5th Semester Syllabus

Department: Environmental Engineering						
***Course Code*: 24EV510**		***Course Title: Atmospheric Environmental Engineering***				
Total Credits: 4 L-45; T-0; P-30; SL&TW: 45		***SDGs addressed: 3, 7, 11, 13, 15***	***Course Category: PCC***	***Course Type: Theory Integrated with Laboratory***		
Teaching Learning Process		***Contact Hours/Semester***	***Assessment Weightage and Marks***			
	Lecture	***45***		**CIE**	**SEE**	**Total**
	Tutorial	***-***	***Weightage, %***	***40***	***60***	***100***
	Practical	***30***	***Maximum Marks***	***40***	***60***	***100***
	Self-learning & Term work	***45***				
	Total	***120***	***Minimum Marks***	***20***	***25***	***45****

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

Course Pre-Requisite: Basics of math and science, Elements of Environmental Engineering

Course Objective: This integrated course covers air pollution sources, classification, impacts, and basics of air quality monitoring. The course emphasizes air quality standards and meteorological parameters that influence dilution and pollutant dispersion. The course highlights the need to understand and apply various mathematical models to assess the fate and transport of pollutants and air and noise pollution control technologies and regulations.

Course Outcomes (COs)

CO	Course Outcome	Highest Level of Cognitive Domain	Working Knowledge
CO1	Explain the composition and structure of the atmosphere, classify the sources of air pollution, and describe the types of emission inventory and need for source apportionment studies.	L2	1, 3, 4, 5, 7
CO2	Assess the impact of meteorological factors on the dilution and dispersion of air pollutants and grasp the basics of modeling and stability class.	L4	2, 3, 4, 5
CO3	Analyze the plume behavior and describe various air pollution monitoring methods.	L3	1, 2, 4, 5, 6, 7, 9
CO4	Paraphrase the effects of air pollution and remember the regulations governing air quality.	L2	1, 5, 7, 8, 9
CO5	Explain the basic mechanisms involved, working principles and design aspects of air pollution equipment and noise pollution control.	L3	1, 2, 4, 5, 6, 7, 8, 9

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 atmosphere, scales of air pollution – local, regional, and global. Sources of air Pollutants: Natural and Anthropogenic, Classification of air Pollutants: Point, area, line source, volume primary and secondary pollutants, photochemical oxidants with examples. Emission inventory and source apportionment. Units of measurements of air pollutants and conversions – numerical problems. **Self-Learning and Term work** ● NAAQS standards ● Conversion of units of air pollution	**09**
2	Air Pollution Meteorology Role of meteorology in air pollution. Meteorological factors – Solar radiation, temperature, lapse rate, wind velocity profile, humidity, precipitation, Maximum/ Mean mixing depths, atmospheric stability conditions, wind rose diagram. Models: Gaussian and box model, Inversion – types, plume behavior under different atmospheric stability conditions, Pasquil – Gifford atmospheric stability classification. Effect of topography on pollutant dispersion, land/ sea breeze effects. **Self-Learning and Term work** ● Advection, diffusion and dispersion phenomenon ● Wind Velocity Profile	**09**
3	Atmospheric Dispersion of Stack Emissions Plume rise, effective stack height, plume rise formulations, guidelines for fixing stack height, problems on plume rise calculations. Measurement of Air Pollutants Criteria for station selection, Measurement of various gaseous (CO, HC, NOx, SOx, etc.) pollutants, particulate matter and microbial, sampling devices, sampling train, sampling methods/ techniques, stack sampling techniques.*Indoor air quality, IAQ Standards* **Self-Learning and Term work** ● stack height norms and real-world case studies from EPA and CPCB ● microbial air sampling protocols for IAQ	**09**
4	Effects of Air Pollution Effect of air pollutants on humans, plants and animals, materials, and structures/ monuments. acid rain, wet deposition, greenhouse effect, global warming, ozone depletion, visibility reduction, and haze formation. Air Pollution Control Regulations, Air pollution laws/ acts, air quality and emission standards, air pollution indices. **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	**07**

5	Air Pollution Control Equipment: General methods, control by process changes, Particulate Matter Control – settling chambers, inertial separators, cyclones, fabric filters, scrubbers, wet collectors, and electrostatic precipitates, Numerical Problems, Control of gaseous pollutants – adsorption, absorption, combustion, and condensation. Noise pollution – Sources, effects, attenuation, governing equations, and standards. Applications of AI & ML in Atmospheric Environmental Engineering. **Self-Learning and Term work** ● Particulate Matter and gaseous Control devices ● Noise pollution equipment	**11**

Note: Components in SL and TW shall be assessed in CIE only.

Semester	List of Experiments/ Programs	No. of 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	4
3	Air Pollution Monitoring -Particulate Matter – PM10, PM2.5 using High Volume Air Sampler (HVAS).	4
4	Particulate Matter monitoring – SPM using High Volume Air Sampler (HVAS).	1
5	Particulate Matter monitoring – RSPM using High Volume Air Sampler (HVAS).	1
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.	4
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	Sensor-based real-time monitoring - Gaseous and Non-gaseous pollutants	2
13	CIE and laboratory test	2

Text Books:

- Wark, K., Warner, C.F., and Davis, W.T., (1998), "Air Pollution"- Its Origin and Control" third 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 Approach", Prentice Hall of India, New Delhi.

- Crawford, M. (1980), "Air pollution Control Theory", THM Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- Noel De Nevers, (2000), "Air Pollution Control Engineering", International Edition. McGraw Hill International

Journals/Magazines:

- Refer to good research articles from Atmospheric environment, Air Pollution Research, Science of total environment, etc.

Web/Digital Resources:

- WHO Global Air Quality Guidelines https://www.who.int/news-room/questions-and-answers/item/who-global-air-quality-guidelines
- CPCB Website
- Guidelines for the Measurement of Ambient Air Pollutants https://cpcb.nic.in/openpdffile.php?id=UmVwb3J0RmlsZXMvMjdfMTQ1ODExMDQyNl9OZXdJdGVtXzE5Nl9OQUFRTVNfVm9sdW1lLUkucGRm

SWAYAM/NPTEL:

Air pollution and control offered by IIT Roorkee.

Course Articulation:

Course Outcome	Program Outcome											Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	3	2	2
CO2	-	3	3	3	3	2	-	1	1	-	2	3	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	3	3	2
CO4	-	-	-	-	-	2	2	-	-	1	2	3	2	2
CO5	3	3	3	3	3	-	2	-	-	-	-	3	2	3

High – 3, Medium – 2, Low –1

Department: Environmental Engineering						
Course Code: 24EV520		*Course Title: Remote Sensing and GIS in Environmental Engineering*				
Total Credits: 3 *L-45; T-0; P-0; SL&TW: 45*		*SDGs addressed: 4, 6, 11, 13*	*Course Category: PCC*		*Course Type: Theory*	
Teaching Learning Process		*Contact Hours/Semester*	*Assessment Weightage and Marks*			
	Lecture	**45**		**CIE**	**SEE**	**Total**
	Tutorial	**-**	*Weightage, %*	*40*	*60*	*100*
	Practical	**-**	*Maximum Marks*	*40*	*60*	*100*
	Self-learning & Term work	*45*				
	Total	**90**	*Minimum Marks*	*20*	*25*	*45**

Note: *For passing the course, 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)

CO	Course Outcome	Highest Level of Cognitive Domain	Working Knowledge
CO1	Explain the fundamentals and principles of remote sensing (RS) and remote sensing systems including EM spectrum, resolutions, and RS satellites.	L2	1, 3
CO2	Discuss spatial data acquisition, compare manual interpretation and digital image processing	L2	2, 6
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	1, 4
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	7, 8
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	5, 8

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

Course Syllabus:

Unit No.	Content	Lecture 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	**09**

	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 **Self-Learning and Term work** ● Basics of thermal and hyper-spectral sensing ● Explore a Remote Sensing Satellite: Technical Features and Use Cases ● RS satellite specifications	
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** ● Spatial filtering ● Classification algorithms ● Open Access Remote Sensing Tools for Beginners	**09**
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** ● Explore the Impact of Map Projections on Area and Shape Distortion ● Evaluate coordinate system errors in public GIS datasets ● QGIS software download and installation ● Collection of coordinates, Creating a shapefile in QGIS using the point coordinate data	**09**
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** ● Innovative Applications of Terrain Modeling such as modeling sound propagation (e.g., for noise barriers), Solar energy potential mapping using hill shade and slope. ● Data Acquisition and Map Design ● Heads-up digitization ● Geo-referencing ● Overlay/neighborhood	**09**

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** ● Role of Low-Cost Sensors in Environmental Monitoring ● Mobile Apps and GIS in Solid Waste Routing ● Read and Teach applications in RS and GIS	**09**

Note: Components in SL and TW shall be assessed in CIE only.

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:

Course Outcome	Program Outcome											Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	-	-	1	1	1	-	-	-	-	3	3	2
CO2	3	3	-	-	-	1	2	-	-	-	1	3	3	2
CO3	3	3	1	-	2	1	2	-	1	-	-	2	2	2
CO4	3	3	2	1	2	-	-	-	-	-	1	3	2	2
CO5	3	3	2	1	2	1	-	-	-	-	2	3	3	3

High – 3, Medium – 2, Low –1

Department: Environmental Engineering						
Course Code: 24EV530		***Course Title: Water Treatment and Supply Engineering***				
Total Credits: 3 L-45; T-0; P-0; SL&TW: 45		***SDGs addressed: 11,14,15***	***Course Category: PCC***		***Course Type: Theory***	
Teaching Learning Process		***Contact Hours/Semester***	***Assessment Weightage and Marks***			
	Lecture	**45**		**CIE**	**SEE**	**Total**
	Tutorial	**-**	***Weightage, %***	***40***	***60***	***100***
	Practical	**-**	***Maximum Marks***	***40***	***60***	***100***
	Self-learning & Term work	***45***				
	Total	**90**	***Minimum Marks***	***20***	***25***	***45****

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

Course Pre-Requisite: Fluid Mechanics

Course Objective: The student acquires mastery in computing population and water demand, and describes types of water supply schemes, water quality parameters, and standards. Provides knowledge on the principles, design of unit operations, and processes in water distribution systems. Exposes to the recent trends in water treatment and supply systems.

