and package treatment units, considering water economics and nanomaterial applications for sustainable water treatment.	L3

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 –Create

Course Syllabus

Unit No.	Content	Lecture Hours	Tutorial Hours
1	**Basic Considerations** – Water – (Surface & Ground) quality characteristics, Drinking Water Quality Standards, guidelines, inter-relationship between water quality characteristics. **Pipe hydraulics** Water demand, design period, peak factor. Water Intakes-types and design aspects. Pipes and pipe materials, Pumps, and pumping station. Hazen-William equation, Manning's equation, Cole Brooke-White equation, Darcy Weisbach equation Rising main economics, Hydraulic transients - numerical problems.	**14**	**-**

	Self-Learning and term work ➢ Comparative study of BIS and WHO drinking water quality standards and water quality guidelines. ➢ Independent learning of pipe materials, intake structures, pumps, and emerging practices through technical literature and case studies.		
2	**Urban and rural water treatment facilities** – norms and schemes. **Water Treatment Facilities:** Screening – design considerations. Theory, Design principles and criteria: aeration, Parshall flume, flash mixer, coagulation-flocculation systems, types of settling, sedimentation, filtration, Miscellaneous treatment- Removal of hardness, fluoride, nitrate, arsenic, selenium, and boron - Numerical Problems **Self-Learning and term work** • Explore recent advancements and case studies on treatment processes for the removal of hardness, fluoride, nitrate, arsenic, selenium, and boron. • Independently practice the design and numerical analysis of screening, aeration, coagulation–flocculation, sedimentation, filtration, and Parshall flume units.	**16**	**-**
3	**Advanced clarifiers:** Theory, Design principles and criteria: Tube settlers, pulsators, Diffused Air flotation - Numerical Problems **Disinfection** – Principle, Theory, kinetics of Disinfection, disinfection methods, influencing factors; Numerical Problems **Miscellaneous Water Treatment Facilities: Theory, Design principles and criteria:** Water Softening Process, Removal of Iron and Manganese; Fluoridation and defluoridation, membrane filtration (UF/RO), ion exchange, activated carbon adsorption. **Self-Learning and term work** • Study recent advances in advanced clarification, membrane filtration (UF/RO), ion exchange, and activated carbon adsorption through technical literature and case studies. • Collaboratively solve numerical problems related to advanced clarifiers and disinfection system design, comparing alternative design approaches.	**8**	**-**
4	**Water supply and distribution Appurtenances** for collection and conveyance, gravity, and pressure flows. Service reservoirs and service connection (ferrule). Distribution system - types. Hardy- cross and Newton-Raphson methods of pipe network analysis - Simple problems. Intermittent residual chlorine boosting in the water distribution system, water quality in distribution system with special reference to biofilms, Corrosion- prevention and control. **Self-Learning and term work** • Explore the application of Hardy–Cross and Newton–Raphson methods for pipe network analysis using spreadsheets or simulation software. • Collaboratively solve pipe network analysis problems using Hardy–Cross and Newton–Raphson methods and compare the results.	**12**	**-**
5	**Water Treatment Plant Residues** – Collection, Conveyance, Treatment and Disposal 5 R Technologies –reduce, reuse, recycle, reclaim and recovery, Automation in Water Supply and Smart Water Supply Systems, Package treatment units, implications of 24x7 supply, Water Economics & Pricing and application of nanomaterials package treatment units. Alum recovery in	**10**	**-**

	filter backwash **Self-Learning and term work** • Review the principles of 24×7 water supply, water economics, and pricing, and their implications for sustainable water utility management. • Prepare a group case study on a smart or automated water supply system, highlighting its components, benefits, and implementation challenges.		

Text Books:

- Weber W.J., (1975) "Physico - Chemical Processes for Water Quality Control".
- Peavy, H.S., Rowe and Tchobonoglous, G., (1985), "Environmental Engineering" McGraw Hill.
- Santhosh Kumar Garg, "Water Supply Engineering", Khanna Publishers (Recent Edition).
- B. S. N. Raju, "Water Supply and Wastewater Engineering"
- David Hendricks, (2010), "Fundamentals of Water Treatment Unit Processes": Physical, Chemical, and Biological, CRC Press.
- Edward M. Motley, Guang Zhu, Syed R. Qasim, (2000), "Water Works Engineering": Planning, Design and Operation, Prentice Hall.
- CPHEEO Manual, "Water Supply and Treatment", GOI Publications (2024).

Reference Books:

- American Public Health Association, American Water Works Association, & Water Environment Federation. (2023). Standard Methods for the Examination of Water and Wastewater (24th ed.).
- Fair, G.M., Geyer J.C and Okun, (1969) "Water and Wastewater Engineering" Vol II, John Wiley Publications.
- Design data handbook by IWA
- Sawyer, C. N., Mc Carty, P. L., and Perkin, G. F., (2015), "Chemistry for Environmental Engineering and Science", V Edn., Tata McGraw Hill Publishing Company Ltd., New Delhi.
- NEERI Laboratory Manual, Nagpur, Maharashtra
- Environmental Engineering Laboratory Manual" authored by B. Kotaiah.

Journals/Magazines:

Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources:

https://ocw.mit.edu/courses/1-85-water-and-wastewater-treatment-engineering-spring- 2006/pages/lecture-notes/

SWAYAM/NPTEL:

https://archive.nptel.ac.in/courses/105/105/105105201/

Practice Based Learning:

No.	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Population forecasting methods	Excel Spread Sheet	Software Skill
2	Rising main economics	R Main	Software Skill
3	Design of Water Treatment Plants	Water Plant and Excel Spread Sheet	Software Skill
4	Design of Distribution system	Demo version of Water Gem	Software Skill

Lab Component:

Unit No.	Content	Practical Hours
1	Water treatment process Laboratory – Introduction to the laboratory / equipment /	2

	instruments and applications. Precision and Accuracy, Significant numbers. Sample collection preservation techniques.	
2	Dissolved oxygen (DO).	2
3	Aeration Process for Fe removal. Aeration for improving DO (continuous monitoring) – linkage with two film theory.	2
4	Conducting Settling Experiments and identifying Type 1 and Type 2 settling and the determination of settling efficiency	2
5	Jar Test apparatus for Optimum coagulant (Natural and chemical) dose Determination	2
6	Water Softening – Determination of initial and final concentration for parameters – Total hardness, TDS, Alkalinity etc. (Surface water and Sub surface water)	2
7	Performing Sieve Analysis for Filter Sand samples	2
8	Carrying out experiments on Single and Multimedia Filters and Head Loss calculation	2
9	Filtration Process - Single Media and Dual Media Filters. Particle size distribution analysis, Determination of Effective Size and Uniformity Coefficient.	2
10	Chlorine demand, Available chlorine and Break Point Chlorination Curve Residual chlorine in water distribution system (Near OHT and in different user taps).	2
11	Determination of colour and metals in water.	2
12	Batch Adsorption – GAC, Natural Adsorbents, Isotherms and Break through curves & interpretations	2
13	Household Water Treatment Units – Ground water, RO treated water and Bottled water quality analysis	2
14	Demonstration of Advanced Instruments such as ICP, UV-VIS Spectrophotometer, HPLC	2
15	Field visit to Water Treatment Plant	-
16	CIE	2

Course Articulation Matrix:

COURSE OUTCOMES ↓	**PROGRAM OUTCOMES**					
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	2	3	3	2	3
CO4	3	3	2	3	3	2
CO5	3	3	2	3	3	2

High – 3, Medium – 2, Low-1

EPARTMENT OF ENVIRONMENTAL ENGINEERING						
Course Code: 26MTEV120		**Course Title: Design of Wastewater Treatment Systems**				
Total Credits: 05		**SDGs addressed: 6, 13, 14**	**Course Category: PCC**	**Course Type: Theory Integrated with Laboratory**		
Teaching Learning Process		**Total Contact Hours/semester**	**Assessment Weightage and Marks**			
	Lecture	**60**		**CIE**	**SEE**	**Total**
	Tutorial	**-**	**Weightage %**	**40**	**60**	**100**
	Practical	**30**	**Maximum Marks**	**40**	**60**	**100**
	Self-learning and Term work	**60**	**Minimum Marks**	**20**	**25**	**45***
	Total	**150**				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Objective: To impart comprehensive knowledge of wastewater characteristics, unit operations, biological processes, sludge management, and small-community treatment systems, enabling students to analyze, design, and evaluate sustainable wastewater conveyance and treatment solutions

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcomes	Highest Level of Cognitive Domain
CO1	Apply the principles of wastewater characterization and biokinetics to determine appropriate sewerage systems, appurtenances, and sustainable wastewater conveyance and treatment solutions.	L3
CO2	Apply wastewater characterization principles, unit operation concepts, and numerical methods to determine appropriate wastewater treatment processes and their operational requirements.	L3
CO3	Apply the principles of aerobic, anoxic, and anaerobic biological treatment to select appropriate treatment systems, advanced reactor technologies, and sludge management strategies for sustainable wastewater treatment.	L3
CO4	Apply engineering principles to determine suitable sludge processing operations, including digestion, thickening, dewatering, conditioning, and disposal, for sustainable wastewater management.	L3
CO5	Apply engineering principles and software-based modelling techniques to determine appropriate small-community wastewater treatment systems, hydraulic profiles, pumping requirements, and sewer network configurations.	L3

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 –Create

Course Syllabus

Unit No.	Content	Lecture Hours	Tutorial Hours
1	**Domestic Wastewater:** characteristics, flow fluctuations, types of reactors and mass balance approach. Simple problems. **Kinetics of biological wastewater treatment systems** – biokinetic constants and their determination, batch and continuous system.	**12**	**-**

	Design of Sewer: Types of sewerage systems, Design of sanitary sewer: partial flow in sewers, economics of sewer design; sewer appurtenance; material, construction, inspection and maintenance of sewers; Design of sewer outfalls-mixing conditions; conveyance of corrosive wastewaters. **Self-Learning and term work** • Mass Balance Problem Solving • Biokinetic Constant Determination • Design a sanitary sewer for a small community.		
2	**Design principles and design of Unit operation systems** - Objectives, process flow sheets based on characterization. Screens, equalization, grit chamber, oil and grease removal, primary sedimentation tank. Secondary sedimentation tank - design criteria and examples. **Self-Learning and term work** • Compare treatment sequences for domestic vs. industrial wastewater. • Compile a mini-project report integrating all unit operations. • Suggest improvements for efficiency and sustainability	**16**	**-**
3	**Design Criteria and design of Unit processes** - Aerobic, Anoxic and Anaerobic systems, Suspended and attached growth systems, activated sludge process and modifications, SBR, MBR, MBBR - design criteria and examples. **Biological Sludge Separation**, conditioning and volume reduction, toxicity assays **Self-Learning and term work** • Design and evaluate biological wastewater treatment systems. • Apply biokinetics, manage sludge effectively. • Assess toxicity impacts for sustainable treatment solutions.	**12**	**-**
4	**Design of Sludge Processing Units** – Chemical and biological sludge – sources and generation, Quantification and characterization, Sludge Volume Index (SVI), alternate uses of sludge and disposal options. **Sludge Digestion**- aerobic and anaerobic, Sludge Drying Bed, Sludge Thickeners, sludge filter press, design criteria and examples. **Self-Learning and term work** • Analyze sludge characteristics, design digestion and dewatering units. • Evaluate sustainable disposal and reuse strategies	**12**	**-**
5	**Wastewater treatment systems for small communities**– septic tanks, soak pits, two-pit latrines, eco-toilet. Natural and constructed wetlands. **Wastewater Treatment**: Hydraulic Profile and Pumps and Use of computer software in sewer networks. **Self-Learning and term work** • Design decentralized wastewater treatment systems. • Analyze hydraulic profiles and select pumps • Apply computer software for sewer network modelling.	**8**	**-**

Textbooks:

- Metcalf and Eddy, "Wastewater Engineering, Treatment and Reuse", 4th Edition, Tata McGraw Hill Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2014.
- Karia, G. L., and Christian, R. A., "Wastewater Treatment: Concepts and Design Approach", Prentice – Hall of India, 2018.

Reference Books:

- Qasim Syed R., (2009), "Wastewater treatment plants: planning, design, and operation" - 2nd edition, CRC Press LLC
- Peavy, H. S., Rowe, D. R., and Tchobanoglous, G., (2015), "Environmental Engineering", McGraw Hill Book Co.
- Benefield R. D., and Randal C. W., (1980), "Biological Process Design for Wastewater Treatment", Prentice Hall, Englewood Chiffs, New Jersey.
- Ronand L., and Droste, (1997)," Theory and Practice of Water and Wastewater Treatment", John Wiley and Sons Inc.

Journals/Magazines:

- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources:

- http://cpheeo.gov.in/
- https://cpcb.nic.in/

SWAYAM/NPTEL:

- https://onlinecourses.nptel.ac.in/noc21_ce25/preview
- https://onlinecourses.nptel.ac.in/noc23_ch17/preview
- https://onlinecourses.nptel.ac.in/noc23_ch30/preview

Practice Based Learning:

No.	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Quantification of Wastewater Generation	Excel Spread Sheet	Software Skill
2	Gravity main economics	Excel Spread Sheet	Software Skill
3	Design of SewageTreatment Plants	Excel Spread Sheet	Software Skill
4	Design of sewer system	Demo version of Sewer Gem	Software Skill

Lab Component:

Unit No.	Content	Lecture Hours
1	Domestic and Industrial Wastewater Characterization	2
2	Determination of Biochemical Oxygen Demand (BOD)	2
3	Determination of Chemical Oxygen Demand (COD)	2
4	Coagulation, Flocculation, and Sedimentation	2
5	Determination of Process Parameters for Aerobic Treatment Units	2
6	Determination of Process Parameters for Anaerobic Treatment Units	2
7	Wastewater Polishing Units – Water Hyacinth, Duckweed, etc.	2
8	Adsorption Experiments Using Activated Carbon – Experimental Procedure and Data Collection	4
9	Adsorption Studies – Plotting of Isotherms and Breakthrough Curves	2

10	Sludge Analysis – Proximate Analysis (Moisture, Volatile Matter, Fixed Carbon and Ash)	2
11	Sludge Analysis – Ultimate Analysis (C, H, N, S and O), VSS, VFA and Nitrates	2
12	Sludge Analysis – Settleability, Filterability Using Buchner Funnel Tests and Capillary Suction Time Test	2
13	Demonstration of Advanced Instruments – GC, HPLC, ICP, TKN, SEM and XRD	2
14	Repetition/Revision	2
15	CIE	2

Course Articulation Matrix:

COURSE OUTCOMES ↓	**PROGRAM OUTCOMES**					
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	2	3	3	2	3
CO4	3	3	2	3	3	2
CO5	3	3	2	3	3	2

High – 3, Medium – 2, Low

DEPARTMENT OF ENVIRONMENTAL ENGINEERING						
Course Code: 26MTEV130		**Course Title: Applied Environmental Chemistry and Microbiology**				
Total Credits: 04		**SDGs addressed: 3, 6, 9, 14**		**Course Category: PCC**		**Course Type: Theory**
Teaching Learning Process		**Total Contact Hours/semester**	**Assessment Weightage and Marks**			
	Lecture	**45**		**CIE**	**SEE**	**Total**
	Tutorial	**30**	**Weightage %**	**40**	**60**	**100**
	Practical	**-**	**Maximum Marks**	**40**	**60**	**100**
	Self-learning and Term work	**45**	**Minimum Marks**	**20**	**25**	**45***
	Total	**120**				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Objective: The course is an applied science course dealing with relevant aspects of chemistry and microbiology. The chemistry provides an in-depth knowledge of basics of chemistry, variety of reactions and introduces equilibrium chemistry. The course also lays foundation of electrochemistry, colloidal and surface chemistry. The course also provides the student the basics as well as application aspects of both microbiology for Environmental Pollution Control.