Course Outcomes (COs)

CO	Course Outcome	Highest Level of Cognitive Domain	Working Knowledge
CO1	Describe about water source and supply mechanism with the forecasting population	L2	1,2
CO2	Design the pipe hydraulics for different pipe materials and pumps.	L3	3,4
CO3	Explain the working principle and design of water treatment units.	L3	5,6,7,8
CO4	Illustrate the concepts of water distribution network and design with different or various appurtenances.	L3	4,6,7
CO5	Integrate water economics in the implementation of advanced water treatment with patented materials.	L3	8,9

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Introduction** Water Sources, need for water supply, schemes - types and objectives. Drinking water quality parameters, guidelines, and standards – International, national, regional, and local. Population forecasting methods, Selection of appropriate methods and numerical problems. Unit operations and processes, treatment flow sheets for different sources of water.	**08**

	Self-Learning and Term work ● **Water Supply Schemes:** Gravity systems, pumping systems, combined systems ● **Importance of Forecasting:** Planning water supply infrastructure and Estimating future demand ● Concepts of Rainwater Harvesting	
2	**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. **Self-Learning and Term work** ● Understand assumptions and limitations of each equation ● Practice solving for head loss, velocity, discharge ● Compare empirical vs theoretical approaches	**10**
3	**Water treatment design** Design principles and criteria: aeration, Parshall flume, flash mixer, coagulation-flocculation systems, types of settling, sedimentation, tube settlers, pulsators, filtration, disinfection processes – numerical problems. Miscellaneous treatment- Removal of hardness, fluoride, nitrate, arsenic, selenium, and boron. **Self-Learning and Term work** ● Compare different aeration methods (cascade, diffused, mechanical) ● Select appropriate coagulants for different water sources ● Compare types of settling (discrete, flocculent, zone, compression)	**12**
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** ● Develop a layout plan for a small urban water distribution network ● Calculate storage requirements based on demand fluctuations ● Create hydraulic models using EPANET or WaterGEMS	**08**
5	**Recent trends** Advanced water treatment, 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 filter backwash. Applications of AI & ML in Water Treatment and Supply Engineering. **Self-Learning and Term work** ● Performance study under varying influent conditions ● Design a SCADA system for real-time monitoring and control ● Compare lifecycle costs of conventional vs advanced systems	**07**

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

- Howard S. Peavy, Donald R. Rowe, George T, (2015), "Environmental Engineering" - McGraw Hill International Edition. New York.
- Edward M. Motley, Guang Zhu, Syed R. Qasim, (2000), "Water Works Engineering": Planning, Design and Operation‖, Prentice Hall.
- S. K. Garg, Environmental Engineering Vol.-I, (2019), "Water supply engineering" – M/s Khanna Publishers, New Delhi.

Reference Books:

- CPHEEO Manual on water supply and treatment engineering, Ministry of Urban Development, Government of India, New Delhi. (recent edition)
- Mark. J Hammer, (2013), "Water & Wastewater Technology", John Wiley & Sons Inc., New
- David Hendricks, (2010), "Fundamentals of Water Treatment Unit Processes": Physical, Chemical, and Biological, CRC Press.
- Viessman W, Hammer M.J., Perez E.M., Chandik P. A., (2011), "Water supply and pollution control" eighth edition, PHI Learning Private Ltd., New Delhi.
- B.C. Punmia and Ashok Jain, (2010) "Environmental Engineering I-Water Supply Engineering" Laxmi Publications (P) Ltd., New Delhi.

Journals/Magazines:

- Journal articles in reputed journals describing applications of Remote Sensing and GIS in Environmental Management.

Web/Digital Resources:

- Videos on YouTube
- Coursera
- CPCB and KSPCB Website
- http://cpheeo.gov.in/
- https://cpcb.nic.in/

SWAYAM/NPTEL:

- https://nptel.ac.in/courses/105105201
- https://www.youtube.com/watch?v=5NzMt6PErYo

Course Articulation:

Course Outcome	Program Outcome											Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	-	1	1	1	-	-	-	-	3	3	2
CO2	3	3	3	-	2	1	2	-	-	-	1	3	3	2
CO3	3	3	1	-	2	1	2	-	1	-	-	3	3	3
CO4	3	3	2	1	2	-	-	-	-	-	1	3	2	2
CO5	3	3	2	1	2	1	-	-	-	-	2	3	3	3

High – 3, Medium – 2, Low –1

<table>
<tr><td colspan="7">Department: Environmental Engineering</td></tr>
<tr><td colspan="2">Course Code: 24EV540</td><td colspan="5">Course Title: Municipal and Bio-Medical Waste Management</td></tr>
<tr><td colspan="2">Total Credits: 3
L-45; T-0; P-0; SL&TW: 45</td><td>SDGs addressed: 11, 15, 16 & 17</td><td colspan="2">Course Category: PCC</td><td colspan="2">Course Type: Theory</td></tr>
<tr><td rowspan="6">Teaching Learning Process</td><td></td><td>Contact Hours/Semester</td><td colspan="5">Assessment Weightage and Marks</td></tr>
<tr><td>Lecture</td><td>45</td><td></td><td>CIE</td><td>SEE</td><td>Total</td></tr>
<tr><td>Tutorial</td><td>-</td><td>Weightage, %</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Practical</td><td>-</td><td rowspan="2">Maximum Marks</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">100</td></tr>
<tr><td>Self-learning & Term work</td><td>45</td></tr>
<tr><td>Total</td><td>90</td><td>Minimum Marks</td><td>20</td><td>25</td><td>45*</td></tr>
</table>

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

Course Pre-Requisite: Elements of Environmental Engineering-Sources and characterization

Course Objective: The student will have a thorough understanding of key functional elements in municipal solid waste management including waste minimization concepts. The course also provides a comprehensive knowledge on biomedical waste management practices incorporating the role of private public partnerships.

Course Outcomes (COs)

CO	Course Outcome	Highest Level of Cognitive Domain	Working Knowledge
CO1	Identify improper practices of solid waste disposal, their environmental implications and understands the basic engineering principles of solid waste management.	L2	1, 2 , 4
CO2	Discuss the need for economics in collection and transportation of solid waste and describes various types of collection systems to analyze system dynamics.	L2	3, 4, 5
CO3	Appreciate the management concepts, stresses on 4R approach, PPP model and Community involvement for effective management of municipal solid and biomedical waste	L3	2, 3, 4, 5
CO4	Compare various treatment options for both municipal and bio-medical waste and disposal options.	L4	6 , 7
CO5	Interpret the Solid waste Management Rules, 2016.	L4	4 , 9

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Introduction:** Objectives, principles, functional elements of municipal solid waste (MSW) management system – major problems. Environmental implications of open dumping of MSW, MSW rules, C&D waste – management & handling. **Engineering Principles:** Waste projection along with population projection, waste generation rates, source segregation, frequency, storage and refuse collection, processing at source, physical and chemical composition, quantity of waste, and engineering properties of MSW. **Self-Learning and Term work** ● Explore local municipal waste management practices ● Group projects on waste audits (household/institutional level). ● Review current waste rules and guidelines	**09**
2	**Collection and Transport:** Access and point of collection, primary and secondary collection – economics. Equipment types, personnel, route - optimization, Solid Waste Transport Means and Methods, Separation and Processing: Unit operation for component separation, Material recovery facilities (MRF), 5R concepts for dry waste components **Self-Learning and Term work** ● Conduct a **waste audit** at your institution/household: measure dry vs wet waste generated in a Semester ● Compare how the 5R principles are implemented in different cities. ● Study local municipal collection methods (door-to-door vs community bins)	**09**
3	**Biomedical Wastes:** (BMW) Health care systems, sources, categories, generation, and handling of BMW. Segregation, BMW (Management and Handling) Rules, Radio-active waste containment, Treatment methods, disposal options. Community-based waste management, waste as a resource concept, public-private partnership (PPP) in MSW and BMW management. Integrated Solid Waste Management (ISWM) – steps, hierarchy, and components. **Self-Learning and Term work** ● Study color coding and BMW categories in detail ● Explore case studies of **PPP models in waste-to-energy plants**. ● **Debate/discussion:** "Is Waste-to-Energy better than Recycling in Indian context?"	**09**
4	**Treatment and Disposal Options for MSW:** Composting, vermi-composting, combustion, incineration, pyrolysis, types and design criteria, plasma technique. Aerobic and Anaerobic Digestion. **Disposal Options:** Engineered sanitary landfill design – regulatory criteria, gases, and leachate control, and leachate treatment technology. Secured landfill	**10**

	facility (SLF) for a centralized system. **Self-Learning and Term work** ● Explore real-world **biogas plants** ● Compare **composting vs. anaerobic digestion** efficiency. ● **Group project:** Compare costs & benefits of incineration vs. pyrolysis.	
5	**Legal aspects of solid waste management:** Present scenario, Municipal SWM rules, 2016, Biomedical waste Management Rules, 2016, E-Waste Management Rules, 2016, Construction and Demolition Waste Management Rules, 2016, Hazardous Waste Management Rules, 2016 and Plastic waste Management Rules, 2016. Applications of AI & ML in Municipal and Bio-Medical Waste Management. **Self-Learning and Term work** ● Explore how different Indian states implement these rules (Kerala, Maharashtra, Karnataka models). ● **Debate:** "Are bans on single-use plastics effective without strict enforcement?" ● **Case study discussion:** Biomedical waste mishandling cases during COVID-19.	**08**

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

- Tchobanoglous G., Theisen H.., and Vigil S., "Integrated Solid Waste Management – Engineering Principles and Management Issues", McGraw Hill Inc., New York. 2019.
- Flintoff F., "Management of Solid Wastes in Developing Countries", WHO Regional Publications, South East Asia, New Delhi, 1976.
- Peavy H.S., Rowe D.R. and Tchobanoglous, G., (2015), "Environmental Engineering", Mc Graw Hill Book Co.

Reference Books:

- Sasikumar K. and Sanoop Gopi Krishna, "Solid Waste Management", Eastern Economy Edition, PHI, New Delhi, 2009.
- CPHEEO manual on Municipal Solid Waste Management (2016)
- Bhide and Sundareshan, "Solid Waste Management in Developing Countries", UN publications, 1985.

Journals/Magazines:

- Waste Management & Research: SAGE Journals (sagepub.com).
- Journal of Material Cycles and Waste Management | Home (springer.com)

Web/Digital Resources:

- Unit 1 (bbau.ac.in).
- MSWM- Module 2-notes - lecture notes of municipal solid waste management - CE 474 Municipal Solid - Studocu

SWAYAM/NPTEL:

- Municipal Solid Waste Management, IISc Bangalore by Prof. T.V. Ramachandra

Course Articulation:

Course Outcome	Program Outcome											Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	3	2	-	3	3	2	-	3	3	3	1	3
CO2	3	3	3	-	2	3	2	1	1	3	3	3	2	2
CO3	3	2	3	3	2	3	3	3	-	1	-	2	1	2
CO4	3	3	3	3	3	3	3	-	2	3	3	-	2	2
CO5	3	2	-	3	2	3	3	1	2	-	3	2	2	1

High – 3, Medium – 2, Low –1

Department: Environmental Engineering						
Course Code: 24EV551		*Course Title: Life Cycle Analysis and Environmental Risk Assessment*				
Total Credits: 3 *L-45; T-0; P-0; SL&TW: 45*		*SDGs addressed: 12,13,14,15,17*	*Course Category: PEC-I*		*Course Type: Theory*	
Teaching Learning Process		*Contact Hours/Semester*	*Assessment Weightage and Marks*			
	Lecture	**45**		**CIE**	**SEE**	**Total**
	Tutorial	*-*	*Weightage, %*	*40*	*60*	*100*
	Practical	*-*	*Maximum Marks*	*40*	*60*	*100*
	Self-learning & Term work	*45*				
	Total	**90**	*Minimum Marks*	*20*	*25*	*45**

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

Course Pre-Requisite: Basics of maths and science, Environmental Chemistry, Elements of Environmental Engineering.