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcomes	Highest Level of Cognitive Domain
CO1	Name and distinguish a variety of chemical reactions and their importance. Review equilibrium chemistry and perform dimensional analysis. Apply Le Chatelier's principle to find feasibility of reaction.	L3
CO2	List and describe types of electrodes and electrode potential. Classify colloids, discuss their properties and their environmental significance. Reproduce the two-film theory and identify the salient features.	L2
CO3	Describe various analytical techniques for measuring water quality parameters and wastewater characteristics. Explain the concepts of buffering capacity in water/river. Discuss the need for microbiology and identify different flora and fauna of importance in water, air and soil media.	L3
CO4	Draw and identify bacterial cell structure and morphological features. Solve numerical problems on generation time, specific growth rate and decay rate. Analyze single & multiple substrate utilization rates. Apply various growth models and determine biokinetic coefficients.	L3
CO5	Distinguish between fungi and virus. Classify and characterize using different methods. Formulate enzymatic relationships using kinetics. Apply the knowledge of using microbes in pollution control activities. Review emerging microbial contaminants.	L2

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5, Evaluate, L6 – Create

Course Syllabus:

Unit No.	Content	Hours	
		Lecture	Tutorial
1	**Introduction** Importance of Environmental Chemistry as applied to Environmental Engineering, Modes of expression for molarity, normality, molality, ppm, numerical problems. Types of reactions. Concepts of equivalent mass in relation to acids, bases, salts and oxidizing and reducing agents. Chemical equilibrium – redox and ionic Equations, Le-chateliers principle, Gibs free energy and numerical problems on finding the feasibility of reaction. **Self-learning and Term work** • Green chemistry principles, laboratory safety • Chemical hazards and handling.	**08**	**06**
2	**Electrochemistry** Electrolytes, conductance and Electrical Conductivity of water/wastewater and its correlation with dissolved salts. Electrochemical cells, Electrodes, electrode potential and Nernst equation, Electrolysis and Faraday's laws. Measurement of emf and pH electrode potential, etc. Buffers and buffer index. Electrochemical wastewater treatment **Colloidal Chemistry** Colloids – Types, properties, Principles of coagulation, flocculation and factors affecting the process. Colloidal dispersion in water, air and emulsions. Theory of colloids – double layer theory, zeta potential, destabilization of colloids (Schulze – Hardy rule) as applied to coagulation process. Environmental applications of colloidal chemistry (water treatment, soil remediation and nanotechnology). **Self-learning and Term work** • Corrosion and its prevention, electrochemical sensors, fuel cells, • Environmental applications of electrochemical & colloidal processes.	**08**	**06**
3	**Water and wastewater analysis** Sampling and preservation techniques; drinking water and wastewater quality standards. Water / wastewater quality characteristics- physical, chemical and biological parameters; analysis of pH, alkalinity, chlorides, hardness and solids. Color, Fluoridation and defluoridation – significance and determination. Chlorination – residual chlorine and break point chlorination, Biochemical oxygen demand (BOD) – dissolved oxygen (DO determination and environmental significance). Types and measurement of BOD. Rate of biochemical oxygen demand and theoretical oxygen demand. Chemical oxygen demand (COD) – determination and its application in wastewater treatment. **Self-learning and Term work** • Advanced water quality monitoring techniques, emerging contaminants • Smart technologies for water and wastewater quality assessment.	**09**	**06**
4	**Microbiology** **Introduction** Microbiology and its Environmental Significance, Microbial Diversity in the Environment- Bacteria, Fungi, Algae, and Virus; Microbial Infectious Diseases, Bacterial growth curve, Enzymes: Classification, kinetics of enzymatic reactions, Monod's equation and Michali's - Menton equation with numerical problems, Microbial interactions and its industrial applications.	**10**	**06**

	Self-learning and Term work • Microbial biotechnology, Microbial fuel cells, • Beneficial microorganisms in environmental protection.		
5	**Applied Microbiology** Indicator microorganisms, TC, FC, FS, Microbial enumeration techniques-Plate count, MTFT and MFT - Determination of MPN using Thomas formula and Standard methods, comparison with MPN table (Lab component). Indoor microbial environment - air changes per hour (Lab component). Metabolism, Catabolism and Anabolism, bio concentration and bio magnification. **Recent trends** - Use of microbial consortia in bioremediation, water and wastewater treatment. **Self-learning and Term work** • Bioaugmentation, probiotics and beneficial microbes • Emerging applications of microorganisms in environmental monitoring and resource recovery.	**10**	**06**

Textbooks:

- Pelzer, Chan and Ried (1998), "Microbiology", Tata McGraw Hill Publishers
- Sawyer C.N. and McCarty, P.L., (2003), "Chemistry for Environmental Engineering and Science", 5th Edition, TATA Mc Graw Hill Publishing Co.Ltd., New Delhi

Reference Books:

- Gaudy and Gaudy (1980), "Microbiology for Environmental Scientists and Engineers", McGraw Hill.
- Mall C.A.S & Day J.W., "Ecosystem Modelling in Theory and Practice: An Introduction with Case Histories", John Wiley Publications
- APHA, (2002), "Standard Methods for Examination of Water and Wastewater"; 21st Edition.
- Chakraborthy P, (2005), "Textbook of Microbiology", 2nd Edition, New Central Book Agency Pvt. Ltd.,

Journals/Magazines:

- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources:

http://www.oficyna.pwr.edu.pl/wp-content/media/Ko%C5%82wzan-B.-Adamiak-W.-Grabas-K.-Pawe%C5%82czyk-A.-Introduction-to-environmental-microbiology.pdf

SWAYAM/NPTEL:

- Anjali Pal, Sudha Goel 'Environmental Chemistry and Microbiology' IIT Kharagpur (**https://onlinecourses.nptel.ac.in/noc21_bt22/preview)**

Course Articulation Matrix:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	-	3	-	3
CO2	3	1	3	2	3	2
CO3	3	-	2	3	3	3
CO4	3	3	3	2	-	3
CO5	3	3	3	3	3	3

High – 3, Medium – 2, Low – 1

DEPARTMENT OF ENVIRONMENTAL ENGINEERING						
Course Code: 26MTEV140		**Course Title: Solid Waste Engineering and Management**				
Total Credits: 04		**SDGs addressed: 3, 11, 12, 13, 15**	**Course Category: PCC**		**Course Type: Theory**	
Teaching Learning Process		**Total Contact Hours/semester**	**Assessment Weightage and Marks**			
	Lecture	**45**		**CIE**	**SEE**	**Total**
	Tutorial	**30**	**Weightage %**	**40**	**60**	**100**
	Practical	**-**	**Maximum Marks**	**40**	**60**	**100**
	Self-learning and Term work	**45**	**Minimum Marks**	**20**	**25**	**45***
	Total	**120**				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Objective: To develop competency in analyzing solid waste management problems and selecting appropriate engineering solutions that promote resource efficiency, environmental protection, public health, and sustainability.

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcomes	Highest Level of Cognitive Domain
CO1	Identify improper practices of solid waste disposal and their environmental implications. Know the basic engineering principles of solid waste management and waste generation rate.	L3
CO2	Explain the various types of collection systems, segregation and transportation of solid waste means.	L3
CO3	Identify the conventional and advanced treatment options of solid waste management and interpret the concept of 4R.	L3
CO4	Describe the different disposal methods of solid waste and operational aspects of solid waste	L3
CO5	Explain the recent development in solid waste reuse and role of various organization in solid waste management	L2

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 –Create

Course Syllabus

Unit No.	Content	Lecture Hours	Tutorial Hours
1	**Introduction** Sources of solid waste, engineering classification, characterization, quantification; functional elements of solid waste management system– Environmental implications of open dumping, Construction debris – management & handling. **Waste Generation:** Rate of generation, frequency, storage and refuse collection, Physical and chemical composition, quantity of waste, engineering properties of waste E-Waste Management, Bio-medical waste management. **Self-learning and Term work** • Case study on E-waste or biomedical waste management • Recent trends in Municipal Solid Waste Management in India.	**10**	**6**

2	**Collection, Segregation and Transport:** Handling and segregation of wastes at source, Collection (primary &secondary) and storage of municipal solid wastes, collection Equipment, transfer stations, collection route optimization and economics, regional concepts. System dynamics. **Self-learning and Term work** • Regional solid waste management concepts • Field visit to a transfer station or municipal collection facility	**8**	**6**
3	**Treatment Methods**: Refuse processing technologies. Mechanical and thermal volume reduction. Biological and chemical techniques for energy and other resource recovery: Composting, vermin composting, vermin gradation, fermentation. Incineration and Pyrolysis of solid wastes. **Waste Minimization:** 4R: reduce, recover, recycle and reuse, case study, guidelines. **Self-learning and Term work** • Case studies on waste minimization practices • Field visit to a composting, biomethanation, or Waste-to-Energy plant	**9**	**6**
4	**Disposal Methods:** Impacts of open dumping, site investigation and selection, sanitary Land Filling-Types, geotechnical considerations, design criteria and design, Liners-earthen, geo membrane, geo synthetics and geo textiles. **Operational aspects of MSW Landfills**: Daily cover, leachate disposal, Ground Water monitoring, leachate and gas collection systems–Design, leachate treatment. Landfill post-closure environmental monitoring; land fill remediation. **Self-learning and Term work** • Case study on a sanitary landfill facility • Daily cover materials and operational practices	**10**	**6**
5	**Recent Developments in Solid Wastes Reuse and Disposal**: Power Generation, Blending with construction materials and Best Management Practices (BMP). CommUnity based waste management, Waste as a Resource concept, Public private Partnership (PPP) **Role of various organizations in Solid Waste Management**: Governmental, Non -Governmental, Citizen Forums. **Self-learning and Term work** • Smart and sustainable waste management systems • Waste-to-Energy (WtE) technologies	**8**	**6**

Text Books:

- Tchobanoglous G.,Theissen H., and EIiassenR., "Solid Waste Engineering Principles and Management Issues", Mc Graw Hill, NewYork.
- Pavoni J.L.,"Hand book of Solid Waste Disposal".
- Peavy, Rowe and Tchobanoglous, "Environmental Engineering",McGrawHill.
- Mantell C.L., (1975), "Solid Waste Management",JohnWiley

Reference Books:

- CPHEEO Manual on Solid Waste Management.
- WHO Manual on Solid Waste Management.
- Vesiland A., "Solid Waste Engineering", Thompson Books.
- Flintoff F.,(1976),"Management of Solid Wastes in Developing Countries", WHO

Regional Publications, South East Asia, NewDelhi

Journals/Magazines:

- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources:

- https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SCIA4002.pdf

SWAYAM/NPTEL:

- https://nptel.ac.in/courses/105103205

Course Articulation Matrix:

COURSE OUTCOMES↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-
CO2	3	2	-	3	2	-
CO3	3	3	1	2	-	2
CO4	3	-	-	3	-	-
CO5	3	-	-	3	2	2

High – 3, Medium – 2, Low

DEPARTMENT OF ENVIRONMENTAL ENGINEERING						
Course Code: 26MTEV151		**Course Title: Industrial Pollution Control**				
Total Credits: 05		**SDGs addressed: 6, 9,12**		**Course Category: PEC**		**Course Type: Theory with Tutorial**
Teaching Learning Process		**Total Contact Hours/semester**	**Assessment Weightage and Marks**			
	Lecture	**45**		**CIE**	**SEE**	**Total**
	Tutorial	**30**	**Weightage %**	**40**	**60**	**100**
	Practical	**-**	**Maximum Marks**	**40**	**60**	**100**
	Self-learning and Term work	**45**	**Minimum Marks**	**20**	**25**	**45***
	Total	**120**				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Objective: To develop the ability to analyze industrial pollution potential, apply pollution control norms, design monitoring programs, and propose feasible prevention strategies, while understanding the roles of government and industry in achieving sustainable development.

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcomes	Highest Level of Cognitive Domain
CO1	Categorize industries based on pollution potential and relate pollution control norms.	L2
CO2	Illustrate general industrial process flow with waste generation points and summarize on fundamental principles and technologies for industrial pollution prevention.	L3
CO3	Select and evaluate feasibility of industrial pollution prevention plans.	L4
CO4	Design monitoring programs for pollution prevention and explain governmental and corporate responsibilities in industrial pollution prevention and sustainable development.	L3
CO5	Suggest suitable pollution prevention strategies for a given industry	L3

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 –Create

Course Syllabus

Unit No.	Content	Lecture Hours	Tutorial Hours
1	**Fundamentals of environmental pollution and prevention** Necessity of pollution control. Industrial pollution and management strategies. Types and categories of industries, rules for consent for establishment and operation, discharge standards, industrial hubs and pollution control norms. Mass load calculations at source and discharge points- simple numerical problems **Self-Learning and term work** • Understand pollution control necessity, classify industries, • Apply regulatory norms, perform mass load calculations. • Evaluate industrial pollution management strategies.	**08**	**6**

2	**Industrial processes and waste streams** Typical industrial process flow diagrams, type and volume of waste generation, characterisation – conventional and emerging contaminants – effects on environment, dual, triple and hybrid treatment technologies **Pollution prevention technologies or Waste Minimization/waste prevention Techniques** Change in Plant operations, retrofit modification, 5R concepts, process, material substitution/separation, cleaner technologies, water pinch analysis, zero liquid discharge **Self-Learning and term work** • Map industrial waste streams, characterise pollutants, • Evaluate treatment technologies. • Design pollution prevention strategies including ZLD systems	**10**	**6**
3	**Pollution prevention feasibility and plan.** Environmental, technical, economic & institutional feasibility analysis. Identifying pollution prevention opportunities and their implementation. Facility Environmental Management auditing, and water quality management. **Self-Learning and term work** • Evaluate feasibility of pollution prevention plans, identify opportunities, implement cleaner technologies, conduct environmental audits. • Design water quality management programs.	**9**	**6**
4	**Monitoring industrial pollution prevention programs** Product- Life Cycle Analysis and Assessment (LCA), Life Cycle Engineering (LCE), Prevention of Significant Deterioration (PSD) for industrial areas. **Governmental & Corporate responsibilities** Policies & strategies, Regulations & standards, Community actions, Environmental programs, sustainable development initiatives, partnerships and international programs. **Self-Learning and term work** • Apply life cycle approaches, evaluate PSD compliance. • Understand governmental and corporate responsibilities. • Design monitoring programs for industrial pollution prevention.	**10**	**6**
5	**Industry-specific pollution prevention strategies** Study on sources/processes of waste generation and its prevention in Printing, Textile, Pulp & Paper, Electronics and pharmaceutical industry and other industries of concern. **Self-Learning and term work** • Map industrial waste streams, characterize pollutants, • Evaluate prevention technologies. • Design feasible pollution prevention strategies tailored to specific industries.	**8**	**6**

Text Books:

- S.C. Bhatia, Pramod Kumar and Sarvesh Devaraj Industrial Pollution and Its Control (Volume I & II). Wood head Publishing India Pvt. Ltd., 2017.
- Harry Freeman Industrial Pollution Prevention Handbook (1st Edition). MacGraw Hill Inc., 1994.
- Ryan Dupont, Kumar Ganesan and Louis Theodore Pollution Prevention: Sustainability, Industrial Ecology and Green Engineering (2nd Edition). CRC Press. 2016.
- S.C. Bhatia Managing Industrial Pollution (1st Edition). Macmillan, 2003.

- H. Panda. “The Complete Guide on Industrial Pollution Control”, (1st Edition). Asia Pacific Business Press Inc., 2011.
- Ireneusz Zbicinski, Product Design and Life Cycle Assessment (1st Edition) Baltic University Press, 2006.

Reference Books:
- S. P. Mahajan Pollution Control in Process Industries (22nd reprint). Tata McGraw Hill Education, 2008.
- Nancy J. Sell Industrial Pollution control – Issues and Techniques (2nd Edition). John Wiley & Sons, 1992.
- Nelson Leonard Nemerow, Industrial Water Pollution: origins, characteristics, treatment (1st Edition) Addison-Wesley Educational Publishers Inc., 1978.
- Nelson L. Nemerow, Zero Pollution for Industry (1st Edition), Wiley-Interscience, 1995.

Journals/Magazines:
Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials

Web/Digital resources:
- Videos on YouTube
- Coursera
- https://css.umich.edu/sites/default/files/publication/CSS95-01.pdf
- https://www.taylorfrancis.com/books/mono/10.1201/9781315368436/pollution- prevention-ryan-dupont-kumar-ganesan-louis-theodore
- https://www.niir.org/books/book/complete-guide-on-industrial-pollution-control/isbn-9788178331409/zb,,183,a,0,0,a/index.html
- https://www.diva-portal.org/smash/get/diva2:604277/FULLTEXT01.pdf
- https://corporate.dow.com/en-us/about/legal/issues/dioxin/reducing-emissions.html
- https://www.aramco.com/-/media/publications/enviro-news/2018-28.pdf
- https://www.aramco.com/-/media/publications/enviro-news/2020-31.pdf

SWAYAM/NPTEL:
- Electrochemical Technology in Pollution Control, IISc Bangalore, Prof. J. R. Mudakavi, https://nptel.ac.in/courses/103108162
- Basic Environmental Engineering and Pollution Abatement, Prof. P. Mondal, IIT Roorkee, https://nptel.ac.in/courses/103107215
- Fundamentals of Environmental Pollution and Control, Prof. J. Bhattacharyya, IIT Kharagpur, https://nptel.ac.in/courses/123105001

Course Articulation Matrix:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	3	1	2	3	1
CO2	2	3	1	2	3	1
CO3	3	2	2	3	2	2
CO4	3	2	3	3	2	3
CO5	3	3	2	3	3	2

High – 3, Medium – 2, Low

DEPARTMENT OF ENVIRONMENTAL ENGINEERING						
Course Code: 26MTEV152		**Course Title: Ecology And Environmental Statistics**				
Total Credits: 04		**SDGs addressed: 6, 7, 13, 14, 15**	**Course Category: PEC**		**Course Type: Theory**	
Teaching Learning Process		**Total Contact Hours/semester**	**Assessment Weightage and Marks**			
	Lecture	**45**		**CIE**	**SEE**	**Total**
	Tutorial	**30**	**Weightage %**	**40**	**60**	**100**
	Practical	**-**	**Maximum Marks**	**40**	**60**	**100**
	Self-learning and Term work	**45**	**Minimum Marks**	**20**	**25**	**45***
	Total	**120**				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Objective: The course introduces both ecology and statistics for environmental engineers. It explains different ecosystems and their interactions through symbiotic and synergic relationships, reviews ecological indices and modes. It describes trophic levels of lakes, influence of nutrient loading and control measures for eutrophication. The course also provides an in-depth knowledge of basic statistics, statistical methods used for data processing, analysis and interpretation. It describes distribution methods, variance, correlation and regression and testing of hypotheses.