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)

CO	Course Outcome	Highest Level of Cognitive Domain	Working Knowledge
CO1	Explain the significance of LCA in achieving circular economy and fundamental concepts and various approaches with examples.	L2	1,3
CO2	Describe and apply the various mathematical or deterministic, release assessment models and solve numerical problems	L3	2,3
CO3	Able to apply the concepts of LCA to any new/given scenario and ability comprehend data and use software	L3	1,2,6
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	5,7
CO5	Explain the fundamental concepts of sustainable product design and supply chain	L2	2,6,8

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

Course Syllabus:

Unit No.	Content	Lecture Hours
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 and Term work** ● Social lifecycle assessment ● Life cycle analysis with visual and augmented reality ● Sustainable procurement	**09**
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 and Term work** ● Assimilation capacity in airshed ● Carrying capacity in watershed ● Ecosystem simulation models	**10**
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 and Term work** ● Lifecycle costing ● Consequential LCA and decision making ● Spatially explicit LCA	**10**
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 and Term work** ● Basics of statistics ● Probability Distribution ● Digital twins of realtime LCA	**09**

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 and Term work** ● Environmental Product Declaration ● Carbon footprint ● Product stewardship	**08**

Note: Components in SL and TW shall be assessed in CIE only.

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

Course Articulation:

Course Outcome	Program Outcome											Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	3	-	-	-	-	3	3	3	-
CO2	3	3	3	-	-	3	-	-	-	-	3	3	3	-
CO3	3	3	3	-	-	3	-	-	-	-	3	3	3	3
CO4	3	3	-	-	-	3	-	-	-	-	-	3	3	-
CO5	3	3	-	-	-	3	-	-	-	-	-	3	3	-

High – 3, Medium – 2, Low –1

Department: Environmental Engineering						
Course Code: 24EV552		***Course Title: Environmental Biotechnology***				
Total Credits: 3 L-45; T-0; P-0; SL&TW: 45		***SDGs addressed: 6,7,9,12,13,14,15***	***Course Category: PEC-I***		***Course Type: Theory***	
Teaching Learning Process		***Contact Hours/Semester***	***Assessment Weightage and Marks***			
	Lecture	**45**		**CIE**	**SEE**	**Total**
	Tutorial	**-**	***Weightage, %***	***40***	***60***	***100***
	Practical	**-**	***Maximum Marks***	***40***	***60***	***100***
	Self-learning & Term work	***45***				
	Total	**90**	***Minimum Marks***	***20***	***25***	***45****

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

Course Pre-Requisite: Environmental Chemistry, Elements of Environmental Engineering, Sources and Characterization, Environmental Microbiology.

Course Objective: The course integrates appropriate aspects of microbiology and biochemical engineering with consideration of practical applications towards process design and scale-up, the advantages and drawbacks of applying biotechnological methods to environmental problems, microbiological thermo dynamics, kinetics

Course Outcomes (COs)

CO	Course Outcome	Highest Level of Cognitive Domain	Working Knowledge
CO1	To understand the concepts of biotechnology and sustainable ecology.	L2	1,3,4,6,7,8,9
CO2	Describe the processes involved in microbial communities	L2	1,3,4,6,7,8,9
CO3	Understand and take measures to mitigate the effects of biodegradation	L3	1,3,4,6,7,8,9
CO4	Apply the concepts of biological treatment processes in water, wastewater, and waste management	L3	1,3,4,6,7,8,9
CO5	Understand the role of microbes in an environment with case studies.	L3	1,3,4,5,6,7,8,9

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	Environmental Biotechnology and Sustainability. Scope and applications of the subject. Basics of ecosystem structure and function. Microbial Ecology and Environmental Biotechnology: Concepts and importance of microbial ecology in Environmental Biotechnology.	**09**

	Self-Learning and Term work ● Staying updated with emerging technologies and methods (e.g., CRISPR in bioremediation). ● Online courses, scientific journals, workshops. ● Critical thinking and problem-solving for real-world environmental challenges. ● Working in groups for field surveys, lab experiments, and project implementation.	
2	Methods in Microbial Ecology relevant to Environmental Biotechnology: Culture dependent and - independent analyses of microbial communities; PCR based methods, Microarray. **Self-Learning and Term Work** ● Reading research articles (e.g., *Applied and Environmental Microbiology*) ● Complex projects (e.g., metagenomics) require collaboration across microbiology, bioinformatics, chemistry, and engineering.	**08**
3	Microbial Principles of Biodegradation, Bio detoxification, and other processes relevant for Environmental Applications: Microbial engines, (metabolism), Requirements for biodegradation, acclimation, Common biotransformation mechanisms; Effect of organic contaminant structure on biodegradability; Cooperation between different microbial species for enhanced biodegradation; Applying biodegradation kinetics to fate and transport modeling. **Self-Learning and Term Work** • Study the role of microbes in break down pollutants, the environmental factors influencing these processes, and the application of these principles for environmental cleanup. • Investigate the mechanisms microorganisms use to detoxify persistent pollutants • Isolate and identify specific types of microorganisms from contaminated soil using dilution plate techniques.	**09**
4	Microbial Interactions with Heavy Metals and Metalloids: Bioremediation, Biohydrometallurgy and other aspects of Environmental Biotechnology Aerobic and Anaerobic Degradation of Aliphatic and Aromatic Compounds. Microbial interaction with plastics, antibiotics, and other emerging pollutants. Microbially Enhanced Phosphorus and Nitrogen Removal **Self-Learning and Term Work** ● Key for adapting to fast-evolving fields like plastic biodegradation and emerging contaminants ● Research papers (e.g., *Journal of Hazardous Materials*) ● Online tools (e.g., KEGG pathway database) ● MOOCs and webinars (Coursera, NPTEL, EdX)	**09**
5	Microbially Enhanced Oil Recovery; Microbial role in Carbon Storage and Capture (sequestration, conversion to useful biopolymers, etc.). Case studies: Bioremediation, Carbon Storage and Capture, Bioenergy. Applications of AI & ML in Environmental Biotechnology. **Self-Learning and Term Work** ● Environmental biotech evolves quickly with new tools (e.g., metagenomics, synthetic biology)	**10**

	• Scientific journals (e.g., *Environmental Science & Technology*, *Bioresource Technology*) • Online platforms (Coursera, edX, YouTube lectures) • DIY lab projects, internships	

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

- Environmental Biotechnology, Principles and Applications by Bruce E Rittman and Perry L McCarty, McGraw-Hill Higher education.
- Environmental Biotechnology Edited by Hans-Joachim Jördening and J Winter, WILEY-VCH Verlag Gmbh & Co.

Reference Books:

- Bioremediation and Natural Attenuation by Pedro J J Alvarage and Walter A Illman, Wiley Interscience.
- Environmental Biotechnology, Vol 10 Handbook of Environmental Engineering, Edited by L K Wang etal, Humana Press.

Journals/Magazines:

- Journal articles on Sciencedirect.com, acs.org, springer link, and Taylor & Francis.

Web/Digital Resources:

- **https://guides.lib.udel.edu/c.php?g=85302&p=548534**
- **Environmental Biotechnology Network: https://ebnet.ac.uk/**

SWAYAM/NPTEL:

- Environmental Biotechnology (12 Semesters) by Dr. Pinaki Sar, IIT Kharagpur.

Course Articulation:

Course Outcome	Program Outcome											Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	-	-	-	3	3	-	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	-	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

High – 3, Medium – 2, Low –1

Department: Environmental Engineering						
Course Code:24EV553		*Course Title: Natural Resources Conservation and Management*				
Total Credits: 3 *L-45; T-0; P-0; SL&TW: 45*		*SDGs addressed: 3, 6, 7, 8, 11, 13, 14, 15, 17*	*Course Category: PEC-I*		*Course Type: Theory*	
Teaching Learning Process		*Contact Hours/Semester*	*Assessment Weightage and Marks*			
	Lecture	*45*			*CIE*	*SEE*	*Total*
	Tutorial	*-*	*Weightage, %*		*40*	*60*	*100*
	Practical	*-*	*Maximum Marks*		*40*	*60*	*100*
	Self-learning & Term work	*45*					
	Total	*90*	*Minimum Marks*		*20*	*25*	*45**

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

Course Pre-Requisite: Basic Science, Environmental Studies

Course Objective: This course gives the student the feel and understanding of natural resources availability, impact, and need for its conservation. It prepares the student with a thorough understanding of biodiversity, planning, and legislation for effective resource management.

Course Outcomes (COs)

CO	Course Outcome	Highest Level of Cognitive Domain	Working Knowledge
CO1	Classify natural resources, identify the threats, and comprehend the flow of resources in nature capability on issues such as resource allocation, use, and pollution problems of forests.	L2	1,2
CO2	Enhances thinking capability on issues such as resource allocation, use and pollution problems of water, and abiotic components of natural resources.	L2	3
CO3	Outlines the importance of food security, modern agricultural practices, use, and impact of chemical fertilizers and pesticides. Able to estimate and identify food production and its problems related to storage, transport, and allocation.	L2	4,5
CO4	Capable of determining energy demand. Able to understand the energy footprint, crisis in energy production, and impacts of fossil fuel burning. Develop knowledge of alternate energy sources for sustainable development.	L2	6,7
CO5	Understand symbiotic and synergic relationships of different ecosystems. Appreciates the need for conserving biodiversity and identifies possible threats. Able to list and appreciate the ecological importance of major biodiversity hot spots. Capable of applying the knowledge of environmental legislation for resource management.	L2	8,9

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Natural resources** Classification, Resources Appraisal, Resource problem, Renewable resources flow, destruction versus conservation. **Forest Resources** Uses, Ecological and economic significance, types and management, forest resources of the world and India, deforestation and its impact and solution **Self-Learning and Term Work** ● Understanding different types of resources (forest, water, land, energy), their economic and ecological importance, sustainable management practices, conservation techniques, and the impact of human activities like mining and deforestation ● Collective action for conservation, community forestry, collaborative resource assessment, coordinating with various organizations for development projects, and engaging in public awareness and extension services for sustainable resource use.	**09**
2	**Water Resources** Hydrologic cycle, global and national water resources, demand and distribution, Classification of surface water bodies for designated best usage. Management of water resources, Environmental Impact of large dams, River water disputes, water pollution problems. **Self-Learning and Term Work** ● Understanding water quality, groundwater and surface water management, rainwater harvesting, and the impact of climate change. ● Focus on collaborative governance, community-based water management, resolving water disputes, and the development of effective partnerships for sustainable solutions.	**08**
3	**Food Resources** World food production and problems, food security, agro production, livestock production, modern agricultural practices, use of pesticides and fertilizers – environmental impact, environmental limits of increasing food production, sustainable agriculture. **Mineral Resources** Exploration, causes for depletion, environmental impacts, and conservation measures. **Self-Learning and Term Work** ● Food Resources - focus on sustainable agriculture, global food security, and malnutrition. ● Mineral Resources - critical mineral supply chains and their environmental impact ● Food Resources - developing innovative food production systems and reducing food wastage through collaborative efforts. ● Mineral Resources - resource conservation and developing sustainable alternatives and recycling initiatives.	**08**

4	**Energy Resources** Energy resources, world energy demand, Indian resources, renewable, alternate / non-conventional energy resources – solar, tidal, wind, geothermal, hydel, hydrogen, biomass, nuclear, wave(ocean) **Land Resources** Land as a resource, soils – types and degradation- soil erosion and pollution, soil conservation **Self-Learning and Term Work** ● Energy Resources - Recent advancements in solar PV Efficiency or Geothermal Energy Harnessing ● Land Resources - properties of different soil types or the impact of mulching and polyculture. ● Energy Resources - complex integration challenges, such as creating smart grids for renewal energy. ● Land Resources - Sustainable Land Management, Land-based Resource management and Integrated resource planning.	**10**
5	**Biodiversity Resources** Genetic and species diversity, Ecosystem diversity, types of ecosystems-structure and function, symbiotic and synergic relationships, importance of biodiversity, value of biodiversity, hot-spots of biodiversity, threats to biodiversity, conservation of biodiversity **Environmental Legislation for Resource Management** Legal framework, organizations and institutions, acts promulgated by India – Wildlife Act, Biodiversity Conservation Act, Environmental (Protection) Act, Forest Act. Applications of AI & ML in Natural Resources Conservation and Management. **Self-Learning and Term Work** ● Biodiversity fundamentals, species identification (using tools like iNaturalist), understanding ecosystems and ecological niches, and learning about threats like habitat loss and invasive species. ● Researching specific laws and principles, analyzing case studies, and exploring enforcement mechanisms. ● Carry out collaborative biodiversity surveys, community-based conservation projects, stakeholder engagement in natural resource management, and sharing local knowledge for better preservation efforts. ● Form/Create mock regulatory agency, environmental impact assessments, and a community outreach project, should apply these topics to real-world scenarios.	**10**

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

- Anjaneyulu Y., (2004), "Introduction to Environmental Science", B.S. Publications, Hyderabad
- Misra S.P. and Pandey S.N., (2008), "Essential Environmental Studies", Ane Book Publishers, New Delhi.
- Ram Krishna Mandal., (2015), "Natural resources management under sustainable development"

Reference Books:

- Journal articles on Sciencedirect.com, acs.org, springer link, and Taylor & Francis.
- Trivedi P R and Sudharshan K N., "Environment and natural resources conservation"
- Vajiram and Ravi., (2018), "Natural Resources"

Journals/Magazines:

- Journal Of Natural Resource Conservation and Management (Online) ISSN:2582-9211
- Natural Resources Conservation and Research ISSN:2578-1936 (Online)
- https://www.scilit.net/publishers/17953
- https://systems.enpress-publisher.com/public/journals/29/pageHeaderTitleImage_en_US.png

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

SWAYAM/NPTEL:
Natural Resources Conservation (12 Semesters) by Prof. Sudip Mitra, IIT Guwahati

Course Articulation:

Course Outcome	Program Outcome											Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	1	-	2	3	2	1	2	1	3	2	2
CO2	3	3	2	2	-	2	3	2	1	2	1	3	2	2
CO3	3	3	2	2	-	2	2	2	2	3	1	3	2	2
CO4	3	2	3	2	2	3	3	2	2	3	1	3	3	2
CO5	3	2	2	1	-	3	3	3	2	3	2	3	3	3

High – 3, Medium – 2, Low –1

<table>
<tr><td colspan="7">Department: Environmental Engineering</td></tr>
<tr><td colspan="3">Course Code:24EV554</td><td colspan="4">Course Title: Hazardous Waste Technology and Management</td></tr>
<tr><td colspan="2">Total Credits: 3
L-45; T-0; P-0; SL&TW: 45</td><td>SDGs addressed: 11,13,14,15</td><td colspan="2">Course Category: PEC-I</td><td colspan="2">Course Type: Theory</td></tr>
<tr><td rowspan="6">Teaching Learning Process</td><td></td><td>Contact Hours/Semester</td><td colspan="4">Assessment Weightage and Marks</td></tr>
<tr><td>Lecture</td><td>45</td><td></td><td>CIE</td><td>SEE</td><td>Total</td></tr>
<tr><td>Tutorial</td><td>-</td><td>Weightage, %</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Practical</td><td>-</td><td rowspan="2">Maximum Marks</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">100</td></tr>
<tr><td>Self-learning & Term work</td><td>45</td></tr>
<tr><td>Total</td><td>90</td><td>Minimum Marks</td><td>20</td><td>25</td><td>45*</td></tr>
</table>

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

Course Pre-Requisite: Environmental Chemistry, Solid Waste Management, Atmospheric Environmental Engineering, Wastewater Engineering.

Course Objective: The course provides fundamentals on sampling, characterization of hazardous waste, design of treatment schemes and relevant rules, guidelines for management, and economic analysis.

Course Outcomes (COs)

CO	Course Outcome	Highest Level of Cognitive Domain	Working Knowledge
CO1	Explain the basics of hazardous materials/wastes and remember the related Acts and regulations	L2	1,3
CO2	Classify if the given waste is hazardous or not and assess its toxicological impacts and risks involved	L4	3,4
CO3	Discuss techniques related to waste minimization, waste stabilization, resource recovery and transportation of hazardous wastes	L2	5,6
CO4	Describe and design an ideal treatment scheme for remediating contaminated sites and suggest disposal options.	L4	5,6
CO5	Explain recent trends in hazardous waste management based on the application of life cycle engineering concepts.	L4	7,8

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

Course Syllabus:

Unit No.	Content	Lecture 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** ● Properties of persistent chemicals (example: Per- and polyfluoroalkyl substances) ● Partition Coefficient ● Identify any product of interest involving hazardous raw material and theoretical estimate affinity of compound to attributes	**09**
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** ● Exposure pathways ● Assume a hypothetical case of chemical spill - identify and list the properties of chemical and perform risk assessment ● Case study on Vaniyambadi Chromium contamination, TN	**08**
3	**Waste minimization and resource recovery:** Elements of waste minimization strategy, waste reduction techniques and benefits, development of waste tracking system, waste compatibility for treatment and disposal, hazardous waste conversion to useful end products. hazardous waste stabilization. **Transportation of hazardous wastes:** Regulation for hazardous materials, registration codes for hazmat vehicles for bulk transport of hazardous wastes, hazardous substances emergency response. **Self-Learning and Term work** ● Tests for waste stabilization ● Microbial-Induced Calcite Precipitation ● Stabilization of Heavy Metals in Industrial Sludge Using Nano-Additives	**08**

4	**Treatment of hazardous wastes:** Air stripping, soil vapor extraction, carbon adsorption – numerical problems. Biological methods, in-situ and ex-situ remediation processes using several techniques, slurry phase treatment and solid phase treatment; thermal processing – incineration, plasma, pyrolysis, etc. **Land disposal:** Secured landfills – design approaches, liner, and cover systems, stability of landfills, closure and post-closure operations and environmental monitoring; other disposal options. **Self-Learning and Term work** ● Numerical examples involving estimation of emissions from landfills ● Smart Landfills ● Smart Landfills vs Traditional Landfills	**11**
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. **Self-Learning and Term work** ● UN Plastics Treaty (hazardous additives in plastics) ● Extended Producer Responsibility (EPR) policies for hazardous products ● Disaster-resilient hazardous waste storage	**09**

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

- Hazardous waste management – Wentz C A (recent edition) McGraw Hill International.
- Michael D. L., Philip L. B. and Jeffrey C. E., (2001). "Hazardous waste management", Second edition, McGraw-Hill Higher Education.

Reference Books:

- CPCB, India - guidelines on 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://www.npcindia.gov.in/NPC/Files/delhiOFC/EM/Hazardous-waste-management- rules-2016.pdf**
- **https://cpcb.nic.in/rules/**

SWAYAM/NPTEL:

- Solid and Hazardous Waste Management (15 Semesters) by Prof. Vinod Kumar Garg, Central University of Punjab, Bathinda.

Course Articulation:

Course Outcome	Program Outcome											Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	3	-	-	-	-	3	2	-	2
CO2	3	3	3	-	-	3	-	-	-	-	3	3	3	3
CO3	3	3	-	-	-	3	-	-	-	-	3	3	3	3
CO4	3	3	3	-	-	3	-	-	-	-	3	3	3	3
CO5	3	3	-	-	-	3	-	-	-	-	3	2	-	2

High – 3, Medium – 2, Low –1

<table>
<tr><td colspan="7">Department: Environmental Engineering</td></tr>
<tr><td colspan="3">Course Code:24EV561</td><td colspan="4">Course Title: Alternate Building Materials</td></tr>
<tr><td colspan="2">Total Credits: 3
L-45; T-0; P-0; SL&TW: 45</td><td>SDGs addressed:
7, 9, 11, 12, 15</td><td colspan="2">Course Category: PEC-II</td><td colspan="2">Course Type:
Theory</td></tr>
<tr><td rowspan="6">Teaching Learning Process</td><td></td><td>Contact Hours/Semester</td><td colspan="4">Assessment Weightage and Marks</td></tr>
<tr><td>Lecture</td><td>45</td><td></td><td>CIE</td><td>SEE</td><td>Total</td></tr>
<tr><td>Tutorial</td><td>-</td><td>Weightage, %</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Practical</td><td>-</td><td rowspan="2">Maximum Marks</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">100</td></tr>
<tr><td>Self-learning & Term work</td><td>45</td></tr>
<tr><td>Total</td><td>90</td><td>Minimum Marks</td><td>20</td><td>25</td><td>45*</td></tr>
</table>

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

Course Pre-Requisite: Construction Engineering Materials

Course Objective: The students are exposed to the concepts of sustainability in the context of building and conventional engineered building materials.