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcomes	Highest Level of Cognitive Domain
CO1	Classify and discuss the structure and function of ecosystems, describe symbiotic and synergic relationships, Illustrate the need for bio- geo- cycles, apply ecosystem models.	L1
CO2	Describe various trophic status of lakes, stratification and mixing of lakes, apply Leibig's and Shelford's law, explain the importance of biodiversity and its protective measures.	L2
CO3	Discuss the need for statistical methods for environmental data processing and analysis. Describe and perform frequency analysis and grouping of data.	L4
CO4	Review basic statistical data analysis and probability concepts. Distinguish between normal, Poisson's and binomial distribution. Solve numerical examples	L4
CO5	Describe correlation and regression methods of data analysis. Estimate the regression coefficient using different methods. Solve numerical problems. Perform different methods of null hypotheses on a given set of data. Solve numerical examples to understand different methods of null hypotheses.	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

Course Syllabus:

Unit No.	Content	Hours	
		Lecture	**Tutorial**
1	**Ecology:** Classification of Ecosystems, Structure and Function of Ecosystems, Energy flow in Ecosystems, Ecological Niche and succession, Biogeochemical cycles, Ecological Pyramids. System ecology and Ecosystem Modeling **Aquatic and Terrestrial Ecosystems**: Diversity and dominance Indices, Ecosystem Models. **Self-Learning and term work**	**8**	**05**

	• Conduct a case study on ecological succession in a natural or disturbed habitat. • Develop a simple conceptual ecosystem model indicating inputs, outputs, and feedback mechanisms.		
2	**Lake Ecosystem**: Trophic levels, stratification, **Limiting factors,** nutrient loading, nutrient enrichment, Leibig's Law, **Shelford's law of tolerance,** control of eutrophication. Biodiversity and ecological perspective – human benefits, threats, conservation, preservation and protection. **Self-Learning and term work** • Conduct a case study on a eutrophic lake, identifying the causes, impacts, and possible restoration measures. • Prepare a report on the biodiversity of a local ecosystem, highlighting dominant flora and fauna. • Analyze the major threats to biodiversity in a selected region and suggest appropriate conservation measures.	**08**	**05**
3	Cumulative frequency; Surge's rule; Frequency polygon; Ogives; Problems. **Characteristics of Distributions**: Central Tendency – Averages: Arithmetic mean (Ungrouped data & Grouped data); Median (Ungrouped data & Grouped data); Mode (Ungrouped data & Grouped data); Skewness; Geometric mean; Weighted mean; Moving averages – equations to river hydraulics; Problems. **Self-Learning and term work** • Applications of moving averages in river hydraulics and hydrological data analysis. • Solving numerical problems on frequency distributions and measures of central tendency. • Use MS Excel or statistical software • Solve engineering case studies involving statistical analysis of environmental or hydrological data.	**09**	**05**
4	**Probability:** Basic concepts; Types – Classical approach, Relative frequency approach, Subjective approach; Probability rules; Problems. **Probability Distributions:** Binomial distribution – derivation; Poisson distribution – derivation; Normal distribution – errors, Gauss function, Area under normal curve, Use of standard normal probability distribution table; Problems. **Self-Learning and term work** • Use statistical software such as MS Excel, R, Python, or SPSS to visualize probability distributions and analyze datasets. • Prepare a mini-project report involving probability analysis and interpretation of real-world engineering data.	**10**	**08**
5	**Correlation and Regression Analysis:** Scatter Diagrams; Correlation coefficient; Multiple correlation coefficient; Simple linear regression; Multiple regression equation; Estimation using regression line; Method of Least Squares; Standard error of estimate; Problems. **Testing Hypotheses:** Concepts basics; Null hypothesis; Level of Significance; Degrees of Freedom; Hypothesis testing of Means; The Chi-Squared test; F distribution; Students test; Analysis of Variance – within samples and between samples; Problems **Self-Learning and term work** • Applications of correlation, regression, and hypothesis testing in engineering, environmental science, and water resources. • to use MS Excel, R, Python, SPSS, or Minitab for statistical	**10**	**07**

	analysis and interpretation of results. • Present a seminar or case study demonstrating the application of regression analysis or hypothesis testing in environmental engineering, hydrology, water quality assessment, or other engineering disciplines.		

Text Books:

- Odum E.P. & Barret G.W., (2005), "Fundamentals of Ecology", 5th Edition , Cengage Learning
- Adam M. Neville and John B. Kennedy, "Basic Statistical Methods for Engineers and Scientists", International Text Book Company.
- Richard I. Levin and David S. Rubin, "Statistics for Management", Prentice Hall of India Pvt. Ltd., New Delhi.

Reference Books:

- George E. P. Box, William G. Hunter, and J. Stuart Hunter, "Statistics for Experiments an Introduction to Design, Data Analysis, and Model Building", John Wiley & Sons.
- APHA, "Standard Methods for Examination of Water and Wastewater"; 24st Edition.

Journals/Magazines:

- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources:

- https://unstats.un.org/unsd/environment/envpdf/UNSD_Yaounde_Workshop/Session%2002-1%20Basic%20concepts%20(UNSD).pdf

Course Articulation Matrix:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	3	1	3
CO2	1	1	3	3	2	3
CO3	1	2	2	3	3	3
CO4	2	2	3	1	3	3
CO5	1	2	1	3	3	3

High – 3, Medium – 2, Low – 1

DEPARTMENT OF ENVIRONMENTAL ENGINEERING						
Course Code: 26MTEV153		**Course Title: Vulnerability Assessment and Disaster Management**				
Total Credits: 04		**SDGs addressed: 11, 13, 15, 17**		**Course Category: PEC**		**Course Type: Theory**
Teaching Learning Process		**Total Contact Hours/semester**	**Assessment Weightage and Marks**			
	Lecture	**45**		**CIE**	**SEE**	**Total**
	Tutorial	**30**	**Weightage %**	**40**	**60**	**100**
	Practical	**-**	**Maximum Marks**	**40**	**60**	**100**
	Self-learning and Term work	**45**	**Minimum Marks**	**20**	**25**	**45***
	Total	**120**				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Objective: The course aims to provide students with an understanding of disaster management principles, including hazard identification, vulnerability assessment, mitigation, preparedness, response, recovery, and disaster resilience. It also introduces disaster management policies, legal frameworks, emerging technologies, stakeholder participation, and recent disaster case studies to support effective disaster risk reduction and sustainable development.

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain disaster concepts, hazard and risk components, classify natural and man-made disasters, and describe the disaster management cycle and disaster risk reduction strategies.	L3
CO2	Evaluate hazard identification, vulnerability and disaster assessment to support risk prioritization and Emergency Response Planning (ERP).	L3
CO3	Assess disaster mitigation, preparedness, response, and recovery strategies for effective disaster risk reduction and resilient reconstruction**.**	L4
CO4	Describe disaster management policies, legal provisions, international frameworks, and the applications of information technology in disaster management.	L4
CO5	Discuss the roles of government, public, NGOs, and public–private partnerships in disaster management, and the lessons learned from recent disaster case studies.	L6

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Syllabus:

Unit No.	Content	Lecture Hours	Tutorial Hours
1	**Introduction:** Disaster, definition, classification, causes and impacts. Hazard, vulnerability, exposure, capacity and risk. **Natural disasters** - Drought, Floods, Earth Quake, Volcanoes, Land Slides, Cyclones, Tsunami; **Manmade disasters**- Air accidents, Rail and Road accidents, Industrial, Chemical, Biological (Bio-Terrorism) nuclear Disasters, accidental oil spills and other types of Disasters. Scope of disaster management, disaster management cycle, disaster Managers and stakeholders, their roles and responsibilities in various phases of disasters, Risk management, Resource management, impact reduction. **Self-learning and Term work**	**09**	**06**

	• Case studies on natural and manmade disasters • Resource management during disasters examples		
2	**Hazard identification, Vulnerability Assessment and disaster assessment:** Hazard-Exposure-vulnerability-risk relationship, Vulnerability types, Vulnerability assessment (VA), need and importance, Process of VA, Steps in VA, Prioritization, Emergency Response Plan (ERP). **Disaster Assessment:** Objectives, importance, rapid and detailed damage assessment, assessment tools and techniques. Post disaster needs assessment. **Self-learning and Term work** • Risk prioritization using a risk matrix • GIS and remote sensing in vulnerability assessment	**08**	**06**
3	**Disaster Mitigation and preparedness:** Mitigation planning and strategies, structural and non-structural mitigation measures for various manmade and natural disasters. Disaster resistant constructions, building bye-laws. Pre disaster Planning for various natural and manmade disasters, Early warning systems, disaster prediction and forecasting, risk communication, warning dissemination mechanisms, community-based disaster preparedness, capacity building, awareness programs, training, mock drills. **Disaster Response:** Search and rescue operations, shelter planning and camp management, relief operations, Recovery planning and implementation; short-term and long-term recovery; rehabilitation and reconstruction. Build Back Better (BBB) principles, sustainable recovery; climate-resilient reconstruction. **Self-learning and Term work** • Building bye-laws and safety standards • Development of an early warning and evacuation plan	**10**	**06**
4	**Disaster Management Policies and Legal Framework:** DMA-2005, National Disaster Management Policy; National Disaster Management Plan (NDMP), Incident Response System (IRS), Standard Operating Procedures (SOPs). DMP. **International Frameworks and Standards:** Sendai Framework for Disaster Risk Reduction (2015–2030); Sustainable Development Goals (SDGs) and disaster resilience, Global Disaster alerting and coordination system (GDACS). **Information Technology in Disaster Management**: Role and importance of Information Technology (IT) in disaster risk reduction and emergency management. Application of GIS, Remote sensing, AI, IoT, smart EOC for Disaster Management. Use of Unmanned aerial vehicles (UAVs) in disaster management and monitoring. **Self-learning and Term work** • Artificial Intelligence (AI) and IoT in disaster risk reduction • Case study on the implementation of the Incident Response System (IRS)	**10**	**06**
5	**Government, Public and NGO participation in DM:** Role of NGOs in disaster management, Public–Private Partnerships (PPP), Community participation in disaster risk reduction; Corporate Social Responsibility (CSR), resource mobilization and emergency logistics; disaster risk financing and relief mechanisms from government. **Case Studies:** Systematic analysis of recent national and international disaster such as Wayanad landslides-2024, COVID-19 pandemic, Odisha train collision,	**08**	**06**

	Myanmar earthquake etc., **Self-learning and Term work** • Corporate Social Responsibility (CSR) in disaster management • Literature review on disaster risk financing and relief mechanisms		

Text Books:

- National Research Council 2007. Improving Disaster Management: The Role of IT in Mitiga- tion, Preparedness, Response, and Recovery. Washington, DC: The National Academies Press. https://doi.org/10.17226/11824
- National Research Council 2007. Successful Response Starts with a Map: Improving Geospa- tial Support for Disaster Management. Washington, DC: The National Academies Press. https://doi.org/10.17226/11793

Reference Books:

- Trim, P.R.J. (2004), "An integrative approach to disaster management and planning", Disaster Prevention and Management, Vol. 13, No. 3, pp. 218, 225. https://doi.org/10.1108/09653560410541812
- National Research Council 2006. Facing Hazards and Disasters: Understanding Human Dimen- sions. Washington, DC: The National Academies Press. https://doi.org/10.17226/11671
- National Research Council 2007. Tools and Methods for Estimating Populations at Risk from Natural Disasters and Complex Humanitarian Crises. Washington, DC: The National Acade- mies Press. https://doi.org/10.17226/11895.
- National Research Council 2006. The Indian Ocean Tsunami Disaster: Implications for U.S. and Global Disaster Reduction and Preparedness: Summary of the June 21, 2005 Workshop of the Disasters Roundtable. Washington, DC: The National Academies Press. https://doi.org/10.17226/11619.
- WCDR Session Report UNEP, (2005), “Environmental Management and Disaster Prepared- ness” Building a multi-stakeholder partnership.

Journals/Magazines:

- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources:

- https://nidm.gov.in/research.asp
- http://www.adrc.or.jp/top_gen.asp
- http://www.cdc.gov

SWAYAM/NPTEL:

- NPTEL 8 weeks course on “Natural Hazards” by Prof. Javed N. Malik, IIT Kanpur
- Short Term Training Programs by NIDM, GOI

Course Articulation Matrix:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	-	1	-	-	-
CO2	3	3	-	3	2	3
CO3	3	3	-	3	-	-
CO4	3	3	-	3	2	2
CO5	3	3	-	3	-	3

High – 3, Medium – 2, Low – 1

DEPARTMENT OF ENVIRONMENTAL ENGINEERING						
Course Code: 26MTEV161		**Course Title: Climate Change and Impacts**				
Total Credits: 04		**SDGs addressed: 11, 13, 15, 17**		**Course Category: PEC**		**Course Type: Theory**
Teaching Learning Process		**Total Contact Hours/semester**	**Assessment Weightage and Marks**			
	Lecture	**45**		**CIE**	**SEE**	**Total**
	Tutorial	**30**	**Weightage %**	**40**	**60**	**100**
	Practical	**-**	**Maximum Marks**	**40**	**60**	**100**
	Self-learning and Term work	**45**	**Minimum Marks**	**20**	**25**	**45***
	Total	**120**				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Objective: The course emphasizes the history of earth's climate, climate change, climate change impacts and vulnerability. It also covers the significant influence of anthropogenic and developmental activities on global warming and climate change. Several climate change models are also introduced. The student gains the knowledge of climate change mitigative measures, emission trading and its monitoring.

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcomes	Highest Level of Cognitive Domain
CO1	Review earth's climate change, identifies the causes for climate change and describes the climate change models and their application.	L3
CO2	Describe impacts of climate change on various environmental compartments and stresses the need for vulnerability assessment and its approach.	L2
CO3	Explain the Indian scenario of climate change and its impact and reviews various impact predictive models.	L2
CO4	Define & describes emission trading, distinguishes different types of emission trading, understands the consequences of emission trading., Highlight the need for emission trading, Describe emission trading mechanisms	L3
CO5	State the importance of suitable monitoring and enforcing agencies, their role and responsibilities in emission trading.	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Syllabus:

Unit No.	Content	Lecture Hours	Tutorial Hours
1	**Introduction**: Global warming aggravations, Earth's climate, climate change, drivers of climate change, Kyoto, Montreal and New Delhi Protocols **Climate models**: Models for climate change, GCMs, RCMs, climate change scenarios; Sector models – water resources, Agricultural, forestry, energy, GHG prediction models **Self-learning and term work** • Consequences of climate change • Interlinks of air pollution and climate dynamics	**10**	**6**

2	**Climate change impacts**: Impacts of climate change on water sector, agriculture sector, infrastructure and energy systems with case studies. **Vulnerability/adaptation**: Need for vulnerability assessment; generic steps, approaches and tools of assessment; adaptation to climate change by various sectors. **Self-learning and term work** • Adaptation vs. mitigation of climate change • Economic burden on infrastructure due to climate change	**10**	**6**
3	**Mitigation**: Mitigation measures for climate change, CDM and case studies **Climate change and India:** impacts, sectoral and regional vulnerability in India **Self-learning and term work** • Evaluation of model simulation • Hazard, vulnerability, disaster triangle	**10**	**6**
4	**Emission trading:** Evolution of emission trading and design features, trading mechanisms. Cost-effective permit markets, the role of transaction costs, the role of technical change, Consequences of emission trading. **Self-learning and term work** • Low carbon economy • Climate change policies like GHG protocol	**8**	**6**
5	**Monitoring and enforcement**: domestic enforcement process, nature of international enforcement process, economic enforcement, current enforcement practice, program Effectiveness, global responsibilities for controlling climatic change. **Self-learning and term work** • Kyoto protocol • Paris agreement	**7**	**6**

Text Books:

- Shukla, P.R., et al. (2004), "Climate Change and India: VulnerabilityAssessment and Adapta- tion" - Universities Press
- Konrad Soyez, and Hartmut Grabl, (2008), "Basic Facts, Evaluation and Technological Options" - Springer Publications

Reference Books:

- Thomas H. Tietenberg ,(2006), "Emissions trading: principles and practice" an REFPress book
- Noel D Nevers, (2000), "Air Pollution Control Engineering", McGraw Hill InternationalEdi- tions, Civil Engineering Series, McGraw Hill
- Wark K., Warner C.F., and Davis W.T., (1997), "Air Pollution – Its Origin and Control",Third Edition, Prentice Hall of India Publishers

Journals/Magazines:

- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources:

- **https://files.eric.ed.gov/fulltext/ED503680.pdf**

SWAYAM/NPTEL:

- **https://onlinecourses.swayam2.ac.in/nou21_ge37/preview**

Course Articulation Matrix:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	3	3	1	2	3
CO2	3	3	3	0	0	3
CO3	3	3	3	0	2	3
CO4	3	3	3	0	0	3
CO5	3	3	3	0	0	3

High – 3, Medium – 2, Low – 1

DEPARTMENT OF ENVIRONMENTAL ENGINEERING						
Course Code: 26MTEV162		**Course Title: Hazardous Waste Management**				
Total Credits: 04		**SDGs addressed: 3, 6, 8**		**Course Category: PEC**		**Course Type: Theory**
Teaching Learning Process		**Total Contact Hours/semester**	**Assessment Weightage and Marks**			
	Lecture	**45**		**CIE**	**SEE**	**Total**
	Tutorial	**30**	**Weightage %**	**40**	**60**	**100**
	Practical	**-**	**Maximum Marks**	**40**	**60**	**100**
	Self-learning and Term work	**45**	**Minimum Marks**	**20**	**25**	**45***
	Total	**120**				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Objective: Upon completion of this course, students will be able to analyze, develop, and implement comprehensive environmental health and safety management systems that minimize risks, ensure regulatory compliance, and promote sustainability in various industries and workplaces.

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain risk assessment models and tools. Perform the process of risk assessment and illustrate exposure assessment models and Apply various testing methods for exposure assessment in different environmental systems and human exposure models.	L3
CO2	List hazard identification methods and Describe release assessment models and monitoring methodologies including statistical models and Review of case studies with respect to risk identification, assessment and emergency preparedness.	L4
CO3	Identify the sources and describe characteristics of hazardous wastes. Enumerate on waste minimization and resource recovery techniques	L3
CO4	Prepare the protocol for safe transport, treatment and disposal of hazardous wastes.	L5
CO5	Propose and design the treatment methods including Engineered land fill and containment and Describe in-situ and ex-situ bioremediation processes for contaminated soil.	L5

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 –Create

Course Syllabus

Unit No.	Content	Lecture Hours	Tutorial Hours
1	Introduction: Definition, history – episodes, sources, and generation of hazardous wastes. Biomedical wastes, household hazardous wastes. Regulations: Management and handling transboundary movement Rules, Superfund amendments and reauthorization Acts (SARA), hazard ranking system (HRS), Resource Conservation and Recovery Act (RCRA), Assessment of Hazardous waste sites. Hazardous waste Acts in all countries, E-waste rules. **Self-learning and Term work**	**09**	**6**

	• Review hazardous waste management regulations of India and one developed country and prepare a comparative summary. • Identify and classify hazardous waste sources in the university campus or a nearby locality and present the findings.		
2	**Characterization of Hazardous Wastes**: Ignitability, corrosivity, reactivity, toxicity. Designated hazardous wastes. Toxicology and Risk assessment: Toxic effects – persistent organic pollutants. LD/LC50, Dose-response, Risk exposure assessment, risk characterization and hazard quotient/index (HQ/HI), chronic daily intake (CDI), potency/slope factor, and reference dose (RfD); Numerical examples. **Self-learning and Term work** • Solve numerical problems on hazard quotient (HQ), hazard index (HI) and chronic daily intake (CDI) using published datasets. • Conduct a simplified risk assessment for a selected laboratory, hospital or industrial facility and recommend control measures.	**09**	**6**
3	**Hazardous Waste Management** Sources, Classification, Impacts of Mismanagement, Problems in Developing Countries and Regulations for Hazardous Waste Management Transportation of Hazardous Waste – requirements, regulations, containers and Labeling, bulk and non-bulk transport, Emergency Response, personal protective equipment. **Self-learning and Term work** • Study a recent hazardous waste transportation or disposal incident and prepare a technical case review. • Develop a hazardous waste transportation and emergency response plan for a selected industrial waste stream.	**09**	**6**
4	**Treatment & Disposa**l: Physico-chemical, Chemical and Biological Treatment of hazardous waste, Thermal treatment – Incineration and pyrolysis **Hazardous waste landfil**l – Site selection, design approach, liner and leachate and gaseous collection systems. Cover system, Contaminant transport through landfill barriers, landfill stability, closure and post closure care, other types of disposal facilities, Design Criteria and Examples. Facility Siting and Process Selection for treatment, storage, disposal facility (TSDF). In-situ and Exsitu bioremediation of contaminated soils. Software mini tab **Self-learning and Term work** • Review an emerging hazardous waste treatment technology and prepare a technical brief highlighting its advantages and limitations. • Recommend an appropriate treatment and disposal scheme for a given hazardous waste based on technical, environmental and economic considerations.	**09**	**6**
5	**Recent trends:** Cradle-grave concepts, Life cycle engineering concepts, soil remediation, site remediation options, hazardous waste source reduction, hazardous liquid waste treatment – new options, electronics hazardous waste processing, air and water quality at secured landfills, hazardous wastes from electrical/fuel cell vehicles, municipal hazardous wastes, hazardous wastes management, and economic losses. Applications of AI & ML in Hazardous Waste Technology and Management.	**09**	**6**

	Self-learning and Term work • **Self-Learning:** Review a recent journal article on AI/ML, circular economy or e-waste management and summarize its key findings. • **Team Work:** Propose an innovative hazardous waste management solution incorporating AI, IoT or resource recovery concepts and present the proposal.		

Text Books:

- Lagrega M.D., Buckingham P.L., and Evans J.C., (1994), "Hazardous wasteManagement", McGraw Hill International Edition
- Wentz C.A., (1995), "Hazardous Waste Management", McGraw Hill International Edition

Reference Books:

- Sincero A.P., and Sincero G.A., (1996)," Environmental Engineering- A Design Approach", Eastern Economy Edition, Prentice Hall of India Pvt., Ltd.
- Lehman, (1983), "Hazardous Waste Disposal", Plenum Press.
- Fawcett, (1984), "Hazardous and Toxic Materials: Safe Handling and Disposal", JohnWiley.
- CPCB guidelines for Hazardous Wastes

Journals/Magazines:

- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources:

- **https://inis.iaea.org/collection/NCLCollectionStore/_Public/30/001/30001804.pdf**

SWAYAM/NPTEL:

- **https://nptel.ac.in/courses/105106056**

Course Articulation:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	3	2	2
CO2	3	3	2	3	2	2
CO3	3	3	2	3	2	2
CO4	3	3	3	3	3	2
CO5	3	3	2	3	3	3

High – 3, Medium – 2, Low-1

DEPARTMENT OF ENVIRONMENTAL ENGINEERING						
Course Code: 26MTEV163		**Course Title: Waste to Resources**				
Total Credits: 04		**SDGs addressed: 12, 13, 16**	**Course Category: PEC**		**Course Type: Theory**	
Teaching Learning Process		**Total Contact Hours/semester**	**Assessment Weightage and Marks**			
	Lecture	**45**		**CIE**	**SEE**	**Total**
	Tutorial	**30**	**Weightage %**	**40**	**60**	**100**
	Practical	**-**	**Maximum Marks**	**40**	**60**	**100**
	Self-learning and Term work	**45**	**Minimum Marks**	**20**	**25**	**45***
	Total	**120**				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Objective: Concise Unified Objective Statement (for syllabus use): To impart comprehensive knowledge of water supply, treatment, distribution, advanced technologies, and residue management, enabling students to analyze, design, and evaluate sustainable water systems in urban and rural contexts.

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcomes	Highest Level of Cognitive Domain
CO1	Describe the 4R concept, sources and characterization of different wastes. Able to identify improper practices of solid waste disposal and their environmental implications. Understands the basic engineering principles of solid waste management.	L3
CO2	Explain different waste to energy biochemical and thermos chemical technologies based on their composition and characteristics	L4
CO3	Explicate the recovery of byproducts during energy production from waste for effective management of environment.	L3
CO4	Summarize on in-house industrial waste to energy plants, Centralized and Decentralized Energy production, distribution and use.	L5
CO5	Discuss on global as well as Indian practices on energy recovery from waste with success and failures of the applications.	L5

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 –Create

Course Syllabus

Unit No.	Content	Lecture Hours	Tutorial Hours
1	**Introduction** Need of energy production from wastes, Principles of Waste Management and Waste Utilization. Current Energy scenario and energy from waste, Waste Management Hierarchy, and 5R concept. Waste as an Alternate Energy source. Wastes suitable for energy production. Waste Sources & Characterization, Waste production from different sectors. Classification of waste, domestic waste, industrial waste (hazardous and non-hazardous). Characterization of waste for energy utilization - Physical, Chemical, Proximate and ultimate analysis, Leaching properties. **Self-Learning and Term work** ● Study the waste generation and characterization of a selected sector and	**09**	**6**

	prepare a short technical report. ● Conduct a campus/locality waste audit in teams and recommend suitable waste-to-resource options		
2	**Technologies** for Waste to Energy Biochemical Conversion – Biomass energy, Energy production from organic waste through anaerobic digestion and fermentation, energy production from algae. Energy from fecal sludge. Microbial Fuel Cell. Thermo-chemical Conversion – Incineration and heat recovery, Pyrolysis, Gasification; syngas utilization, Plasma Arc Technology, and other newer technologies. **Self-Learning and Term work** ● Review one emerging waste-to-energy technology and present its advantages, limitations and applications. ● Compare biochemical and thermochemical conversion technologies for a selected waste stream through a group presentation.	**09**	**6**
3	**Waste to Energy** Options Landfill gas, collection, and recovery. Refuse Derived Fuel (RDF). Alternate Fuel Resource (AFR) – production and use in Cement plants, Thermal power plants, and Industrial boilers. Co-generation and Tri generation concepts. Conversion of wastes to fuel resources for other useful energy applications. Energy from Plastic Wastes – Non-recyclable plastic wastes for energy recovery. **Self-Learning and Term work** ● Analyze a successful landfill gas, RDF or plastic-to-energy project and summarize the key outcomes. ● Develop a conceptual waste-to-resource plan for a municipality or industry using appropriate recovery technologies.	**09**	**6**
4	**Centralized and Decentralized Waste to Energy Plants** Location and Siting of 'Waste to Energy' plants. Industry Specific Applications – current-In-house use – agro-waste, pharmaceuticals, Pulp and paper, refinery and petrochemical industry, and any other industry. Centralized and Decentralized Energy production, distribution, and use. Waste to Energy & Environmental Implications, Environmental standards for Waste to Energy Plant operations and gas clean-up. **Self-Learning and Term work** ● Study the environmental standards applicable to waste-to-energy plants and prepare a compliance checklist. ● Design and present a conceptual layout of a centralized or decentralized waste-to-energy facility for a selected location.	**09**	**6**
5	**Recent Trends** Ethical issues on converting waste to energy, Global Best Practices in Waste to energy production. Indian Scenario on Waste to Energy Production. Role of the Government and NGOs in promoting Waste to Energy. National energy management with specific implications in developing countries. Applications of AI and ML in conversion of waste to energy. **Self-Learning and Term work** ● Review a recent research paper on AI/ML, circular economy or smart waste management and summarize the findings. ● Prepare a group seminar proposing an innovative waste-to-resource solution for a local environmental problem.	**09**	**6**

Text Books:

- Marc Rogoff, Francois Screve, "Waste-to-Energy Technologies and Project Implementation", 2011, 2nd Edition, ISBN: 9781437778724
- Naomi B Klinghoffer, Marco J Castaldi, "Waste to Energy Conversion Technology", 2013, Woodhead Publishing ISBN: 9780857096364
- Management of Municipal Solid Waste, Ramachandra T. V. 2016, "Commonwealth of Learning", Canada, Centre for Ecological Sciences, Indian Institute of Science, India, Karnataka Environment Research Foundation, India, Published by Teri Press, New Delhi.

Reference Books:

- Industrial and Urban Waste Management in India, TERI Press.
- Advances in Waste-to-Energy Technologies, Rajeev Pratap Singh, Vishal Prasad, Barkha Vaish, 2013, 1st Edition.
- Wealth from Waste: Trends and Technologies by Banwari Lal and Patwardhan, TERI Press.
- Fundamentals of waste and Environmental Engineering, S. N Mukhopadhyay, TERI Press.
- Gazette Notification on Waste Management Rules 2016.
- Report of the Task Force on Waste to Energy, Niti Ayog (Formerly Planning Commission) 2014.
- Municipal Solid Waste Management Manual, CPHEEO, 2016
- CPCB Guidelines for Co-processing in Cement/Power/Steel Industry

Journals/Magazines:

Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources:

- Waste to energy plant guidelines 2017
  https://www.giz.de/en/downloads/GIZ_WasteToEnergy_Guidelines_2017.pdf
  https://www.energy.gov/sites/prod/files/2019/08/f66/BETO--Waste-to-Energy-Report August-- 2019.pdf
- Waste to energy status in India
- http://dr.ddn.upes.ac.in:8080/jspui/bitstream/123456789/1932/1/Waste%20to%20energ y%20s tatus%20in%20India%20A%20short%20review_RSER.pdf
- Feasibility of Waste to Energy plants in India https://cdn.cseindia.org/docs/aad2019/swati-AAD.pdf

SWAYAM/NPTEL:

Waste to Energy Conversion by Prof. P. Mondal, IIT Roorkee.

Course Articulation:

COURSE OUTCOME↓	PROGRAM OUTCOME					
	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	3	-	3	-	3
CO2	3	-	-	3	3	3
CO3	3	-	-	-	-	-
CO4	3	-	-	3	-	3
CO5	3	3	-	3	3	3

High – 3, Medium – 2, Low-1

2nd Semester

DEPARTMENT OF ENVIRONMENTAL ENGINEERING				
Course Code: 26MTEV210	**Course Title: Air Pollution and Control Techniques**			
Total Credits: 05	**SDGs addressed: 13, 11**		**Course Category: PCC**	**Course Type: Theory integrated with lab**

		Total Contact Hours/semester	Assessment Weightage and Marks			
Teaching Learning Process	**Lecture**	**60**		**CIE**	**SEE**	**Total**
	Tutorial	**-**	**Weightage %**	**40**	**60**	**100**
	Practical	**30**	**Maximum Marks**	**40**	**60**	**100**
	Self-learning and Term work	**60**	**Minimum Marks**	**20**	**25**	**45***
	Total	**150**				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Objective: The course covers the air pollution sources, classification, effects, and measurement of air pollutants, standards. The course emphasizes on global burden of disease, importance of meteorology in dilution and dispersion, pollutants, models for estimating dilution and dispersion of pollutants and control technologies.

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcomes	Highest Level of Cognitive Domain
CO1	Able to distinguish pristine and polluted atmosphere based on composition and explain the interlinks of air emissions, global burden of disease, climate change and urban planning.	L4
CO2	Describe the basic concepts of atmospheric stability and influence of meteorological parameters which influence the dispersion of air pollutants and to create wind rose diagram	L3
CO3	Explain the underlying principle of sampling, general guidelines, sampling types, procedure and importance of gaseous and particulate matter monitoring for assessing ambient air quality	L2
CO4	Explain different types of models, assess the suitability of models for given scenario and estimate plume rise	L3
CO5	Able to describe working principle and design aspects of various air pollution control equipment and importance of source apportionment in framing policy matters	L3

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 –Create

Course Syllabus

Unit No.	Content	Lecture Hours
1	**Introduction :** Composition and structure of the atmosphere; Interlinks of air emissions, Radiative forcing, UHI, climate change and urban planning. Air pollution: sources, classification and Impacts on public health and Environment. Global burden of disease. Numerical problems on Units and conversions. **Self-Learning and Term work** ● NAAQS standards ● Conversion of units of air pollution	**10**

2	**Meteorology:** Wind circulation, solar radiation, lapse rates, atmospheric stability conditions and Pasquill and Gifford atmospheric stability classification, wind velocity profile, Maximum Mixing Depth, Ventilation coefficient, Temperature Inversions, plume behavior, Wind rose diagram, general characteristics of stack emissions **Self-Learning and Term work** ● Advection, diffusion and dispersion phenomenon ● Assessing vertical wind velocity profile	**12**
3	**Ambient air quality monitoring:** Sampling concepts (active, passive, stationary, mobile monitoring). General guidelines for monitoring and Sampling devices for gaseous and non-gaseous pollutants. Stack sampling (Isokinetic sampling), gas exhaust analyzer. Importance of Indoor air quality & monitoring parameters **Self-Learning and Term work** ● Stack height norms and real-world case studies from EPA and CPCB ● microbial air sampling protocols for IAQ	**12**
4	**Pollutants' dispersion models:** Need for air quality models, types of models. Box model, Gaussian plume dispersion model – for point source (with and without reflection, for ground level and elevated source). Plume rise and effective stack height calculations and Numerical Problems. **Self-Learning and Term work** ● Respiratory distress in livestock near polluted areas ● Effects of acidification on plant leaves and aquatic life ● Reaction mechanism of pollutants	**13**
5	**Air Pollution Control Equipment:** Mechanisms, Control equipment for particulate matter – gravity settling chambers, centrifugal collectors, wet collectors, scrubbers, fabric filters, electrostatic precipitator (ESP) - Design principles and design criteria, Numerical problems. Need for Emission inventory and source apportionment **Self-Learning and Term work** ● Trend analysis for Particulate Matter concentration for your own city ● Estimating cities noise pollution	**13**

Text Books:

- Wark K., Warner, C.F., and Davis W.T., (1998), "Air Pollution- Its Origin and Control" 3rd edition, Harper & Row Publishers, New York.
- Stern A.C, Boubel R.W, Turner D.B., Fox D.L (1984) "Fundamentals of Air Pollution" Second edition Academic Press Inc

Reference Books:

- Sincero A.P. and Sincero G.A. (1999), "Environmental Engineering - A Design Ap- proach", Prentice Hall of India, New Delhi.