Course Outcomes (COs)

CO	Course Outcome	Highest Level of Cognitive Domain	Working Knowledge
CO1	Discuss the Environmental issues concerned with building materials and cost-effective building technologies	**L2**	5, 6, 7
CO2	Identify alternate fuels for manufacturing construction materials and reduce water and energy footprint during manufacturing.	**L3**	5, 8, 9
CO3	Analyze different alternative building materials for use in an environmentally sustainable manner.	**L4**	4, 5, 9
CO4	Suggest strategies for reusing different types of waste/ industrial/demolition waste materials in the construction sector highlighting closed loop system.	**L2**	5, 6, 8
CO5	Recommend various types of alternative building materials and technologies and design energy-efficient buildings by considering local climatic conditions and building materials.	**L3**	5, 6, 9

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	Introduction: Energy in building materials, Environmental issues concerned to building materials, Embodied energy and life-cycle energy, Global warming and construction industry, green concepts in buildings, green building ratings – IGBC and LEED manuals, Rainwater harvesting & amp; solar passive architecture. Environmental friendly and cost-effective building technologies, Requirements for buildings of different climatic regions. **Self-Learning and Term work** ● Data analysis ● Mini project/field ● Mind maps	**09**
2	Role of Material: Carbon from Cement, alternative cement and cementitious material, Alternative fuel for cement for the reduction in carbon emission, minimization of natural resource utilization, Reduction in water and energy consumption in concrete, Volatile organic content (VOC) emission issues and indoor air quality for Sustainability and Health hazard, eco-friendly paints. **Self-Learning and Term work** ● numerical /analytical tasks ● Case study research ● Problem solving workshop	**09**
3	Alternate Building Materials: Lime, Pozzolana cement, Raw materials, Manufacturing process, Fibers- metal and synthetic, Properties and uses. Fiber-reinforced plastics, materials, Properties and applications, and different composite materials. Building materials from agro and industrial wastes, Types of agro wastes, Types of industrial and mine wastes, Properties and applications – case studies. Masonry blocks using industrial wastes. Construction and demolition waste reuse. Industrial sludge utilization in construction, plastic waste utilization in Construction. **Self-Learning and Term work** ● Reflection Exercise ● Mini Project/Prototype Development ● Material Survey	**09**
4	Alternate Building Technologies: Use of arches in the foundation, alternatives for wall constructions, composite masonry, confined masonry, cavity walls, rammed earth, Ferro cement and ferroconcrete building components, Materials and specifications, Properties, Construction methods, Applications. Alternate Roofing Systems: Concepts, Filler slabs, Composite beam panel roofs, Masonry vaults and domes	**09**

	Self-Learning and Term work ● Analytical Task ● Hand on Demonstration/model making/ Problem solving	
5	Equipment for Production of Alternate Materials: Machines for the manufacture of concrete, Equipment for production of stabilized blocks, Moulds and methods of production of precast elements, renewable energy in buildings, Cost concepts in buildings, Cost saving techniques in planning, design and construction, Cost analysis: Case studies using alternatives. **Self-Learning and Term work** ● Case Study ● Model making ● Problem Solving task	**09**

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

- KS Jagadish, B V Venkatarama Reddy, and K S Nanjunda Rao, "Alternative Building Materials and Technologies", New Age International pub.
- Arnold W Hendry, "Structural Masonry", Macmillan Publishers.

Reference Books:

- RJS Spence and DJ Cook, "Building Materials in Developing Countries", Wiley pub.
- LEED India, Green Building Rating System, IGBC pub. 3. IGBC Green Homes Rating System, CII pub.
- Relevant IS Codes.

Journals/Magazines:

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

Web/Digital Resources:

- https://www.youtube.com/watch?v=gnkkRsn5Wsw
- https://www.youtube.com/watch?v=lSCz1fL7DzQ
- https://www.betonamit.com/html/expansive-cement.html
- https://www.youtube.com/watch?v=XYiRY5o99yQ
- https://www.youtube.com/watch?v=aYoDgfeHsII

SWAYAM/NPTEL:

- Building Materials and Composites, by Prof Sumana Gupta, IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc20_ar04/preview

Course Articulation:

Course Outcome	Program Outcome											Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	3	3	-	3	-	3	3	-	3
CO2	3	3	-	-	-	3	3	-	3	-	3	3	-	3
CO3	3	-	2	-	-	3	3	2	3	-	3	3	3	3
CO4	3	3	-	-	-	3	3	-	3	-	-	3	3	3
CO5	3	3	2	-	-	3	3	2	3	-	3	3	3	3

High – 3, Medium – 2, Low –1

<table>
<tr><td colspan="7">Department: Environmental Engineering</td></tr>
<tr><td colspan="3">Course Code:24EV562</td><td colspan="4">Course Title: Environmental Initiatives for Smart Cities</td></tr>
<tr><td colspan="2">Total Credits: 3
L-45; T-0; P-0; SL&TW: 45</td><td>SDGs addressed:
3, 6, 9, 11, 13</td><td colspan="2">Course Category: PEC-II</td><td colspan="2">Course Type: Theory</td></tr>
<tr><td rowspan="6">Teaching Learning Process</td><td></td><td>Contact Hours/Semester</td><td colspan="4">Assessment Weightage and Marks</td></tr>
<tr><td>Lecture</td><td>45</td><td></td><td>CIE</td><td>SEE</td><td>Total</td></tr>
<tr><td>Tutorial</td><td>-</td><td>Weightage, %</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Practical</td><td>-</td><td rowspan="2">Maximum Marks</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">100</td></tr>
<tr><td>Self-learning & Term work</td><td>45</td></tr>
<tr><td>Total</td><td>90</td><td>Minimum Marks</td><td>20</td><td>25</td><td>45*</td></tr>
</table>

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

Course Pre-Requisite: Elements of Environmental Engineering.

Course Objective: This course explores the integration of waste treatment technologies into smart city initiatives. It covers the principles, design, and application of modern waste treatment methods and technologies that contribute to sustainable urban environments.

Course Outcomes (COs)

CO	Course Outcome	Highest Level of Cognitive Domain	Working Knowledge
CO1	Explain the concept of smart cities and their importance in sustainable urban development.	**L2**	3, 4, 5, 6
CO2	Identify and analyze various waste treatment technologies, including their applications, benefits, and limitations.	**L3**	3, 4, 6, 7
CO3	Evaluate the role of digital technologies and IoT in improving waste management systems.	**L4**	2, 3, 4, 6, 7
CO4	Assess the environmental, social, and economic impacts of waste treatment technologies within smart cities.	**L2**	2, 3, 4, 6
CO5	Apply planning and policy frameworks to support sustainable urban growth	**L3**	3, 7, 9

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Introduction to Smart Cities and Waste Management** Definition and Characteristics of Smart Cities Importance of Waste Management in Urban Areas Overview of Waste Streams (Municipal, Industrial, Hazardous, etc.) **Self-Learning and Term work** ● Indian case studies ● Plan a route optimization ● Regulation and policies	**09**
2	**Waste Treatment Technologies** Conventional Waste Treatment Methods - Centralized wastewater treatment, Landfills, Incineration) Advanced Waste Treatment Technologies - Decentralized wastewater treatment, Composting and Anaerobic Digestion, Waste-to-Energy Conversion, Technological Challenges and Opportunities **Self-Learning and Term work** ● Sampling methods ● Analytical tasks ● Energy Audit	**09**
3	**Pollution Monitoring and Role of IoT and Digital Technologies** Pollution monitoring, Introduction to IoT in water treatment and supply, water distribution and wastewater collection and treatment, Waste Management, Smart Bins and Sensors for Waste Collection, Data Analytics for Predictive Waste Management **Self-Learning and Term work** ● Case study ● Hand-on Demonstration/model making ● Design of sensors	**09**
4	**Environmental and Social Impacts, economic considerations** Life Cycle Analysis of Waste Treatment Technologies, Environmental Impacts and Sustainability Metrics, Social Acceptance and Community Engagement Cost-Benefit Analysis of Waste Treatment Technologies, Economic Incentives for Waste Management, Public-Private Partnerships in Waste Management **Self-Learning and Term work** ● Poster presentation ● Case study/ Group event/Debate ● Model making	**09**
5	**Policy and Regulatory Framework** Regulations and Standards for Waste Management, Global Policies on Waste and Smart Cities, Local Government Initiatives and Support, e-governance. Applications of AI & ML in Environmental Initiatives for Smart Cities. **Self-Learning and Term work** ● Case study/ Group event/ Debate	**09**

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

• G. L. Sharma et al "Municipal Solid Waste Management": Theory and Practice" (2018)
• K. S. Rao "Environmental Management: Problems and Solutions" (2017)

Reference Books:

- Anil Ahuja, 2016, "Integration of Nature and Technology for Smart Cities", 3rd ed. Springer International Publishing AG
- Claudio Coletta, Leighton Evans, Liam Heaphy, Rob Kitchin, 2018, "Creating Smart Cities", 1st edition, Routledge

Journals/Magazines:

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

Web/Digital Resources:

- www.edx.org
- www.ocw.mit.edu
- www.futurelearn.com
- www.coursera.org
- www.smartcities.gov.in
- www.data.worldbank.org
- www.esri.com

SWAYAM/NPTEL:

- Integrated Waste management for a Smart City (12 Semesters) by Dr. Brajesh Kumar Dubey, IIT Kharagpur https://nptel.ac.in/courses/124105158
- City and Metropolitan Planning (15 Semesters) by Dr. Sanjukkta Bhaduri, School of Planning and Architecture, New Delhi.

Course Articulation:

Course Outcome	Program Outcome											Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	3	-	-	1	-		-	-	3	3	3	-
CO2	3	3	3	2	3	-	-		-	-	3	3	-	2
CO3	3	3	3	2	3	-	-		-	-	3	3	3	2
CO4	3	3	-	-	3	-	-	2	-	-	-	3	3	-
CO5	3	3	-	-	-	-	-	2	-	-	-	3	3	-

High – 3, Medium – 2, Low –1

<table>
<tr><td colspan="7">Department: Environmental Engineering</td></tr>
<tr><td colspan="3">Course Code:24EV563</td><td colspan="4">Course Title: Environmental Law and Legal System</td></tr>
<tr><td colspan="2">Total Credits: 3
L-45; T-0; P-0; SL&TW: 45</td><td>SDGs addressed: 6,7,9,11,12,13,14, 15,16</td><td colspan="2">Course Category: PEC-II</td><td colspan="2">Course Type: Theory</td></tr>
<tr><td rowspan="6">Teaching Learning Process</td><td></td><td>Contact Hours/Semester</td><td colspan="4">Assessment Weightage and Marks</td></tr>
<tr><td>Lecture</td><td>45</td><td></td><td>CIE</td><td>SEE</td><td>Total</td></tr>
<tr><td>Tutorial</td><td>-</td><td>Weightage, %</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Practical</td><td>-</td><td rowspan="2">Maximum Marks</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">100</td></tr>
<tr><td>Self-learning & Term work</td><td>45</td></tr>
<tr><td>Total</td><td>90</td><td>Minimum Marks</td><td>20</td><td>25</td><td>45*</td></tr>
</table>

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

Course Pre-Requisite: Environmental Studies, Constitution of India

Course Objective: The course provides a strong base of the concepts and scope of environmental legal systems. It imparts basic knowledge about the environment and its allied problems, to create awareness about environmental problems among people and to develop an attitude of concern for the environment.

Course Outcomes (COs)

CO	Course Outcome	Highest Level of Cognitive Domain	Working Knowledge
CO1	Understand the laws related to environmental pollution and sustainability	**L2**	1,4,,6,7,8,9
CO2	Describes the Environmental Protection Act and the powers of the authorities in mitigation of pollution	**L2**	1,4,5,6,7,8,9
CO3	Understand the necessity of protecting forests and biodiversity	**L3**	1,4,5,6,7,8,9
CO4	Understand the recent national and international laws and amendments	**L3**	1,4,5,6,7,8,9
CO5	Awareness of the mitigation, protection, and preventive regulations of water and air attribute	**L3**	1,4,5,6,7,8,9

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Introduction** - Development v. Environment; Sustainable Development–Inter-generational and Intra-generational Equity; Precautionary Principle; Polluter Pays Principle; Public Trust Doctrine; Community rights. **Self-Learning and Term work** ● Professionals need to stay current on **laws, ethics, and global best practices**. ● Follow environment-related news, legal updates, and court rulings ● Study cases like the Narmada Dam, Vedanta mining case, or Standing Rock protests ● Use online tools: UN SDG portal, environmental law journals, webinars ● **Inclusive participation** in Environmental Impact Assessments (EIA) ● **Stakeholder dialogues** on development projects ● **Collaborative research** for sustainable solutions (e.g., eco-design, green infrastructure) such as Joint forest management involving local communities and government, Public-private partnerships in sustainable energy, NGO + legal + community efforts in environmental justice	09
2	**The Environment (Protection) Act**, 1986 – Aims and Objects; Meaning of "Environment" and "Environmental Pollutant"; Powers and Functions of the Central Government; Environment Authority - Constitution; Delegation of Powers; Offences/Penalties; Effectiveness of the Act; Environmental Impact Assessment, 2006; Environmental Audit; law relating to hazardous substance and activities-issues of liability; Need for effective climate change law and energy law. **Self-Learning and Term work** ● Track updates via MoEFCC, UNEP, NGT website ● Read landmark judgments (e.g., M.C. Mehta cases) ● Use online legal platforms (LiveLaw, Indian Kanoon) ● Filing Public Interest Litigations (PILs) ● Drafting environment-friendly policies ● Joint environmental monitoring and auditing ● Public consultations and participatory governance	09
3	**Protection and conservation of forests, Biodiversity and Wildlife** The Indian Forest Act, 1927; The Forest (Conservation) Act, 1980; Kinds of Forest Land - Private, Reserved, Village, Protected; Use of Forest Land for Non-Forest purposes; The Biological Diversity Act, 2002—access to biological resources and benefit sharing; Regulation of genetically modified organisms; The Manufacture, Use, Import, Export	09

	and Storage of Hazardous Micro-Organisms Genetically Engineered Organisms or Cells Rules, 1989. Protection of Wildlife - the Wildlife (Protection) Act,1972; Sanctuaries and National Parks; Licensing of Zoos and Parks. **Self-Learning and Term work**\ ● Environmental laws are technical, interdisciplinary, and ever-changing and requires understanding of science, policy, and legal language ● Online resources: MoEFCC, Indian Kanoon, NGT judgments ● Environmental law courses (NPTEL, UNEP, WWF-India) ● Government departments (MoEFCC, Forest Dept., CPCB)	
4	**National Green Tribunal** - The National Green Tribunal Act- 2010; Powers and functions of the National Green Tribunal; jurisdiction; locus standi, remedies. **International Environmental Law**- Development of international environmental law; Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, Ozone depletion, Sustainable Development Goals. **Self-Learning and Term Work** ● NGT website, legal portals ● Follow international news on **climate agreements** and environmental summits (COP meetings) ● Use official UN and Basel Convention resources ● Read environmental law journals and articles for latest trends Collaboration among: ● Legal experts (for litigation and policy drafting) ● Scientists and environmentalists (for evidence and impact assessment) ● NGOs and community groups (for awareness and activism) ● Government agencies (for enforcement and compliance)	09
5	The **Water** (Prevention and Control of Pollution) Act, 1974 – Water Pollution – Meaning; Central and State Pollution Control Boards – Constitution, Powers and Functions; Water Pollution Control Areas; Samples of Effluents – Procedure; Consent Requirement – Procedure, Grant/Refusal, Withdrawal, Review, Appeals, Revision; Restraint Order; Citizen Suit Provision; Offences and Penalties; The Water Cess (Prevention and Control of Pollution) Act, 1977. The **Air** (Prevention and Control of Pollution) Act, 1981- Air Pollution – Meaning, Causes and Effects; Central and State Pollution Control Boards - Functions; Air Pollution Control Area; Consent Requirement - Procedure, Grant/Refusal, Withdrawal; Restraint Orders; Citizen Suits; Noise Pollution (Regulation and Control) Rules, 2000; Offences/Penalties; Vehicular pollution.	09

	Self-Learning and Term Work ● Study the official text of Water and Air Acts for detailed clauses. ● Follow real cases and NGT judgments on pollution control. ● Use CPCB and SPCB websites for updates and guidelines. ● Track amendments and new rules (e.g., Noise Pollution Rules). ● Pollution control needs collaboration among: Government agencies (MoEFCC, CPCB, SPCB), Industry representatives, NGOs and community groups, Scientists for monitoring and research, Enforcement of consents and pollution norms, Public awareness and community participation ● Research-based policy interventions	

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

- Shibani Ghosh (ed), Indian Environmental Law: Key Concepts and Principles (2019)
- Usha Tandon et al (ed), Biodiversity: Law, Policy and Governance (2018).
- Environmental Law: Text, Cases and Materials 2nd Edition. Oxford University Press publications (2019).

Reference Books:

- S C Shastri, Environmental Law**:** Eastern Book Company publications (2024).
- Geetanjoy Sahu, Environmental Jurisprudence and the Supreme Court: Litigation, Interpretation, Implementation (2014)
- International Environmental Law - Text, Cases and Materials, Malgosia Fitzmaurice, Professor of International Law, Queen Mary University of London, Meagan S. Wong, Lecturer, School of Law, University of Essex and Joseph Crampin, U.K, Elgar Publications. (2022)

Journals/Magazines:

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

Web/Digital Resources:

- The Oxford Handbook of Environmental and Natural Resources Law in India - **https://doi.org/10.1093/oxfordhb/9780198884682.001.0001**

SWAYAM/NPTEL:

- Sairam Bhat and M. K. Ramesh, National Law School of India University, "Constitution of India and Environmental Governance", https://onlinecourses.nptel.ac.in/noc20_lw02
- Bharti Kumar, National Law University, Delhi, "Environmental Law", https://onlinecourses.swayam2.ac.in/cec20_ge12

Course Articulation:

Course Outcome	Program Outcome											Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	-	3	3	3	3	3	3	3	3	3
CO4	3	3	-	3	-	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

High – 3, Medium – 2, Low –1

<table>
<tr><td colspan="7">Department: Environmental Engineering</td></tr>
<tr><td colspan="3">Course Code:24EV564</td><td colspan="4">Course Title: Environmental Hygiene and Sanitation</td></tr>
<tr><td colspan="3">Total Credits: 3
L-45; T-0; P-0; SL&TW: 45</td><td>SDGs addressed:
3, 6, 11, 14</td><td colspan="2">Course Category: PEC-II</td><td>Course Type:
Theory</td></tr>
<tr><td rowspan="6"></td><td colspan="2"></td><td>Contact Hours/Semester</td><td colspan="3">Assessment Weightage and Marks</td></tr>
<tr><td colspan="2">Lecture</td><td>45</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>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="2">Practical</td><td>-</td><td rowspan="2">Maximum Marks</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">100</td></tr>
<tr><td colspan="2">Self-learning & Term work</td><td>45</td></tr>
<tr><td colspan="2">Total</td><td>90</td><td>Minimum Marks</td><td>20</td><td>25</td><td>45*</td></tr>
</table>

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

Course Pre-Requisite: Environmental studies

Course Objective: The course offers knowledge on the interlinks between environment, water, sanitation, and hygiene (WASH), as applicable to both individual and community/public health and provides insights on various initiatives related to WASH in the country.

Course Outcomes (COs)

CO	Course Outcome	Highest Level of Cognitive Domain	Working Knowledge
CO1	Develop a conceptual understanding of key issues related to Environment, Ecology and Water Management	L2	1, 3, 4, 5
CO2	Describe the significance of hygiene for physical well-being	L2	1, 3, 8
CO3	Paraphrase the urban, and rural sanitation and use of social media (print and digital) for sanitation awareness	L2	1, 3, 8
CO4	Associate environmental attributes, lifestyle practices, and policy matters to individual/community/public health	L3	1, 4, 5, 6
CO5	Explain the existing policies and programs in the country related to wash	L3	7, 8, 9

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Introduction** Environment and Ecology: Concepts, Principles and Components. Environmental Pollution and Health Hazards. Sustainable Development Goals (SDG) pertaining to Environmental Issues. WASH (Water, Sanitation, and Hygiene): Concept, Principles and Practices and program. **Water Management** Water: Use, Sources, Systems in Rural and Urban Settings **Techniques for Effective Water Management**- Rainwater Harvesting, Liquid Waste Management, Institutional Framework for Monitoring Quality and Strategizing. **Self-Learning and Term work** ● Discharge standards and regulations ● Water Sampling (Lab component) ● Case study link with SDG	09
2	**Hygiene:** Definition, Concept, Principles, Importance and Applications. Types of Hygiene: Personal, Food safety- sources of contamination and its effects, Community Medical and Culinary hygiene. Standard Hygiene Practices. Adoption of Hygiene guidelines for Protection and Promotion of Health and Welfare **Self-Learning and Term work** ● Poster Presentation ● Debate ● Model making	09
3	**Sanitation** Sanitation: Definition, Concept, Principles, Importance and Applications Types of Sanitation: Rural (Rural Community Health: Village health sanitation) and Urban, Institutional Sanitation in Public places, scenarios of open defecation and their impacts. Waste Management: Types and its Management Public Awareness through Digital Media - Mobile Apps of Government of India: National Health Policy, Swasth Bharat, Pradhan Mantri Surakshit Mantritva Abhiyan (PM Suman Yojana), My Hospital (Mera aspataal), India fights Dengue, Jansankhya Sthirata Kosh (JSK) Helpline, Ayushman Bhava, Arogya Setu, Covid 19.	09

	Self-Learning and Term work ● Government schemes and its uses ● Waste management rules and regulations ● Debate	
4	**Public Health** Health: Determinants of Health and Well-being, Right to Health Community Health, Health Status and Health Problems in India Communicable and Non- Communicable, water and airborne Diseases Lifestyle Illnesses Emerging Concerns related to Public Health **Self-Learning and Term work** ● Role of Government/ NGO in public health ● Case study ● Mini project (Live examples)	09
5	**Health Administration and Policies and Programs related to WASH** Organization and Administration of Health Care from Centre to the Village Level. Health Education: Components, and Importance. Communication Strategies for Health Promotion. Health Policies and Programs in India. Policies and Programs related to WASH- Governmental Policies and Programs - Total Sanitation Campaign (TSC) Program 1999, Nirmal Bharat Abhiyan 2012; Swachh Bharat Mission 2014, and Role of Local Bodies. Accelerated Rural Water Supply Program (ARWSP), the Sector Reforms Project, Swajal Dhara, and the National Rural Drinking Water Program (NRDWP), Swacch Jal, Jal Jeevan Mission (JJM). Best practices in India. **Self-Learning and Term work** ● Case study ● Poster presentation ● Debate	09

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

- Adelaide M. L. (2008). Environmental Sanitation and Gender among the Urban Poor. Germany: VDM Verlag Dr. MuellerE.K.
- Bansil,P.C. (2004).Water Management in India. New Delhi: Concept Publishing Company.
- Murali, K.V.S.G.K. (2012). Environmental Sanitation. New Delhi: Reem Publications

Reference Books:

- Cronin, A. A. (2019). Gender Issues in Water and Sanitation Programmes: Lessons from India. New Delhi: Sage Publication