Journals/Magazines:

- Refer good research articles from Atmospheric environment, Air Pollution Research, Science of total the environment

Web/Digital resources:

- WHO Global Air Quality Guidelines https://www.who.int/news-room/questions-and-answers/item/who-global-air-quality-guidelines

- Guidelines for the Measurement of Ambient Air Pollutants https://cpcb.nic.in/open-pdffile.php?id=UmVwb3J0RmlsZXMvMjdfMTQ1ODExMDQyNl9OZXdJdGVtXzE5Nl9OQUFRTVNfVm9sdW1lLUkucGRm

SWAYAM/NPTEL:

- Air pollution and control offered by IIT Roorkee

Lab Component:

Unit No.	Content	Practical Hours
1	Atmospheric Laboratory – Introduction to the laboratory/equipment/instruments, environmental system software, and applications. Noise measurement exercise	2
2	Light intensity monitoring (LUX meter), Plotting Wind rose using software	2
3	Air Pollution Monitoring -Particulate Matter – PM10, PM2.5 using High Volume Air Sampler (HVAS).	2
4	Particulate Matter monitoring – SPM using High Volume Air Sampler (HVAS).	2
5	Particulate Matter monitoring – RSPM using High Volume Air Sampler (HVAS).	2
6	Estimating Sulphur oxides and nitrogen oxides in ambient air using HVAS Monitoring	2
7	Exercises on auto exhaust analyser for Petrol Vehicles.	2
8	Stack Sampling Techniques and Demonstration of Stack Monitoring.	2
9	Airborne microbial detection	2
10	Volatile Organic Compounds- monitoring using Tiger Ion Analyzer	2
11	Hands-on application of Environmental System Software to simulate Air pollutant dispersion (example: ISCST/CALINE model, any other)	2
12	Hands-on application of Environmental System Software to simulate Air pollutant dispersion (example: ISCST/CALINE model, any other)	2
13	Sensor-based real-time monitoring - Gaseous and Non-gaseous pollutants	2
14	Mobile monitoring demonstration (in association with KSPCB/Private Consultants)	2
15	Field visit to industry for demonstration of air pollution control equipment’s	2
16	CIE	-

Course Articulation Matrix:

COURSE OUTCOMES↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	3	3	2	2	2
CO2	3	2	3	2	1	3
CO3	2	2	3	2	2	2
CO4	3	2	3	2	2	2
CO5	3	3	3	2	2	2

High – 3, Medium – 2, Low – 1

DEPARTMENT OF ENVIRONMENTAL ENGINEERING						
Course Code: 26MTEV220		**Course Title: Environmental Legislation and Impact Assessment**				
Total Credits: 04		**SDGs addressed: 4, 8, 9, 11, 17**	**Course Category: PCC**		**Course Type: Theory**	
Teaching Learning Process		**Total Contact Hours/semester**	**Assessment Weightage and Marks**			
	Lecture	**45**		**CIE**	**SEE**	**Total**
	Tutorial	**30**	**Weightage %**	**40**	**60**	**100**
	Practical	**-**	**Maximum Marks**	**40**	**60**	**100**
	Self-learning and Term work	**45**	**Minimum Marks**	**20**	**25**	**45***
	Total	**120**				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Objective: The course provides a detailed insight into the Indian environmental legislation aspects, including the National Environmental Policy, legal framework, Green Tribunal and various Acts related to environmental pollution, prevention, and control.

The course also deliberates on carrying capacity concepts, objectives, scope and types of impact assessment. Explains the process of impact assessment and deals with various methodologies. Distinguishes between EMP and DMP. It reviews a few case studies on legislation and EIA.

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain the Constitution of India, the National Environmental Policy and the legal framework related to Environmental aspects	L2
CO2	List and Identify Various Indian Environmental Acts in Vogue, Amendments, modifications, and notifications. Describe the role of the Green Tribunal.	L2
CO3	Discuss the Concept of Carrying Capacity, Steps to carry out Environmental Impact Assessment Studies, define Objectives and types of EIA, List and describe.	L2
CO4	Describe various EIA methodologies and the need for public participation in EIA. Explain the importance of assessment of various attributes and carry out an Environmental Audit. Distinguish between the Environmental Management Plan (EMP) & Disaster Management Plan (DMP)	L4
CO5	Understand the practical application of Environmental Law & Case Laws and review important EIA Case Studies.	L4

L1–Remember, L2–Understand, L3–Apply, L4–Analyze, L5–Evaluate, L6-Create

Course Syllabus:

Unit No.	Content	Hours Lecture	Hours Tutorial
1	**Environmental Legislation:** Introduction & Need for Environmental Legislation, Constitution of India -Fundamental rights, duties, articles & sections related to Env. Protection, Legal Framework, Legislative Act, Rules, Regulations, Notification & Amendments, International Conferences, Protocol & Agreements on Environment Protection, National	09	06

	Environmental Policy -2006, Role of Ministry of Environment, Forest and Climate Change, National Green Tribunal Act (NGT) 2010, National Green Tribunal, The Biological Diversity Act 2002, National Biodiversity Authority. **Self-Learning and Term work** ● Case study ● Group event ● Debate		
2	**Indian Environmental Acts:** Forest Act 1927, Wild Life Protection Act 1972, The Forest Conservation Act 1980, Water Act 1974, Air Act 1981, Environment (Protection)Act 1986 & Rules, Solid Waste management Rules 2026, Biomedical Waste (Managing & Handling) Rules 2016, Hazardous and Other Wastes (Management and Trans boundary Movement) Rules, 2016, Plastic Waste Management (PWM) Rules, 2016, The E-Waste (Management) Rules, 2022, Construction and Demolition Waste Management Rules, 2016, The Noise Pollution (Regulation and Control) Rules, 2000, Coastal Regulation Zone Notification, 2011, The Public Liability Insurance Act of 1991. **Self-Learning and Term work** ● Poster presentation ● Case study ● Group event ● Debate	09	06
3	**Environmental Impact Assessment:** Introduction - Definition, Evolution of EIA in India and other countries, EIA Notification 2006, Purpose and Scope of EIA, Types of EIA, Step-by-step process of EIA, Chapter contents in EIA, EIS, FONSI, TOR, EC practices in India, MoEF&CC guidelines on siting of industries, ecologically sensitive areas, NABET accreditation for EIA consultants. **Self-Learning and Term work** ● Case study ● Group event ● Debate ● Problem solving	09	06
4	**Methodologies & Techniques in EIA**: Ad hoc, checklist, matrix, overlays, networks, Battle Environmental Evaluation Systems (BEES), Cost-Benefit Analysis (CBA), brainstorming, fuzzy, Delphi technique. Public participation in EIA. Attributes – Air, water, land, noise, biotic, socio-economic – Standards, Environmental Management Plan (EMP) and Disaster Management Plan (DMP), Onsite and Offsite Emergency Plan, Environmental Audit. **Self-Learning and Term work** ● Problem solving ● numerical /analytical tasks ● Case study	09	06

	• Group event		
5	**Case Laws on Environmental Issues:** • MC Mehta's Case –Ganga River Pollution, Sriram Food &Fertilisers, Union Carbide • Vellore Citizens Welfare Forum v/s GoI, Goa Foundation V/s Konkan Railway Corporation • Cases decided by the Green Tribunal - Almitra H. Patel & Ors. vs. Union of India and Ors, Samit Mehta vs. Union of India and Ors, Save Mon Region Federation and Ors. vs. Union of India and Ors, Municipal Corporation of Bombay v Ankita Sinha • Polluter Pays Principle, Inter-Generational Equity & Sustainable Development • Precautionary Principle, Public Trust Doctrine, SDGs • Extended Producer Responsibility (EPR) and Circular Economy principles • Environmental Management System MS ISO -14000:2026 **EIA Case Studies –**Water and Wastewater Treatment Plants, Pharmaceutical, Thermal Power Plant, Mining, Airports, Cement Manufacturing Plant, Chemical Fertilisers Plant and Township Development Projects. **Self-Learning and Term work** • Case study • Group event • Debate • Problem solving	09	06

Text Books:

- CPR Environmental Education Centre (2006), Environmental Laws of India – An Introduction.
- Canter L., (1995), "Environmental Impact Assessment", McGrawHill.
- Jain R.K., Urban L. V., Stacey G.S., (1977), "Environmental Impact Analysis–A New Dimension in Decision Making", Van Nostrand Reinhold Co. 12
- Clark B. C. Bisett and Tomlinsan P, (1985),"Perspective on Environmental Impact Assessment", Allied Publishers.

ReferenceBooks:

- IndianActsrelatedtoEnvironmentalPollutionPreventionandControl.
- Anjaneyulu and Valli Manickam, (2010),"Environmental Impact Assessment Methodologies", BS Publications.

Journals/Magazines:

- Technical articles from peer reviewed journals of Science Direct, Springer, Taylor and Francis and patented materials.

- **Web/Digital resources:**
- Ministry of Environment, Forest and Climate Change: Executive summary of the Project reports in Karnataka -https://kspcb.karna-taka.gov.in/node/406
- AccreditationofEIAConsultant:Organizationshttps://nabet.qci.org.in/eiafile/Accredita-tion_EIA_Consultant_organizations.pdf
- ReferenceDMPreport:http://environmentclearance.nic.in/writereaddata/online/RiskAssess-ment/17032016K2ZJUBO1Annexure_RiskAssessment.pdf

SWAYAM/NPTEL:

- Environmental Impact Assessment by Prof. Harshit Sosan Lakra, IIT Roorkee.

PRACTICE BASED LEARNING:

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	EIA methodologies	Using gold reports, preparing checklists, matrices, networks with examples	Use of techniques for Assessment

Course Articulation Matrix:

COURSE OUTCOMES↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	–	3	2	–	3	–
CO2	–	3	2	–	3	–
CO3	2	3	2	2	3	–
CO4	2	3	3	2	3	2
CO5	–	3	3	–	2	3

High–3, Medium–2, Low–1

DEPARTMENT: ENVIRONMENTAL ENGINEERING						
Course Code: 26MTEV230		**Course Title: Transport Processes and Modelling**				
Total Credits: 04		**SDGs addressed: 6, 9, 11, 13, 14, 15**	**Course Category: PCC**	**Course Type: Theory**		
Teaching Learning Process		**Total Contact Hours/ semester**	**Assessment Weightage and Marks**			
	Lecture	**45**		**CIE**	**SEE**	**Total**
	Tutorial	**30**	**Weightage, %**	**40**	**60**	**100**
	Practical	**-**	**Maximum Marks**	**40**	**60**	**100**
	Self-learning And Term work	**45**	**Minimum Marks**	**20**	**25**	**45***
	Total	**120**				

Note: *For passing the student must score a Minimum of 45Marks (CIE+SEE: 20+25 or 21+24)

Course Objective: The course emphasizes various transport processes and illustration of mathematical models in simulation and prediction of pollutant concentration, and dispersion in surface and subsurface water bodies.

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcome	Highest Level of Cognitive Domain
CO1	Illustrate the fate and transport of pollutants with case studies. Derive related equations with analytical solutions.	L3
CO2	Correlation of the mathematical models and prediction of pollutant (conservative and non-conservative) concentrations in lakes and rivers under steady-state conditions with suitable numerical exercises.	L3
CO3	Explain the concept of mixing zone in natural aquatic bodies and its influence on pollutant dispersion and also prepare field monitoring protocol for measuring hydraulic as well water quality parameters.	L2
CO4	Design and compare stratified and completely-mixed lake systems with mathematical equations to compute pollutant distribution in lake, Ocean and estuarine systems.	L3
CO5	Derive 3-D air quality and 1-D groundwater model considering the influencing processes and apply the various prediction models for prediction of groundwater quality.	L3

L1–Remember, L2 –Understand, L3–Apply, L4–Analyze, L5–Evaluate, L6- Create

Course Syllabus:

Unit No.	Content	Lecture Hours	Tutorial Hours
1	Modelling– Introduction, applications in environmental management. Physical phenomena – advection, diffusion, dispersion, Fick's laws of diffusion, convective - diffusion equations for turbulent & shear flow regimes. **Self-Learning:** • Applications of environmental modelling in river and lake water quality management. • Comparison of advection, diffusion, and dispersion processes in natural water bodies.	**08**	**05**

	Term Work: • Numerical problems on advection, diffusion, and dispersion phenomena. • Solution of one-dimensional convective–diffusion equation for a simple environmental system.		
2	Steady-state water quality modeling - models for conservative and non-conservative substances. 1-D Oxygen balance models - Streeter- Phelps equation, critical point method. Calibration and verification of DO simulation model. Dissolved oxygen models for lakes under completely mixed and stratified conditions. **Self-Learning:** • Study recent applications of dissolved oxygen (DO) modelling in rivers and lakes using published case studies. • Explore the use of environmental modelling software (e.g., QUAL2K or WASP) for simulating dissolved oxygen and water quality. **Term Work:** • Solve numerical problems on the Streeter–Phelps equation, critical point method, and dissolved oxygen models for completely mixed and stratified lakes. • Prepare a seminar or technical report on the calibration and verification of a dissolved oxygen simulation model using a selected case study.	**09**	**05**
3	Mixing zones in rivers – types of outfalls and mixing regimes. Stream tube concept, Steady-state 2-D analysis. Parameter estimation - lateral mixing coefficient - critical point method, Case studies. **Self-Learning:** • Study different types of outfalls and mixing regimes in rivers through published case studies and environmental impact assessment reports. • Explore methods for estimating lateral mixing coefficients and their applications in two-dimensional river water quality modelling. **Term work:** • Solve numerical problems on stream tube concepts, steady-state 2-D mixing analysis, and estimation of lateral mixing coefficients using the critical point method. • Prepare a seminar or technical report on a case study involving river mixing zones and pollutant dispersion analysis.	**08**	**05**
4	Data collection and analysis - specialized water quality surveys, estimation of decay and re-aeration rates. Estuaries – Salinity distribution, mathematical analysis of pollutant dispersion in estuaries. Ocean - disposal of wastewater - siting and design of outfalls. **Self-Learning:** • Study advanced water quality survey techniques and methods for estimating decay and re-aeration coefficients using published environmental case studies. • Explore the mathematical modelling of salinity distribution, pollutant dispersion in estuaries, and the design principles of ocean wastewater outfalls. **Term work:**	**10**	**05**

	• Solve numerical problems on decay and re-aeration rate estimation, salinity distribution, and pollutant dispersion in estuarine systems. • Prepare a technical report or seminar on a case study related to estuarine water quality modelling or the siting and design of ocean wastewater outfalls.		
5	Ground water quality modeling concepts - formulation of 1-D model with decay and retardation for instantaneous sources, plume delineation studies. 3-D Air quality modelling Migration of pollutants through soil. Salient features of environmental simulation models / software. Lab Component: River Water Quality Prediction Models – STREAM, QUAL2KW, MIXING ZONE Models, CALINE, ISCST model, AERMOD Data Analysis Models - IA 2D PIT Prediction Models for estuary, lake and ocean using excel spreadsheet **Self-Learning:** • Study groundwater contaminant transport, plume delineation techniques, and 3-D air quality modelling through recent research articles and case studies. • Explore the features and applications of environmental simulation software such as STREAM, QUAL2KW, CALINE, ISCST, AERMOD, and IA 2D PIT for environmental assessment. **Term Work:** • Perform laboratory exercises using groundwater, river, estuary, lake, ocean, and air quality prediction models, and analyze the simulation results using Excel and environmental modelling software. • Prepare a technical report and seminar on pollutant migration through soil or the application and validation of an environmental simulation model using a selected case study.	**10**	**10**

Text Books:

- Thomann R.V., and Mueller J.A., (1987), "Principles of Water Quality Management and Control", Harper & Row Publications.
- Schnoor J.L., (1996) "Environmental Modelling – Fate and Transport of Pollutants in Water, Air and Soil", John Wiley and Sons.

Reference Books:

- Rich L.G., "Environmental Systems Engineering ", McGraw Hill.
- Thomann R.V., (1980), "Systems Approach to Water Quality Management", McGrawHill.
- Lee C.C., and Lin S.D., (1999), "Handbook of Environmental Engineering Calculations", McGraw Hill, New York.
- Metcalf and Eddy Inc., (1995), "Wastewater Engineering - Treatment and Reuse", 3RDEdition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

Journals/Magazines:

- Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources:

- **https://assets.cambridge.org/97805211/19245/frontmatter/9780521119245_front- matter.pdf**

SWAYAM/NPTEL:

- **https://www.digimat.in/nptel/courses/video/103108098/L01.html**

Course Articulation Matrix:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3
CO2	3	1	3	3	3	3
CO3	3	3	3	3	2	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

High–3, Medium–2, Low– 1

DEPARTMENT OF ENVIRONMENTAL ENGINEERING						
Course Code: 26MTEV241		**Course Title: Environment Social Governance**				
Total Credits: 04		**SDGs addressed: 12, 13, 16, 9, 8, 17**	**Course Category: PEC**		**Course Type: Theory**	
Teaching Learning Process		**Total Contact Hours/semester**	**Assessment Weightage and Marks**			
	Lecture	**45**		**CIE**	**SEE**	**Total**
	Tutorial	**30**	**Weightage %**	**40**	**60**	**100**
	Practical	**-**	**Maximum Marks**	**40**	**60**	**100**
	Self-learning and Term work	**45**	**Minimum Marks**	**20**	**25**	**45***
	Total	**150**				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Objective: The course emphasizes on Unit operations and processes of Water treatment facilities and its design considerations.

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcomes	Highest Level of Cognitive Domain
CO1	Understand ESG principles and their importance in sustainable development.	L2
CO2	Evaluate environmental, social, and governance performance of organizations.	L4
CO3	Apply globally accepted ESG frameworks and reporting standards.	L3
CO4	Assess ESG risks, opportunities, and investment decisions.	L3
CO5	Develop ESG implementation and reporting strategies for organizations.	L5

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 –Create

Course Syllabus

Unit No.	Content	Lecture Hours	Tutorial Hours
1	**Introduction to ESG** Sustainability, Evolution of ESG, Sustainable Development Goals, CSR, sustainability vs ESG, Companies practicing ESG – Case studies **Self-Learning and term work** • Circular Economy in Practice • Greenwashing: Identification and Prevention	**08**	**6**
2	**Environmental Pillar** Climate change, Carbon Footprint, Energy, Water, Waste Circular Economy, Biodiversity **Social Pillar** Human Rights, Diversity & Inclusion, Employee Well-being, Occupational Health & Safety, Community Development **Governance Pillar** Corporate Governance, Ethics, Board Structure, Anti-corruption, Transparency, Risk Management **Self-Learning and term work**	**12**	**06**

	• Biodiversity and Nature-based Solutions • ESG in Supply Chain Management		
3	**ESG Reporting, Metrics & KPIs** Materiality Assessment, ESG Indicators, Data Collection, ESG Rating Agencies, Sustainability Reports, Integrated Reporting, ESG Disclosure Requirements **Self-Learning and term work** • Artificial Intelligence and Digital Technologies for ESG • ESG in Higher Education Institutions	**08**	**6**
4	**ESG Standards & Frameworks** Global Reporting Initiative, International Sustainability Standards Board, Task Force on Climate-related Financial Disclosures, Sustainability Accounting Standards Board, United Nations Global Compact **Self-Learning and term work** • Comparative Study of Sustainability Reports • Emerging ESG Regulations	**08**	**6**
5	**ESG Risk Assessment** Climate Risk, Physical & Transition Risks, Enterprise Risk Management, Supply Chain Risks, Sustainable Finance, Numerical problems on business risk assessment and climate adaptation. Greenwashing & Ethics **Self-Learning and term work** • Sustainable Finance and Green Bonds • Water Stewardship and Waste Management	**09**	**6**

Text Books:

- Rasche, A., Gilbert, D. U., Moon, J., & Morsing, M. Corporate Sustainability: Managing Responsible Business in a Globalized World. 1st Edition, Cambridge University Press, 2023.
- Robertson, M. Sustainability Principles and Practice. 3rd Edition, Routledge, 2021.
- Epstein, M. J., & Rejc Buhovac, A. Making Sustainability Work: Best Practices in Managing and Measuring Corporate Social, Environmental and Economic Impacts. 2nd Edition, Berrett-Koehler Publishers, 2014.