- Nath K. J. & Sharma V. P. (2017). Water and Sanitation in the New Millennium. New Delhi: Springer.
- Sharma, P. D. (2012). Ecology and Environment. Meerut: Rastogi Publications

Journals/Magazines:

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

SWAYAM/NPTEL:

- https://www.coursera.org/learn/water-part-1
- https://www.coursera.org/learn/water-part-2
- https://www.coursera.org/learn/faecalsludge
- https://www.coursera.org/learn/sanitation

Course Articulation:

Course Outcome	Program Outcome											Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	3	3	3	-	-	-	3	-	3	3	-
CO2	3	-	-	3	3		-	-	-	-	-	3		-
CO3	3	-	-	3	3	3	-	-	-	-	-	3	3	-
CO4	3	-	-	-	-	3	-	-	-	3	-	3	3	-
CO5	3	-	-	-	-	3	-	-	-	3	-	3	3	-

High – 3, Medium – 2, Low –1

<table>
<tr><td colspan="7">Department: Environmental Engineering</td></tr>
<tr><td colspan="3">Course Code:24EV571OE</td><td colspan="4">Course Title: Hazard Vulnerability Assessment and Disaster Management</td></tr>
<tr><td colspan="3">Total Credits: 3
L-45; T-0; P-0; SL&TW: 45</td><td>SDGs addressed: 3, 9, 11, 13</td><td colspan="2">Course Category: OEC-II</td><td>Course Type: Theory</td></tr>
<tr><td rowspan="6">Teaching Learning Process</td><td></td><td>Contact Hours/Semester</td><td colspan="4">Assessment Weightage and Marks</td></tr>
<tr><td>Lecture</td><td>45</td><td></td><td>CIE</td><td>SEE</td><td>Total</td></tr>
<tr><td>Tutorial</td><td>-</td><td>Weightage, %</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Practical</td><td>-</td><td rowspan="2">Maximum Marks</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">100</td></tr>
<tr><td>Self-learning & Term work</td><td>45</td></tr>
<tr><td>Total</td><td>90</td><td>Minimum Marks</td><td>20</td><td>25</td><td>45*</td></tr>
</table>

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

Course Pre-Requisite: Environmental studies

Course Objective: This course imparts a thorough understanding of natural and man-made disasters, Disaster and vulnerability assessment, emergency response, preparedness, and Planning, mitigate measures along with the role of modern engineering and information technology. The course also supplements details on the legal framework along with a few case studies.

Course Outcomes (COs)

CO	Course Outcome	Highest Level of Cognitive Domain	Working Knowledge
CO1	State and classify disasters and identify cause-effect relationships.	**L2**	1, 5
CO2	Apply the knowledge of vulnerability assessment for per-planning, early warning systems, and response plans. Prepare on-site and off-site ERPs.	**L4**	4, 5
CO3	To comprehend the lessons learned from different natural and man-made disasters leading to newer initiatives for forecasting, planning, and mitigation and preparing Disaster and Environmental Management Plans.	**L3**	4, 7
CO4	Recognize the role of IT in creating vulnerability scenarios through simulation exercises using GIS and other related software and consolidate the information on National policy on disaster management along with the required legal framework for effective mitigation.	**L3**	6, 7
CO5	To deal with case studies regarding different natural and man-made disasters and mention its effect-cause relationship.	**L2**	8

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Introduction** Disasters cause and impacts, the scope of disaster management, disaster Managers- professionals and specialists active in various phases of disasters, Risk management, preparedness, operational functions of disaster management, Resource management, and impact reduction. **Disasters:** Natural disasters - Drought, Floods, Earthquake, Volcanoes, Land Slides, Cyclones, Tsunami; Man-made - Air accidents, Rail and Road accidents, Industrial, Chemical, Biological (Bio- Terrorism) nuclear Disasters, accidental oil spills, and others. **Self-Learning and Term work** ● Case study analysis on manmade and natural disasters ● Disaster dairy - summarizing and reviewing of disaster related articles ● Take quiz on disaster and types	**09**
2	**Disaster Assessment & Preparedness:** Disaster management steps, Vulnerability assessment (VA). Importance and advantages, Process of VA, Steps in VA, Report, Prioritization, Emergency Response Plan (ERP). **Pre-disaster Planning:** Earthquakes, cyclones, epidemics outbreaks, drought and famine. Disaster-resistant constructions, rehabilitation, and reconstruction. Early warning and management, Global Disaster alerting and coordination system (GDACS), Flood forecasting, and flood control systems. **Self-Learning and Term work** ● Flow chart preparation for disaster management ● Conduct basic Vulnerability Assessment of the campus ● Explore GDACS website and report on recent global disaster alert	**13**
3	**Disaster Prevention and Mitigation** Earthquake mitigation, Cyclone mitigation, Landslide hazard mitigation, Flood preparedness and response, building bylaws and adaptation. Environmental Management Plans (on-site and off-site) and Disaster Management Plans (DMP). **Self-Learning and Term work** ● Disaster Mitigation strategy comparison ● Study local building byelaws ● Create personal flood preparedness checklist	**08**
4	**Legal Framework** Disaster ManagementAct and Code, National Policy on Disaster Management. **Information Technology in Disaster Management**: Application of GIS and Remote sensing for Disaster Management, Simulation studies. Use of Unmanned aerial vehicles (UAVs) in disaster management and monitoring. **Self-Learning and Term work** ● Watch tutorials and use QGIS or Google Earth to explore hazard map ● Watch simulation videos and write comments on the same ● Hands on UAV's in disaster management	**09**

5	**Case studies** Bhopal gas tragedy, Meuse Valley, Chornobyl, Fukushima, Tsunami, Forest fires, Gujarat earthquake, Gulf of Mexico Oil Spill, and recent episodes. Applications of AI & ML in Hazard Vulnerability Assessment and Disaster Management. **Self-Learning and Term work** ● Case study and report preparation ● Identification of cause and finding solutions for recent disasters ● Quiz, field visit	**06**

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

- Peter R.J. Trim, (2004), "An Integrative Approach to Disaster Management and Planning", Emerald Group Publishing Ltd.
- Ramesh R. Rao, Jon Eisenberg, and Ted Schmitt, Editors, Committee on Using Information Technology to Enhance Disaster Management, National Research Council "Improving Disaster Management: The Role of IT in Mitigation, Preparedness, Response, and Recovery", The National Academies Press, Washington, D. C.
- Committee on Planning for Catastrophe, (2007), "A Blueprint for Improving Geospatial Data, Tools, and Infrastructure, National Research Council, "Successful Response Starts with a Map: Improving Geospatial Support for Disaster Management", The National Academies Press, Washington, D. C.

Reference Books:

- Committee on Disaster Research in the Social Sciences: Future Challenges and Opportunities.
- "Facing Hazards and Disasters- Understanding Human Dimensions" Division on Earth and Life Studies, (2006), The National Academies Press, Washington D. C.
- UNEP Report, (2005), "Environmental Management and Disaster Preparedness" Lessons Learnt from the Tokyo Typhoon (Typhoon 23 of 2004) in Japan.
- UNEP Report, "Environmental Management and Disaster Preparedness" 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/
- https://ndma.gov.in/
- https://ksdma.karnataka.gov.in/english
- https://www.mha.gov.in/division_of_mha/disaster-management-division

SWAYAM/NPTEL:

- Disaster Management offered by the University of Hyderabad.
- Natural Hazards offered by IIT, Kanpur.

Course Articulation:

Course Outcome	Program Outcome											Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	3	-	-	-	3	3	3	3
CO2	3	3	3	3	-	3	3	-	3	3	3	3	-	3
CO3	3	-	3	3	2	3	3	-	3	3	3	-	3	-
CO4	3	-	3	-	2	3	3	1	-	-	3	3	-	-
CO5	3	3	-	-	-	-	3	-	-	-	3	3	-	3

High – 3, Medium – 2, Low –1

<table>
<tr><td colspan="7">Department: Environmental Engineering</td></tr>
<tr><td colspan="3">Course Code: 24EV572OE</td><td colspan="4">Course Title: Urban Environment and Sustainability</td></tr>
<tr><td colspan="3">Total Credits: 3
L-45; T-0; P-0; SL&TW: 45</td><td>SDGs addressed:
3, 9, 11</td><td colspan="2">Course Category: OEC-II</td><td>Course Type: Theory</td></tr>
<tr><td rowspan="6">Teaching Learning Process</td><td></td><td>Contact Hours/Semester</td><td colspan="4">Assessment Weightage and Marks</td></tr>
<tr><td>Lecture</td><td>45</td><td></td><td>CIE</td><td>SEE</td><td>Total</td></tr>
<tr><td>Tutorial</td><td>-</td><td>Weightage, %</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Practical</td><td>-</td><td rowspan="2">Maximum Marks</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">100</td></tr>
<tr><td>Self-learning & Term work</td><td>45</td></tr>
<tr><td>Total</td><td>90</td><td>Minimum Marks</td><td>20</td><td>25</td><td>45*</td></tr>
</table>

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

Course Pre-Requisite: Environmental studies

Course Objective: This course explores the principles and practices of urban sustainability, focusing on the challenges and opportunities in creating sustainable urban environments. Students will learn about the impact of urbanization on natural resources, the built environment, and human health, as well as the innovative strategies and technologies used to promote sustainability in urban settings.

Course Outcomes (COs)

CO	Course Outcome	Highest Level of Cognitive Domain	Working Knowledge
CO1	Explain the key concepts and principles of urban sustainability and SDGs with relevance to urban settings.	L2	1, 5, 6, 7
CO2	Analyze the environmental, social, and economic impacts of urbanization.	L2	1, 3, 5, 7
CO3	Evaluate strategies and technologies for sustainable urban planning and design.	L4	1, 2, 3, 6
CO4	Design solutions for sustainable transportation, energy, and waste management.	L4	1, 2, 3, 4, 6
CO5	Apply planning and policy frameworks to support sustainable urban growth and engage with community stakeholders to promote sustainability initiatives.	L2	6, 7, 8

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

Course Syllabus:

Unit No.	Content	Hours Lecture
1	**Introduction to Urban Sustainability** Introduction to urbanization, environmental issues associated with urbanization, metros, cities, and towns as sources and sinks, resource consumption, Urban Health and Quality of Life, Sustainable development goals (SDGs), and their relevance to cities. **Self-Learning and Term work** ● Carrying Capacity ● Case study link with SDG ● Debate	**09**
2	**Urbanization and Environmental Impact** Housing scenario across a range of large-medium-small cities, poverty, and slums in an urban context, Patterns and trends of urbanization, Horizontal and vertical growth concept, Impacts of urbanization on land, water, and air resources, social and economic impacts of urbanization, eutrophication, acidification, human/ecosystem toxicity, smog, ozone depletion, Urban heat islands, and climate Change **Self-Learning and Term work** ● Case study ● Poster presentation ● Model making	**09**
3	**Sustainable Urban Planning and Design** Principles of sustainable urban planning, Environmental planning – types of planning, indicators of sustainability in planning and development of settlements, Green building design and certification, sustainable transportation system, emerging technologies in transportation, smart cities – the concept of smart cities and their components, the role of technology in urban sustainability (IoT, data analytics), challenges and opportunities in implementing smart city solutions. **Self-Learning and Term work** ● Building by-laws ● Case study ● National initaitives	**09**
4	**Urban Resource Management** Energy efficiency and renewable energy in urban areas, urban water management–water supply and demand, sustainable water management practices such as rainwater harvesting, grey water recycling, zero waste concept, urban stormwater management, and green infrastructure, waste management and	**09**

	circular economy, urban biodiversity and green spaces such as parks, gardens, and public spaces **Self-Learning and Term work** ● Energu Audit ● Case study ● Government schemes	
5	**Policy, Governance community engagement for Urban Sustainability** Town planning Acts, Environment acts and protocols, Role of policies and regulations in promoting urban sustainability, LCA, Importance of community involvement in sustainability initiatives, Strategies for raising public awareness and promoting behavior change. Applications of AI & ML in Urban Environment and Sustainability. **Self-Learning and Term work** ● LCA case study ● Field visit ● Debate	**09**

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

- Sioshansi Fereidoon, Energy sustainability and the environment technology, 2011.
- BUEREN E.V., Sustainable urban environments: an ecosystem approach, 2012.
- Adams, W.M. Green Development: Environment and Sustainability in the Third World, Routledge, London, 2001.