Reference Books:

- Weybrecht, G. The Sustainable MBA: A Business Guide to Sustainability. 2nd Edition, John Wiley & Sons, 2024.
- Fernando, A. C. Business Ethics and Corporate Governance. 3rd Edition, Pearson India, 2022.

Journals/Magazines:

Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

Web/Digital resources: Courses from world bank, UNFCC, UN , Future Learn, edX
Universal Standards (GRI 1, GRI 2, GRI 3)
https://www.globalreporting.org/standards/standards-development/universal-standards/

SWAYAM/NPTEL:

From Theory to Practice: Implementing ESG and Sustainability in Business
https://onlinecourses.swayam2.ac.in/e-learning/preview/imb25_mg77

Practice Based Learning

Tutorials/Activity	Tool/Software	Learning Outcome
ESG Fundamentals	Compare ESG performance of two companies using publicly available sustainability reports using MS Excel	Understand ESG indicators and stakeholder expectations
Carbon Footprint Calculation	MS Excel/GHG protocol Calculation tools	Carbon Accounting
Materiality Assessment	Mapping tools- word, excel	Identifying most influencing factors for company

Course articulation matrix:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	3	1	1	3	2
CO2	3	3	3	1	2	3
CO3	2	2	3	2	2	3
CO4	3	3	3	2	3	3
CO5	3	3	3	3	3	3

High – 3, Medium – 2, Low-1

DEPARTMENT OF ENVIRONMENTAL ENGINEERING						
Course Code: 26MTEV242		**Course Title: Remote Sensing and GIS**				
Total Credits: 04		**SDGs addressed: 12, 13, 16, 9, 8, 17**	**Course Category: PEC**		**Course Type: Theory**	
Teaching Learning Process		**Total Contact Hours/semester**	**Assessment Weightage and Marks**			
	Lecture	**45**		**CIE**	**SEE**	**Total**
	Tutorial	**30**	**Weightage %**	**40**	**60**	**100**
	Practical	**-**	**Maximum Marks**	**40**	**60**	**100**
	Self-learning and Term work	**45**	**Minimum Marks**	**20**	**25**	**45***
	Total	**150**				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Pre-Requisite: Engineering Physics, Survey Engineering

Course Objective: To impart a fundamental understanding of remote sensing and GIS and their applications in Environmental engineering.

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcome	Highest Level of Cognitive Domain
CO1	Explain the fundamentals and principles of remote sensing (RS) and remote sensing systems including EM spectrum, resolutions, and RS satellites.	L2
CO2	Discuss spatial data acquisition, compare manual interpretation and digital image processing	L2
CO3	Explain and illustrate with examples the importance and need of GIS in environmental resources management. Explain the concepts of co-ordinates and projection systems and differentiate between raster and vector data models.	L2
CO4	Identify sources of input data, explain possible errors in input data and their correction techniques, explain basic vector and raster spatial data analysis and their applicability	L3
CO5	Explain the basics of Web GIS, plan and organize the input data for a given application, choose and perform appropriate spatial analysis, and assess the environmental implications of environmental-related issues.	L3

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

Course Syllabus:

Unit No.	Content	Lecture Hours	Tutorial hours
1	**Basics of Remote Sensing** Basic concepts of remote sensing, electromagnetic radiation – sources, spectrum and radiation laws, passive and active remote sensing, energy interactions - atmosphere and earth's surface features, spectral reflectance curves. **Remote Sensing Systems** Ideal RS system, platforms and orbits, resolutions - spatial, spectral, radiometric, and temporal resolutions, multi-spectral RS, Basics of thermal and hyper-spectral sensing, remote sensing satellites – features and applications	**09**	**6**

	Self-learning and term work • Explore the specifications and applications of any one remote sensing satellite and prepare a brief report. • Work in groups to present the applications of different remote sensing resolutions in environmental engineering.		
2	**Data Acquisition, Visual Image Interpretation, and Digital Image Processing** Types of remotely sensed data products, Elements of visual image interpretation, Image processing - per-processing, registration, enhancement, spatial filtering, transformation, classification, Concept of ground truthing **Self-learning and term work** • Download and interpret a freely available satellite image of a selected region using online resources. • Collaboratively prepare a flowchart illustrating the stages of digital image processing and image classification.	**09**	**6**
3	**Introduction to Geographical Information System (GIS)** Origin and importance of GIS, Maps – scale, and elements, coordinate and projection systems, linkage of remote sensing to GIS. **Data Models and Structures** Spatial data models – raster, vector; spatial and attribute data. **Self-learning and term work** • Install and explore QGIS (or any open-source GIS software) and document its basic tools. • Prepare a thematic map of a selected study area using publicly available spatial data as a team activity	**09**	**6**
4	**Spatial Data Input and Editing** Methods of data input: keyboard, manual digitizing, scanning and automatic digitizing, GPS, data editing: sources and correction of errors, concept of topology. **Spatial Analysis** Raster and vector overlay analysis, terrain modeling, buffering, and neighborhood function, basics of network analysis **Self-learning and term work** • Study different methods of spatial data input and prepare a comparative summary. • Perform a simple buffer or overlay analysis on a common GIS dataset and present the findings in groups.	**09**	**6**
5	**Introduction to Web GIS and hands-on to GIS software Applications of RS and GIS** Measurement, Monitoring, Mapping, and Modelling applications in air, water, and land system management (example with case studies - Watershed management, rainfall-runoff modeling, flood mapping, groundwater vulnerability modeling, optimal routing of solid wastes collection system of an urban area, environmental monitoring, environmental siting and zoning atlas development). Applications of AI & ML in Remote Sensing and GIS in Environmental Engineering. **Self-learning and term work** • Review one recent case study on AI/ML applications in Remote Sensing	**09**	**6**

	and GIS and submit a one-page summary. • Develop and present a group case study demonstrating the application of RS and GIS to solve an environmental engineering problem.		

Text Books:

- Lillesand T. M, Kiefer R. W. and Chipman J. W., "Remote sensing and Image Interpretation",5th Edition, John Wiley & Sons, 2004.
- Burrough P. A., McDonnell R. A., and Lloyd C. D., "Principles of Geographical Information Systems", 3rd Edition, Oxford University Press, 2015.
- Michael N. DeMers, "Fundamentals of Geographical Information Systems", 4th Edition, John Wiley and Sons. Inc., 2008.

Reference Books:

- Anji Reddy "Textbook of Remote sensing and Geographical Information Systems", 3rd Edition, B. S. Publications, Hyderabad, 2008
- Longley P. A., Goodchild M. F, Maguire D. J. and Rhind D. W., Geographical Information Systems: Principles, Techniques, Management and Applications, 2nd Edition, John Wiley & Sons, 2005.

Journals/Magazines:

- Journal articles in reputed journals describing applications of Remote Sensing and GIS in Environmental Management
- Web/Digital Resources:
- Videos on YouTube (Example: https://www.youtube.com/watch?v=ThtQwbi8UVo, https://www.youtube.com/watch?v=HnWNhyxyUHg
- Coursera (Example: 'Introduction to GIS Mapping', 'GIS Data Acquisition and Map Design', 'Spatial Analysis and Satellite Imagery in a GIS')
- CPCB Website

SWAYAM/NPTEL:

- Geographic Information Systems, By Prof. Arun K. Saraf, IIT Roorkee https://onlinecourses.nptel.ac.in/noc22_ce26/preview
- Remote Sensing and GIS, By Prof. Rishikesh Bharti, IIT Guwahati https://onlinecourses.nptel.ac.in/noc22_ce84/preview

Course articulation matrix:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3
CO2	3	-	3	3	3	3
CO3	3	3	3	3	-	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

High – 3, Medium – 2, Low –1

DEPARTMENT OF ENVIRONMENTAL ENGINEERING						
Course Code: 26MTEV243		**Course Title: Environment, Health and Safety**				
Total Credits: 4		**SDGs addressed: 3, 6, 8**		**Course Category: PEC**		**Course Type: Theory**
Teaching Learning Process		**Total Contact Hours/semester**	**Assessment Weightage and Marks**			
	Lecture	**45**		**CIE**	**SEE**	**Total**
	Tutorial	**30**	**Weightage %**	**40**	**60**	**100**
	Practical	**-**	**Maximum Marks**	**40**	**60**	**100**
	Self-learning and Term work	**45**	**Minimum Marks**	**20**	**25**	**45***
	Total	**120**				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Objective: Upon completion of this course, students will be able to analyze, develop, and implement comprehensive environmental health and safety management systems that minimize risks, ensure regulatory compliance, and promote sustainability in various industries and workplaces.

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcomes	Highest Level of Cognitive Domain
CO1	Formulate, implement, and adapt a legally compliant Safety Management System, drives a proactive safety culture, and scales effectively across industries	L2
CO2	Evaluate workplace and community environmental hazards to design engineering controls, risk mitigation strategies addressing case studies and emerging EHS issues.	L2
CO3	Analyze diverse occupational hazards— to design robust control measures, risk assessment strategies, and targeted safety frameworks.	L2
CO4	Diagnose operational and maintenance failures across collection systems, and treatment facilities and to inspect infrastructures safely and design resilient operational management..	L3
CO5	Synthesize operational problems to formulate advanced corrective and predictive maintenance (O&M) strategies by integrating online environmental quality monitoring systems, artificial intelligence (AI), and machine learning (ML) models.	L2

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 –Create

Course Syllabus

Unit No.	Content	Lecture Hours	Tutorial Hours
1	**Introduction to Environmental Health and Safety** – Definition, History, scope and Key regulations of environmental health and safety. EPA - Role of environmental health and safety professionals International standards and best practices **Key components of safety management systems** (e.g. policy, procedures, training) - Implementing and maintaining safety management systems - Safety culture and leadership - Safety management systems in small, medium and high-risk industries.	**09**	**06**

	Self-learning & term work • Study the Environmental Protection Act (EPA) and summarize the roles and responsibilities of an Environmental Health and Safety (EHS) professional. • Prepare and present a safety management plan for an educational institution or a small manufacturing unit.		
2	**Environmental Hazards and Risk Management** - Types of environmental hazards (e.g. air, water, soil pollution) - Risk assessment and management strategies - Environmental hazard control measures (e.g. PPE, engineering controls) - Case studies of environmental hazards in the workplace - Emerging issues in environmental health and safety - Environmental health and safety in the supply chain - Environmental health and safety in the community **Self-learning & term work** • Review a recent environmental accident or pollution incident and identify the hazards, causes, and mitigation measures. • Conduct a qualitative environmental risk assessment of a selected workplace or community using a risk matrix.	**09**	**06**
3	**Occupational Health and Safety** - Types of occupational health hazards (e.g. chemical, physical, biological) - Risk assessment and management strategies - Occupational health control measures (e.g. PPE, training) - Case studies of occupational health hazards in the workplace - Ergonomics and musculoskeletal disorders - Occupational health and safety in the healthcare sector - Occupational health and safety in the construction industry **Self learning & term work** • Study the occupational hazards associated with one industry (construction, healthcare, or chemical) and prepare a brief technical note. • Perform a workplace safety audit of a laboratory/workshop and recommend appropriate engineering and administrative control measures.	**09**	**06**
4	**Water Supply and Treatment Facilities -** Operational Problems and Corrective Measures for pipe distribution networks, appurtenance, conventional and advance treatment units **Wastewater Collection and Treatment Facilities:** Operational Problems and Corrective Measures in Sewer Network, Inspection Methods, Safety Methods, Appurtenances, Pumps and conventional and advance treatment units with Sludge treatment & Maintenance of Fecal Sludge Treatment Plant. **Self learning & term work** • Review the operation and maintenance guidelines for a water or wastewater treatment unit and summarize common operational problems. • Prepare a standard operating procedure (SOP) and safety checklist for any one treatment unit or pumping station.	**09**	**06**
5	**Air Pollution Control Facilities:** Operational Problems and Corrective Measures and O & M of Air control equipment. **O & M of disposal facilities:** Operational Problems and Corrective Measures for engineering landfill, hazardous and biomedical waste disposal facilities. **Recent trends**: Preventive and predictive O&M strategies, online	**09**	**06**

	Monitoring of Environmental quality parameters. Application of AI and ML in operation and maintenance of Environmental facilities **Self learning & term work** • Explore recent applications of AI/ML in environmental monitoring or operation and maintenance of environmental facilities and prepare a one-page summary. • Develop a preventive maintenance schedule and monitoring plan for an air pollution control device or an engineered waste disposal facility		

Text Books:

- Colling D. A "Industrial Safety Management and Technology"–Prentice Hall, New Delhi, 1990.
- Goetsch D. L "Occupational Safety and Health for Technologist, Engineers and Managers", 3rd Edition, Prentice Hall, New Delhi. 2019.
- Metcalf & Eddy Inc, (2014), "Wastewater Engineering, Treatment and reuse"-4th Edition, Tata McGraw Hill Publishers Co. Ltd, New Delhi
- Hammer, M.J., (2013), "Water and Wastewater Technology–SI Version" -2nd Edition, John Wiley and Sons.
- William L Neumann, (1997) "Industrial Air Pollution Control Systems" – McGraw- Hill Professional.

Reference Books:

- Della D. L and Giustina, "Safety and Environmental Management"– Van Nostrand Reinhold International Thomson Publishing Inc, 1996.
- Anand Gopal Mukherjee, "Environmental Pollution and Health Hazards – Causes and Control", Galgotia Publications Pvt. Ltd., New Delhi, 1986.
- Trescothic R.A "Environmental and Industrial Health Hazards", William Heinemann Medical Books Ltd., London, 1973.
- Training Manual on O&M for Municipal Staff", Asian Development Bank, Government of Karnataka.
- CPHEEO, (1999), "Manual on water supply and Treatment", Ministry of Urban Development, GoI, New Delhi.
- CPHEEO, (2013), "Manual on Sewerage and Sewage Treatment", Ministry of Urban Development, GoI, New Delhi.
- Manual on Solid Waste Management" – CPHEEO (2016)

Journals/Magazines:

- Safety: Safety + Health Magazine (safetyandhealthmagazine.com)
- Occupational Health & Safety Magazine Digital Edition -- Occupational Health & Safety (ohsonline.com)

Swayam NPTEL course:

- https://archive.nptel.ac.in/courses/114/106/114106017/
- https://archive.nptel.ac.in/courses/114/106/114106039/

Web/Digital Resources

- https://s201.q4cdn.com/129601114/files/doc_downloads/doc_gov/Environmental-Health-and-Safety-Manual.pdf

Course Articulation Matrix:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	1	3	2	2
CO2	3	3	2	3	2	2
CO3	3	3	2	3	2	2
CO4	3	3	3	3	3	2
CO5	3	3	2	3	3	3

High – 3, Medium – 2, Low-1

DEPARTMENT: ENVIRONMENTAL ENGINEERING						
Course Code: 26MTEV251		**Course Title: Environmental Economics and Forensics**				
Total Credits: 04		**SDGs addressed: 6, 13, 14**	**Course Category: PEC**		**Course Type: Theory**	
Teaching Learning Process		**Contact Hours/Week**	**Assessment Weightage and Marks**			
	Lecture	**45**		**CIE**	**SEE**	**Total**
	Tutorial	**30**	**Weightage, %**	**40**	**60**	**100**
	Practical	**-**	**Maximum Marks**	**40**	**60**	**100**
	Self-learning & Term work	**45**	**Minimum Marks**	**20**	**25**	**45***
	Total	**120**				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course objectives: The course focus on the basics of environmental economics in environmental pollution prevention and importance of forensics in toxicology.

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcomes	Highest Level of Cognitive Domain
CO1	Understand the importance and applications of economics in environmental pollution prevention.	L3
CO2	Associate the relation between LCA and economics and forecasting economic burden.	L3
CO3	Recognize and valuate the source and sinks of ecosystem.	L3
CO4	Understand the definition, needs and history of environmental forensics.	L2
CO5	Apply the knowledge through field investigation, standard protocols and assessment reports. And also, to identify contaminant source(s) in air, water and soil.	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 –Create

Course Syllabus

Unit No.	Content	Lecture Hours	Tutorial Hours
1	Environmental economics: Prevention of pollution or cure; Healing costs of individuals, Environmental fund generation, Environmental (land and water) remediation costs estimates – strategic and long-term planning. Environmental economics in developing and developed countries. Environmental economics. Transboundary waste disposal economics and liability. **Self-learning and Term Work:** • Review a published case study on environmental remediation and estimate the associated environmental costs. • Compare pollution prevention and remediation strategies adopted by two industries through a group presentation.	12	6
2	Vicious circle of environmental poverty. Kuznets curve, Green behavioral solutions. Environmental finance. Economics of alternative vehicle fuels and environmental impacts. LCE and economics, Proactive economies, forecasting economic burden. Economics of treatment facilities. Mass	14	6

	transport and environmental economics. Environmental cost-benefit analysis, Poverty and environmental care. **Self-learning and Term Work:** • Study the life cycle economics of an environmentally sustainable product and prepare a brief report. • Conduct a team-based cost-benefit analysis of an alternative transportation system for a selected city.		
3	Sources and sink functions of ecosystems, externalities as fundamental determinants. Infrastructure social responsibility and associated environmental costs and welfare. Environmental valuation of goods and services. Green national income. Ecological economics. **Self-learning and Term Work:** • Review literature on ecosystem service valuation and summarize one valuation method. • Assess and present the economic value of ecosystem services provided by a nearby natural ecosystem.	10	6
4	Environmental Forensics- Definition, Need for environmental forensics and Requirements; History of environmental forensics. **Self-learning and Term Work:** • Study a documented environmental forensic investigation and summarize the techniques used. • Analyze a real environmental contamination case and present the forensic investigation process as a team.	06	6
5	Field investigations and data collection Requirements of field investigative team, Essential observations, Source identification, Sampling techniques and sampling plan, Site assessment report and Standard protocol. Chemical Fingerprinting of Contaminants Methods for fingerprinting airborne toxins, hydrocarbons in soil and water, pathogens in water supply. Case studies on environmental forensics- Investigative case studies on: Water borne diseases (epidemics); Soil Contamination-Industrial effluent discharges; Oil Spills-Ocean/sea/river, subsoil & groundwater; Urban air quality; Lake/river contamination from sewage disposal. **Self-learning and Term Work:** • Review standard environmental sampling protocols (BIS/APHA/USEPA) used in forensic investigations. • Develop a sampling plan and site assessment report for a hypothetical contaminated site through group work.	12	6

Text Books

1. Nick Hanley, Jason F Shorgen and Ben White, (2006), Environmental Economics Theory and Practice, First/Second Edition, MacMillan.
2. Charles D Kolstad, 2012, Intermediate Environmental Economics, Indian Edition, Oxford University Press, New Delhi
3. David W Pearce and R Kerry Turner, 1990, Economics of Natural Resources.
4. R.E. Hester and R.M Harrison (2008). Environmental Forensics (1st edition). Cambridge Royal Society of Chemistry Publisher.
5. Robert D. Morrison (2000). Environmental Forensics – Principles and Applications (1st Edition). CRC Press.

Reference Books

1. Ecott J. Callan and Janet M. Thomas, 2013, Environmental Economics and Management: Theory, Policy and Applications, Cengage Learning, Delhi.
2. Ramprasad Sengupta, 2013, Ecological Limits and Economic Development, Oxford University Press, New Delhi.
3. Greg Macmaster (2020). Environmental Forensics (1st Edition). Cyclogenesis Publish.
4. Stephen M. Mudge (2008). Methods in Environmental Forensics (1st Edition). CRC Press.

Journal articles

1. Journal articles on Science direct.com, acs.org, springer link and Taylor & Francis.
2. Predatory Journals are not referred for information.

Web Resources

1. https://www.sciencedirect.com/book/9780123695222/introduction-to-environmental- forensics
2. https://www.amazon.in/Environmental-Forensics-Contaminant-Specific-Guide- ebook/dp/B005H8CYYK
3. https://pubs.rsc.org/en/content/ebook/978-0-85404-957-8

Course Articulation:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	1	3	1	3	2
CO2	2	3	2	3	1	1
CO3	3	1	1	2	2	3
CO4	3	2	3	3	3	3
CO5	3	3	1	1	2	3

High – 3, Medium – 2, Low – 1

DEPARTMENT OF ENVIRONMENTAL ENGINEERING						
Course Code: 26MTEV252		**Course Title: Environmental Hygiene and Sanitation**				
Total Credits: 04		**SDGs addressed: 3, 6, 11, 12, 14, 15**	**Course Category: PEC**		**Course Type: Theory**	
Teaching Learning Process		**Total Contact Hours/semester**	**Assessment Weightage and Marks**			
	Lecture	**45**		**CIE**	**SEE**	**Total**
	Tutorial	**30**	**Weightage %**	**40**	**60**	**100**
	Practical	**-**	**Maximum Marks**	**40**	**60**	**100**
	Self-learning and Term work	**45**	**Minimum Marks**	**20**	**25**	**45***
	Total	**120**				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Objective: The course aims to equip students with the knowledge and skills required to understand, analyze, and apply principles of environmental sanitation and hygiene for the planning, design, operation, and management of sustainable water supply, sanitation, sewerage, waste management, and public health systems in rural and urban communities.

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcomes	Highest Level of Cognitive Domain
CO1	Apply the principles of environmental sanitation, hygiene, public health, and sustainable sanitation practices to prevent sanitation-related diseases and improve community health.	L3
CO2	Apply appropriate methods for planning, operation, monitoring, and management of rural water supply, drinking water quality, sanitation, and WASH programmes.	L3
CO3	Apply suitable sanitation technologies, excreta disposal systems, septic tank design principles, and septage management practices for sustainable rural sanitation.	L3
CO4	Apply integrated approaches for rural solid waste, liquid waste, and wastewater management using decentralized and resource recovery techniques.	L3
CO5	Explain the concepts of urban sanitation, sewerage systems, drainage, faecal sludge management, and national urban sanitation policies for improving urban environmental health.	L2

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Syllabus:

Unit No.	Content	Lecture Hours	Tutorial Hours
1	**Fundamentals of Environmental Sanitation and Public Health** **Introduction to Environmental Sanitation:** Evolution, concepts, definition, scope, objectives, and principles of environmental sanitation; relationship between sanitation, hygiene, environment, and public health; environmental determinants of health; role of sanitation in disease prevention and health promotion; sanitation and sustainable development; Sustainable Development Goals (SDGs); environmental sanitation challenges in rural and urban communities; national sanitation policies and programmes. **Environmental Hygiene and Public Health:** Principles of personal,	**10**	**06**

	domestic, community, institutional, school, and workplace hygiene; sanitation and hygiene behaviour; sanitation-related communicable diseases and their prevention; transmission pathways of sanitation-related infections (F-diagram); food hygiene and milk hygiene; housing sanitation, ventilation, lighting, and indoor environmental quality; vector and rodent control measures; environmental health surveillance; sanitation indicators and monitoring; community participation, Information, Education and Communication (IEC), , and social mobilization for sanitation programmes; occupational health and safety of sanitation workers; environmental sanitation legislation, standards, and national sanitation initiatives; and climate-resilient sanitation. **Self Learning and Term Work** • Emerging concepts in sustainable sanitation • Behavior Change Communication (BCC)		
2	**Rural Water Supply and Sanitation:** Community-based rural water supply systems; protected wells, borewells, hand pumps, standposts, and piped water supply schemes; operation and maintenance of rural water supply infrastructure; source protection and sanitary surveillance; drinking water safety plans; waterborne diseases and modes of transmission, prevention and control; integration of water supply with sanitation and hygiene (WASH); community participation and behavior change for sustainable water management; rainwater harvesting, groundwater recharge, water conservation, and climate-resilient rural water supply systems; national drinking water and rural sanitation programmes; safe storage and distribution of drinking water, surveillance, monitoring, and sanitary inspections. **Self Learning and Term Work** • Household water treatment methods • Water quality standards	**08**	**06**
3	**Rural Sanitation, Excreta and Septage Management** **Excreta Disposal and Public Health:** Public health importance of safe excreta disposal; principles and essential components of sanitary latrines; criteria for site selection; household, public, and community latrines and their constructional features; mechanisms of pollution from latrine pits and preventive measures; planning and implementation of rural and urban sanitation programmes; low-cost sanitation technologies; fecal sludge management; **Sanitary Toilet Systems and Septage Management**: Classification, design, and construction of latrine systems, including leach pit latrines; planning, design, construction, operation, and maintenance of sanitary toilet complexes; technology options for community sanitation facilities; toilet seat and superstructure requirements; on-site waste disposal systems; Total Sanitation Campaign and other rural sanitation initiatives; decentralized septage management systems; design and construction of septic tanks; septage management; **Self Learning and Term Work** • Types of latrines and their public health significance. • Zero-waste and resource recovery approaches for excreta management.	**09**	**06**

4	**Solid and Liquid Waste Management in Rural Areas** **Solid Waste Management:** Concepts and characteristics of rural solid waste; sources and classification of refuse; principles of solid waste collection, segregation, storage, transportation, processing, and disposal; Decentralized solid waste management systems, resource recovery; management of biomedical, plastic, and other special wastes; integrated solid waste management planning for rural communities. Role of Gram Panchayats. IEC and behavior change strategies **Disposal of the Dead:** Public health significance of safe disposal of human remains; methods of disposal including burial, cremation, electric cremation, committal to sea or river, and Tower of Silence; environmental and public health considerations; emergency disposal practices during disasters, epidemics, and mass casualty events. **Liquid Waste and Wastewater Management**: Public health importance of household wastewater (sullage) and liquid waste management; classification and characteristics of liquid wastes; principles of on-site sanitation systems; wastewater quality parameters and monitoring; zero-wastewater management concepts; wastewater disposal methods including soak pits, seepage pits, dispersion trenches, kitchen gardens, and others. **Self Learning and Term Work** • Decentralized liquid waste management practices for rural areas. • Self-Help Groups (SHGs) and community participation in waste management.	**10**	**06**
5	Urban Environmental Sanitation, Sewerage and Hygiene **Drainage and Sewerage Systems:** Principles and objectives of drainage and sewerage; types, design, construction, and maintenance of surface and underground drains; methods of stormwater and wastewater disposal; sewerage systems and their components; types of sewers and sewer appurtenances; characteristics of sewage; wastewater quality parameters.. **Urban Sanitation Policy and Management:** National Urban Sanitation Policy (NUSP)—objectives, principles, and key policy issues; components of urban sanitation planning; city sanitation plans; strategies for achieving Open Defecation Free (ODF, ODF+, ODF++) and 100% sanitation; sanitation services for underserved and vulnerable populations; faecal sludge and septage management (FSSM); monitoring and evaluation of sanitation programmes; sanitation indicators and benchmarking; concept of Total Sanitized Cities; public participation, institutional arrangements, financing mechanisms, and smart and climate-resilient urban sanitation systems. **Self Learning and Term Work** • Swachh Survekshan and city rating frameworks • Occupational health and safety measures for sewer cleaning personnel	**08**	**06**

Text Books

1. Park, K. *Park's Textbook of Preventive and Social Medicine*, 27th Edition, M/s Banarsidas Bhanot Publishers, Jabalpur, 2023.
2. Salvato, J. A., Nemerow, N. L., and Agardy, F. J. *Environmental Engineering*, 6th Edition, John Wiley & Sons, 2003.
3. Punmia, B. C., Jain, A. K., and Jain, A. K. *Water Supply Engineering*, Laxmi Publications, Latest Edition.

Reference Books

1. Central Public Health and Environmental Engineering Organisation (CPHEEO). *Manual on Sewerage and Sewage Treatment Systems*, Ministry of Housing and Urban Affairs, Government of India, 2013.
2. CPHEEO. *Manual on Water Supply and Treatment*, Ministry of Housing and Urban Affairs, Government of India, Latest Edition.
3. Ministry of Jal Shakti, Government of India. *Jal Jeevan Mission – Operational Guidelines*, Latest Edition.
4. Ministry of Housing and Urban Affairs (MoHUA). *National Urban Sanitation Policy (NUSP)* and *Faecal Sludge and Septage Management (FSSM) Policy*, Government of India.

Journals/Magazines

1. Journal of Water, Sanitation and Hygiene for Development *(IWA Publishing)*
2. Water Research *(Elsevier)*
3. Science of the Total Environment *(Elsevier)*

Web/Digital Resources

1. World Health Organization (WHO) – Environmental Health, Water, Sanitation and Hygiene https://www.who.int
2. UNICEF – Water, Sanitation and Hygiene (WASH) https://www.unicef.org/wash
3. Ministry of Jal Shakti, Government of India https://jalshakti-ddws.gov.in

SWAYAM/NPTEL

1. Introduction to Environmental Engineering and Science – NPTEL (IIT Kharagpur)
2. Environmental Engineering – NPTEL (IIT Roorkee)
3. Water Supply Engineering – NPTEL (IIT Kharagpur)
4. Wastewater Engineering – NPTEL (IIT Kharagpur/IIT Madras)
5. Municipal Solid Waste Management – NPTEL
6. Environmental Pollution and Control – NPTEL
7. Public Health Engineering – SWAYAM
8. Water, Sanitation and Hygiene (WASH) – SWAYAM/NPTEL (when offered)
9. Solid and Hazardous Waste Management – NPTEL
10. Environmental Management and Sustainability – SWAYAM

Course Articulation Matrix:

COURSE OUTCOMES↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-
CO2	3	2	-	3	2	-
CO3	3	3	1	2	-	2
CO4	3	-	-	3	-	-
CO5	3	-	-	3	2	2

High – 3, Medium – 2, Low – 1

DEPARTMENT OF ENVIRONMENTAL ENGINEERING						
Course Code: 26MTEV253		**Course Title: Life Cycle Analysis**				
Total Credits: 04		**SDGs addressed: 7,11,12,13**		**Course Category: Engineering Science Course**		**Course Type: Professional Core Course 1**
Teaching Learning Process		**Total Contact Hours/semester**	**Assessment Weightage and Marks**			
	Lecture	**15**		**CIE**	**SEE**	**Total**
	Tutorial	**30**	**Weightage %**	**40**	**60**	**100**
	Practical	**-**	**Maximum Marks**	**40**	**60**	**100**
	Self-learning & Term work	**15**	**Minimum Marks**	**20**	**25**	**45***
	Total	**60**				

Note: *For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)

Course Objective: The course demonstrates the need for LCA and achieving circular economy and lays a strong foundation for principles of environmental life cycle assessment, risk, assessment methodologies, and environmental modeling for monitoring, assessing, and quantifying risks through dose-response relationships. It imparts necessary skills through hands-on LCA software and comprehends the data relevant to the specific product, process, or service to perform LCA.

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcome	Highest Level of Cognitive Domain
CO1	Explain the significance of LCA in achieving circular economy and fundamental concepts and various approaches with examples.	L2
CO2	Describe and apply the various mathematical or deterministic, release assessment models and solve numerical problems	L4
CO3	Able to apply the concepts of LCA to any new/given scenario and ability comprehend data and use software	L3
CO4	To perform risk assessment to any hypothetical scenario and calculate risk value and safe target concentration for remediation of contaminated soils (or any attribute)	L4
CO5	Explain the fundamental concepts of sustainable product design and supply chain	L2

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

Course Syllabus:

Unit No.	Content	Lecture Hours	Tutorial
1	**Life-cycle Analysis (LCA) - Concept & fundamentals:** LCA -Goals and principles, advantages of following LCA. Conceptual framework, Material flow and waste management, Life Cycle Inventory, Strategic planning (Red flag, MET). Approaches in LCA Cradle to the grave, cradle to cradle and cradle to gate, gate to gate, Circular Economy. **Self- Learning & Teamwork** • Environmental Product Declarations • Carbon Footprint and Water Footprint Assessment	09	06

2	**Mathematical/Deterministic Models** Atmospheric models, surface water models, groundwater models, watershed runoff models, food chain models, and multimedia models. Discharge models **Consequence assessment models** Component failure & initiating event models event tree, fault tree analysis, Decision tree analysis, stochastic models, Markov models, Release assessment models **Self-Learning & Teamwork** • Climate Change and Environmental Modeling • Climate resilience	10	06
3	**LCA Applications: A**pplication in the public sector, Infrastructure Projects, and Industrial applications. LCA applications to municipal solid-waste management systems, Plastic manufacturing industry, Transport Corridor, Thermal power plants/Nuclear reactors LCA Software Tools (Open LCA/SimaPro/ Gabi or any other). **Self-Learning & Teamwork** • LCA in Green Buildings and Sustainable Construction • LCA Applications in Agriculture and Food Systems	10	06
4	**Risk Assessment (RA)** Importance of RA (with practical examples like underground petroleum leakage, chemical or oil spills in a given attribute), Steps in risk assessment, exposure pathways, cancer slope factor, hazard quotient, numerical problems. Uncertainty and variability in risk assessment. Classical methods, Monte-Carlo method of risk estimation. **Self-Learning & Teamwork** • Ecological Risk Assessment (ERA) • Emerging Contaminants (microplastics) and Risk Assessment	09	06
5	**Sustainable Product Design** Environmental Design for Sustainability: Economic, Environmental Indicators, Social Performance Indicators, Sustainable Engineering Design Principles and Environmental Cost Analysis. Green supply chain, green marketing, and Eco-labeling. Applications of AI & ML in Life Cycle Analysis and Environmental Risk Assessment. **Self-Learning & Teamwork** • Digital Technologies for Sustainable Engineering • Sustainable Supply Chain Case Studies	08	06

Text Books:

- Curran M.A. (1996) "Environmental Life-Cycle Assessment" McGraw Hill, ISBN: 9780070150638, 007015063X
- Lerche I. & Glaesser W. (2006) "Environmental Risk Assessment - Quantitative Measures, Anthropogenic Influences, Human Impact" Springer Heidelberg

Reference Books:

- Curran M.A (2006) "Life cycle assessment: principles and practice, National Risk Management Research Laboratory, EPA/600/R-06/060.

Journals/Magazines:

- Refer to good research/review articles from The International Journal of Life Cycle Assessment (Springer), Journal of Environmental Management, MDPI, etc.

Web/Digital Resources:

- https://www.openlca.org

SWAYAM/NPTEL:

- Brajesh Kumar Dubey "Sustainable Engineering Concepts and Life Cycle Analysis", IIT Kharagpur, https://nptel.ac.in/courses/105105157

Practice Based Learning

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Model or assess life cycle assessment for anyproduct or process of interest	Open LCA	Software exposure
2	Estimating Water Footprint (Green, Blue, Grey) for given product	MS Excel	-

Course Articulation Matrix:

COURSE OUTCOMES↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	3	3	1	3
CO2	3	1	3	3	1	3
CO3	3	3	3	3	1	3
CO4	2	3	3	3	2	1
CO5	2	3	1	3	2	1

High – 3, Medium – 2, Low –1

DEPARTMENT OF HUMANITIES			
Course Code: 26MTHU260	**Course Title: Research Methodology and IPR**		
Total Credits: 02	**SDGs addressed: 9,16,17**	**Course Category: MC**	**Course Type: Theory**

		Total Contact Hours/semester	Assessment Weightage and Marks			
Teaching Learning Process	Lecture	45		CIE	SEE	Total
	Tutorial	30	Weightage %	40	60	100
	Practical	-	Maximum Marks	20	30	50
	Self-learning and Term work	45	Minimum Marks	10	13	23*
	Total	150				

***For passing, the student must score a minimum of 23 marks (CIE+SEE=10+13 or 11+12)**

Course Prerequisite: Nil.

Course Objective: To introduce the candidates to technical research and its methodology along with the basics of intellectual property and its rights. To give exposure to various software/ resources supporting the literature survey, statistical interpretation and plagiarism check. To educate about developing technical reports and presentations. This course will be complementary to project work.

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain the fundamentals of research methodology.	L3
CO2	Explain the fundamentals of Intellectual Property Rights (IPRs), and the concept of novelty.	L4
CO3	Develop a research design by formulating hypotheses and selecting appropriate methodologies.	L4
CO4	Apply appropriate methods of data collection, sampling techniques, and data processing strategies for research studies.	L2
CO5	Prepare and communicate research findings through scientific reports and presentations.	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Syllabus:

Unit No.	Content	Lecture Hours	Tutorial Hours
1	**Introduction:** Concept of research and innovation; innovation vs. invention; need for research (motivation and objectives), Research methods vs Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical. Literature survey tools / search engines. **Self-learning and term work** Self-Study Exercise 1: Understanding Research Types Choose one published research paper from Google Scholar, IEEE Xplore, ScienceDirect, or another scholarly database in your discipline. Identify and briefly justify:	3	3

	• The research problem and objective. • Whether the research is Applied or Fundamental. • Whether it is Quantitative, Qualitative, or Mixed. • Whether it is Descriptive, Analytical, Conceptual, or Empirical. • The research method(s) used. Deliverable: A one-page summary (300–500 words).		
2	Intellectual Property Rights: IPRs - Novelty - Intellectual Property - Importance and Protection of Intellectual Property Rights (IPRs): Patents, Copyrights, Trademarks, Industrial Designs - Integrated Circuits - Geographical Indications - Establishment of WIPO - Application and Procedures. **Self-learning and term work** • Study the fundamentals of Intellectual Property Rights (IPRs) and prepare a summary of the different types of IP protection. • Understand the role, objectives, and major treaties administered by the World Intellectual Property Organization (WIPO). • Compare different forms of Intellectual Property Rights with suitable examples and their duration of protection. Conduct a group activity to identify patentable and non-patentable inventions based on the criteria of novelty, inventive step, and industrial applicability.	**3**	**3**
3	**Research Formulation:** Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs, patents, searching the web - Critical literature review – Identifying gap from literature review - Development of working hypothesis. Use of scholarly platforms for literature survey (open access / licensed software like Thomson Reuters, Web of science, Springer, KNIMBUS). **Self-learning and term work** • Study the process of identifying, selecting, and defining a research problem in a chosen domain. • Explain primary and secondary sources of information with suitable examples relevant to your discipline. • Develop a working hypothesis for a selected research problem and justify its significance. • Identify and discuss a real-world engineering or scientific problem and formulate it into a well-defined research problem. Conduct a literature survey on a selected research topic using scholarly databases such as **Web of Science, SpringerLink, KNIMBUS,** or other institutional resources, and prepare a summary.	**3**	**3**
4	**Data collection and analysis:** Execution of the research - Observation and Collection of data - Methods of data collection – Sampling Methods - Data Processing and Analysis strategies - Data Analysis with Statistical Packages – Hypothesis testing - Generalization and Interpretation, Use of software for statistical analysis (open access / licensed software like Minitab, Maxstar, Stat wing, L stat, JMP). **Self-learning and term work** • Understand various methods of data collection and identify their	**3**	**3**

	advantages, limitations, and applications. • Compare different sampling techniques and determine their suitability for different types of research problems. Explore statistical software (e.g., Minitab, MaxStat) and perform basic descriptive and inferential statistical analyses.		
5	**Reporting, thesis writing and presentation:** Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Illustrations and tables - Bibliography, referencing and footnotes - Oral presentation – Use of visual aids - Importance of effective communication - Application of results and ethics – Reproduction of published material, Plagiarism - Citation and acknowledgement - Reproducibility and accountability. **Self-learning and term work** • Review a published thesis or technical report and analyse its organization, writing style, and formatting. • Learn different referencing and citation styles (e.g., APA, IEEE, Harvard) and prepare a bibliography for a selected topic. • Develop and deliver a group seminar using appropriate visual aids to communicate research findings effectively. Explore the use of **Urkund** or equivalent plagiarism detection software to check the originality of a research report and understand similarity reports.	**3**	**3**

Text Books:

1. Kothari C. R. (2020). Research methodology methods and techniques. Research New Age International.
2. Soetendorp, R. (2004). 'Food for engineers': intellectual property education for innovators. Industry and Higher Education.
3. Garg, B. L., Karadia, R., Agarwal, F., & Agarwal, U. K. (2002). An introduction to research methodology. RBSA Publishers, UK.
4. Sinha, S. C., & Dhiman, A. K. (2002). Research Methodology. New Delhi: Ess Ess.
5. Trochim, W. M. (2005). Research methods: The concise knowledge base. Atomic Dog Publishing.
6. Graziano, A. M., & Raulin, M. L. (2009). Research methods: A process of inquiry. HarperCollins College Publishers.
7. Ullmann, D. (1992). How to Write and Publish a Scientific Paper. Cambridge University Press.
8. Fink, A. (2019). Conducting research literature reviews: From the internet to paper. Sage publications.
9. Coley, S. M., & Scheinberg, C. A. (1990). Proposal writing. Newbury Park, US, Sage Publications.
10. Maskus, K. E. (2000). Intellectual property rights in the global economy. Peterson Institute.
11. Subbaram, N. R. (1998). Handbook on Intellectual Property Law and Practice. Viswanathan Printers and Publishing Private Limited.

Journals/Magazines:

https://www.annualreviews.org/journal/matsci

Web/Video/SWAYAM/NPTEL/Digital resources:

1. https://www.wipo.int/portal/en/index.html
2. https://onlinecourses.swayam2.ac.in/cec21_ge16/preview
3. What Is Research Methodology? | Steps & Tips (scribbr.com)
4. https://gradcoach.com/what-is-research-methodology/

5. https://paperpile.com/g/what-is-research-methodology/
6. https://ddegjust.ac.in/studymaterial/mba/cp-206.pdf
7. https://www.researchprospect.com/research-methodology/

Course Articulation Matrix:

COURSE OUTCOMES↓	PROGRAM OUTCOMES		
	PO1	PO2	PO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

High – 3, Medium – 2, Low – 1

DEPARTMENT OF ENVIRONMENTAL ENGINEERING						
Course Code: 26MTEV27P		**Course Title: Mini Project**				
Total Credits: 02		**SDGs addressed: All SDGs**		**Course Category: PWC**		**Course Type: PROJ**
Teaching Learning Process		**Total Contact Hours/semester**	**Assessment Weightage and Marks**			
	Lecture	**-**		**CIE**	**SEE**	**Total**
	Tutorial	**-**	**Weightage %**	**100**	**-**	**100**
	Practical	**60**	**Maximum Marks**	**40**	**-**	**40**
	Self-learning and Term work	**-**	**Minimum Marks**	**20**	**-**	**20**
	Total	**60**				

Course Objective: Development of research and critical thinking skills and understanding the potential environmental impacts and sustainability consideration of the project / seminar.

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcomes	Highest Level of Cognitive Domain
CO1	Apply knowledge of environmental engineering principles and techniques to the design and development of a mini project	L3
CO2	Analyze and interpret data and information related to the mini project topic and present findings in a clear and concise manner	L5
CO3	Work independently to successfully complete the mini project and communicate effectively with stakeholders and project partners	L5

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Guidelines:

- The mini project is an activity having 2 credits.
- Each student shall be associated with a faculty member serving as internal guide to supervise the mini project.
- If the student is conducting the project work in an industry or an organization an external guide is to be chosen from industry or organization (along with internal guide) with the approval of the Head of the Department
- The student will work with the project guide /supervisor towards the identification of the problem through a systematic literature review and finalize the objectives and scope of work.
- Students are expected to come out with detailed specifications, methodology, resources required, critical issues and any other issues related to design and implementation of the project should be provided in consultation with Guide.
- The student should submit the proposal within ten working days from the commencement of the semester to the Head of Department after due approval from the guide.
- The student is expected to exert on design, development and testing of the proposed work as per the schedule.
- The students should present an interim progress review as per the department calendar of events.
- Completed mini projects documentation should be in the form of a report, and the report should be submitted to the department at the end of the semester.
- The report should include Abstract, Content sheets, Introduction chapter with objectives, literature review chapter, materials and methodology chapter, results and discussion chapter, summary and conclusion followed by reference list and appendix if any.
- The student should make a final presentation at the end of the semester as per the department Calendar of events.

Course Articulation Matrix:

COURSE OUTCOMES↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	2
CO2	3	3	3	3	3	3
CO3	2	2	3	2	2	3

High – 3, Medium – 2, Low – 1

<table>
<tr><th colspan="7">DEPARTMENT OF ENVIRONMENTAL ENGINEERING</th></tr>
<tr><th colspan="3">Course Code: 26MTEV28E</th><th colspan="4">Course Title: Ability/Skill Enhancement Course</th></tr>
<tr><th colspan="2">Total Credits: 01</th><th colspan="2">SDGs addressed: All SDGs</th><th colspan="2">Course Category: SDA</th><th>Course Type: Skill Enhancement</th></tr>
<tr><td rowspan="7">Teaching Learning Process</td><td colspan="2"></td><td>Total Contact Hours/semester</td><td colspan="3">Assessment Weightage and Marks</td></tr>
<tr><td colspan="2">Lecture</td><td>-</td><td></td><td>CIE</td><td>SEE</td><td>Total</td></tr>
<tr><td colspan="2">Tutorial</td><td>-</td><td>Weightage %</td><td>100</td><td>-</td><td>100</td></tr>
<tr><td colspan="2">Practical</td><td>30</td><td>Maximum Marks</td><td>40</td><td>-</td><td>40</td></tr>
<tr><td colspan="2">Self-learning & Term work</td><td>-</td><td rowspan="2">Minimum Marks</td><td rowspan="2">20</td><td rowspan="2">-</td><td rowspan="2">20</td></tr>
<tr><td colspan="2">Total</td><td>30</td></tr>
</table>

Course Objective: Develop professional competencies by enhancing communication, technical writing, digital proficiency, project management, leadership, teamwork, entrepreneurship, innovation, and research, consultancy, and industry readiness.

Course Content

Unit I: Professional Communication and Technical Writing

Develop effective communication, presentation, technical writing, documentation, and professional interaction skills required for engineering practice, research, consultancy, and higher studies.

Unit II: Digital Skills for Environmental Engineers

Explore contemporary digital tools, software platforms, data analysis techniques, modelling tools, and emerging technologies relevant to environmental engineering applications.

Unit III: Project Management and Professional Skills

Develop practical competencies in project planning, teamwork, leadership, decision-making, ethics, quality management, consultancy, and professional practices through activity-based learning.

Unit IV: Innovation, Entrepreneurship and Sustainability

Explore innovation, entrepreneurship, intellectual property, startup development, sustainability concepts, and industry-oriented problem-solving to address contemporary environmental challenges.

Laboratory/Skill Activities

Technical presentation, GIS mapping, water quality analysis, air quality modelling, technical report writing, research review, environmental auditing, startup proposal, patent search, consultancy presentation.

Course Articulation Matrix:

COURSE OUTCOMES↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	2	3	2	2	3
CO2	3	2	3	3	2	3
CO3	2	2	3	2	2	3
CO4	2	2	3	2	2	3

High – 3, Medium – 2, Low – 1

DEPARTMENT OF HUMANITIES						
Course Code: 26MTHU29A		**Course Title: Human Values and Social Responsibility**				
Total Credits: 0		**SDGs addressed: 3,4,5,6,7,8,9,10,12,13**		**Course Category: HSMC**	**Course Type: Theory**	
Teaching Learning Process		**Total Contact Hours/semester**	**Assessment Weightage and Marks**			
	Lecture	**30**		**CIE**	**SEE**	**Total**
	Tutorial	**-**	**Weightage %**	**100**	**-**	**-**
	Practical	**-**	**Maximum Marks**	**40**	**-**	**-**
	Self-learning and Term work	**-**	**Minimum Marks**	**20**	**-**	**-**
	Total	**30**				

Course Objectives:

- To develop human values, ethical leadership, and social responsibility among postgraduate engineering students.
- To enable students to design and implement engineering solutions that promote sustainability, inclusiveness, and societal well-being.

Course Outcomes (COs): At the end of the course students will be able to,

CO	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain the role of human values and ethical leadership in professional practice.	L2
CO2	Evaluate engineering decisions from social responsibility and stakeholder perspectives.	L2
CO3	Apply sustainability principles to promote responsible resource management.	L2
CO4	Assess the societal impact of technologies and recommend responsible innovations.	L2
CO5	Demonstrate ethical and socially responsible practices in engineering and community engagement.	L2

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Human Values and Responsible Leadership** • Human values and their relevance in professional life • Self-awareness, integrity, empathy, and accountability • Ethical decision-making in engineering and management • Leadership for social and organizational responsibility • Balancing personal, professional, and societal values **Self-Learning and term work** • Reflect on a professional or societal issue and explain how human values can guide responsible decision-making.	06

2	**Engineering, Society, and Social Responsibility** • Role of engineers in societal development • Social responsibility in engineering practice • Stakeholder engagement and participatory decision-making • Equity, inclusiveness, and accessibility in engineering solutions • Community engagement and service learning **Self-Learning and term work** • Identify a local community problem and propose an engineering-based solution that promotes social well-being.	06
3	**Sustainability and Responsible Resource Management** • Sustainable development and the UN Sustainable Development Goals (SDGs) • Environmental stewardship and resource conservation • Circular economy and responsible consumption • Sustainable infrastructure and resilient communities • Integrating sustainability into engineering practice **Self-Learning and term work** • Evaluate an engineering product or process and suggest improvements based on sustainability principles.	06
4	**Technology for Society** • Human-centered and inclusive technology design • Social and ethical implications of emerging technologies • Responsible innovation and digital responsibility • Technology for public welfare and quality of life • Case studies of socially responsible engineering innovations **Self-Learning and term work** • Analyze emerging technology and discuss its potential benefits, risks, and societal impact.	06
5	**Governance, Ethics, and Responsible Professional Practice** • Professional ethics and codes of conduct • Environmental, Social, and Governance (ESG) principles • Corporate Social Responsibility (CSR) and sustainable organizations • Public policy, regulations, and responsible engineering practice • Case studies on ethics, sustainability, and social responsibility **Self-Learning and term work** • Assess a campus or community initiative (e.g., energy, water, mobility, or waste management) and recommend measures to improve its social and environmental responsibility.	06

Text Books:

- Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010.
- Engineering for Sustainable Development: Delivering on the Sustainable Development Goals, UNESCO
- Engineering Ethics, Govindarajan M., Natarajan S., and Senthil Kumar V. S.
- Professional Ethics and Human Values, A. Alavudeen, R. Kalil Rahman, and M. Jayakumaran
- The Circular Economy Handbook: Realizing the Circular Advantage is a business and sustainability book by Peter Lacy, Jessica Long, and Wesley Spindler. Palgrave Macmillan, 2020

References

- Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
- Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
- The Story of Stuff (Book).
- The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
- Small is Beautiful - E. F Schumacher.
- Slow is Beautiful - Cecile Andrews
- Economy of Permanence - J C Kumarappa
- Bharat Mein Angreji Raj - PanditSunderlal
- Rediscovering India - by Dharampal
- Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
- India Wins Freedom - Maulana Abdul Kalam Azad
- Vivekananda - Romain Rolland (English)
- Gandhi - Romain Rolland (English)

Weblinks:

- https://onlineethics.org/

Course Articulation Matrix:

COURSE OUTCOMES	PROGRAM OUTCOMES		
	PO1	PO2	PO3
CO1	1	**CO1**	1
CO2	1	**CO2**	1
CO3	1	**CO3**	1
CO4	1	**CO4**	1
CO5	1	**CO5**	1

High – 3, Medium – 2, Low – 1