Reference Books:

- Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case studies, Prentice Hall.
- Gaston, K.J. 2010. Urban Ecology. Cambridge University Press, New York.
- McIntyre, N.E. 2000. Urban ecology as an interdisciplinary field: differences in the use of 'urban' between the social and natural sciences. Urban Ecosystems 4: 5-24.
- Montgomery, M.R. 2009. Urban Transformation of the developing world. Science 319: 761- 764.
- The Urban Environment, Royal Commission on Environmental Pollution, Twenty-sixth Report, chairman: Sir John Lawton CBE, FRS.

Journals/Magazines:

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

Web/Digital Resources:

- THE KARNATAKA TOWN AND COUNTRY PLANNING ACT -

https://www.janaagraha.org/asics/report/Karnataka-Town-and-Country-Planning-Act- 1961.pdf

- Green Building Guide - https://www.rcac.org/wp-content/uploads/2014/12/grn-bldg-guide_4-20-09.pdf

SWAYAM/NPTEL:
Certificate course in Environmental Sustainability by Dr. M. Rajesh, Dr. Sindhu P Nair, Dr. Jalajakumari VT, Dr. P Unnikrishnan, IGNOU Regional Centre, Vatakara

Course Articulation:

Course Outcome	Program Outcome											Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	-	-	3	3	1	-	-	-	-	3	-	-
CO2	3	-	-	-	3	3	-	-	-	-	-	3	2	2
CO3	3	-	-	-	3	3	-	-	-	-	-	3	-	2
CO4	3	1	1	1	-	3	-	-	-	-	2	3	2	-
CO5	3	-	-	-	-	3	-	-	-	-	2	3	-	-

High – 3, Medium – 2, Low

<table>
<tr><td colspan="8">Department: Environmental Engineering</td></tr>
<tr><td colspan="3">Course Code: 24EV573OE</td><td colspan="5">Course Title: Waste Management</td></tr>
<tr><td colspan="2">Total Credits: 3
L-45; T-0; P-0; SL&TW: 45</td><td>SDGs addressed: 3,7,11, 12, 13, 17</td><td colspan="3">Course Category: OEC-II</td><td colspan="2">Course Type: Theory</td></tr>
<tr><td rowspan="6">Teaching Learning Process</td><td></td><td>Contact Hours/Semester</td><td colspan="5">Assessment
Weightage and Marks</td></tr>
<tr><td>Lecture</td><td>45</td><td></td><td>CIE</td><td>SEE</td><td>Total</td></tr>
<tr><td>Tutorial</td><td>-</td><td>Weightage, %</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Practical</td><td>-</td><td rowspan="2">Maximum Marks</td><td rowspan="2">40</td><td rowspan="2">60</td><td rowspan="2">100</td></tr>
<tr><td>Self-learning & Term work</td><td>45</td></tr>
<tr><td>Total</td><td>90</td><td>Minimum Marks</td><td>20</td><td>25</td><td>45*</td></tr>
</table>

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

Course Pre-Requisite: Environmental studies

Course Objective: The course provides knowledge of engineering principles and practices of municipal, biomedical, and e-waste management including treatment and disposal options.

Course Outcomes (COs)

CO	Course Outcome	Highest Level of Cognitive Domain	Working Knowledge
CO1	Identify and know basic engineering principles and practices of waste management of solid waste and their environmental implications.	**L3**	7, 8
CO2	Explain the proper basic engineering principles of Hazardous waste and biomedical waste management and their environmental implications.	**L3**	3, 4
CO3	Explain the basic engineering principles of E-waste management and disposal and their environmental implications,	**L3**	6, 7
CO4	Expound on the necessity and implications of Waste Minimization, Resource Recovery, and Life cycle assessment and management concepts.	**L3**	5, 6
CO5	Identify and relate the relevant regulation of waste management policy adopted at the national and international level	**L3**	7, 9

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Solid Waste Management:** Introduction, Characteristics and Quantities, generation rates, waste Collection, transportation, segregation, processing, treatment and disposal: Case Studies. **Self-Learning and Term work** ● Indian case studies ● Plan a route optimization ● Regulation and policies	**09**
2	**Hazardous Waste Management**: Hazardous wastes and the environment, Waste management hierarchy, Transportation, Hazardous waste treatment, storage, and disposal facilities, Source reduction, recycling, disposal, and treatment, major safety operations in the management of hazardous waste. Biomedical Waste Management: Introduction, types and categories, Segregation, collection and transportation, disinfection, processing, treatment, and Disposal of biomedical waste: Case Studies. **Self-Learning and Term work** ● Policy discussion ● Emergency response drill ● Hazardous waste audit	**09**
3	**Electronic Waste (E-Waste) Management**: Issues and Status in India and Globally E-Waste Management Rules 2016 and Management Challenges Exposure pathway of pollutants emitted from Recycling of E-Waste. E-waste Management: Case Studies. **Self-Learning and Term work** ● Case study ● debate/discussion ● Outreach activities	**09**
4	**Construction and Demolition (C&D) waste management**: Environmental degradation due to indiscriminate disposal of C & D wastes, Quantification & composition of C & D waste generation, Type of C & D wastes products proposed under Rules, Roadmap for C & D waste management, C & D waste processing, Hierarchy in waste management, Importance of recycling C & D Wastes, Sustainable Model' on C & D waste management. Environmental Management – noise and dust, impact on soil and water. **Self-Learning and Term work** ● Problem solving exercise	**09**

	● Recycling model demonstration ● Waste audit projects/mini project	
5	Municipal Solid Waste (Management and Handling) Rules, 2000. Hazardous And Other Wastes (Management and Transboundary Movement) Rules, 2015, Bio-medical Waste Management Rules, 2016, C & D Waste Management Rules, 2016 **Current Issues**: Life cycle assessment, Fly ash rules; recycled plastics usage rules; commuter vehicle batteries (Management and Handling) rules Swachh Bharat Mission and Status in Smart Cities in the Country Construction and Demolition (C&D). Applications of AI & ML in Waste Management. **Self-Learning and Term work** ● National Initiatives ● Comparative chart/Infographic ● Smart cities waste management mini project	**09**

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

• George Techobanoglous et al, (2014) "Integrated Solid Waste Management‖", Mc Graw-Hill, 2014.
• Techobanoglous Thiesen Ellasen (2014), "Solid Waste Engineering Principles and Management", Mc Graw – Hill.

Reference Books:

• Wentz C.A., (1995), "Hazardous Waste Management", Mc Graw Hill International Edition.
• Davis M.L., and Cornwell D.A. (1998)," Introduction to Environmental Engineering", McGraw Hill International Edition.
• Johri R., "E-waste: implications, regulations, and management in India and current global best practices", TERI Press, New Delhi.
• Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Govt. Of. India, New Delhi, 2000.
• Guidelines for Hazardous Waste Management, CPHEEO, Ministry of Urban Development, Govt. Of. India, New Delhi.
• Guidelines for Biomedical Waste Management, CPHEEO, Ministry of Urban Development, Govt. Of. India, New Delhi
• Guidelines for E-waste Management and Handling, CPHEEO, Ministry of Urban Development, Govt. Of. India, New Delhi.

Journals/Magazines:

- Waste Management & Research: SAGE Journals (sagepub.com).
- Journal of Material Cycles and Waste Management | Home (springer.com)

Web/Digital Resources:

- MSWM- Module 2-notes - lecture notes of Municipal Solid Waste Management -CE 474 Municipal Solid - Studocu
- https://www.youtube.com/watch?v=W1WLhJpdaP8/
- https://archive.nptel.ac.in/courses/105/106/105106056/

SWAYAM/NPTEL:

• Solid & Hazardous Waste Management, by Dr. Indumathi Nambi, IIT Madras, https://nptel.ac.in/courses/105106056

• Municipal Solid Waste Management, by Prof. Ajay Kalamdhad, IIT Guwahati, https://nptel.ac.in/courses/105103205

• Electronic Waste Management – Issues and Challenges, Prof Brajesh Kumar Dubey, IIT Kharagpur, https://nptel.ac.in/courses/105105169

Course Articulation:

Course Outcome	Program Outcome											Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	3	-	-	-	-	3	3	3	3
CO2	3	3	2	2	3	3	-	-	-	-	3	3	3	3
CO3	3	3	2	2	3	3	-	-	-	-	3	3	3	3
CO4	3	3	-	-	3	3	-	-	-	-	3	3	3	3
CO5	3	3	-	-	-	-	1	-	-	-	3	3	3	3

High – 3, Medium – 2, Low –1

Department: Environmental Engineering						
Course Code: 24EV58L			*Course Title: Water Analysis Laboratory*			
Total Credits: 1.5 *L-0; T-0; P-45; SL&TW: 0*		*SDGs addressed: 3, 6, 14*	*Course Category: PCCL*		*Course Type: Laboratory*	
Teaching Learning Process		*Contact Hours/Semester*	*Assessment Weightage and Marks*			
	Lecture	-		**CIE**	**SEE**	**Total**
	Tutorial	-	*Weightage, %*	*40*	*60*	*100*
	Practical	*45*	*Maximum Marks*	*40*	*60*	*100*
	Self-learning & Term work	-				
	Total	*45*	*Minimum Marks*	*20*	*25*	*45**

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

Course Pre-Requisite: Elements of Environmental Engineering, Sources and Characterization, Environmental Chemistry and Applications.

Course Objective: The lab course provides an opportunity to collect and preserve water samples, conduct various tests on water quality parameters, and perform experiments on selected lab-scale treatment processes.

Course Outcomes (COs)

CO	Course Outcome	Highest Level of Cognitive Domain	Working Knowledge
CO1	To acquaint with the precision and accuracy of analytical data and to appreciate rounding off to a significant value in the Context of water quality parameters, to adopt various sample preservation techniques.	**L2**	1, 4, 7
CO2	To determine treatment efficiency of various water treatment processes–aeration, adsorption experiments with isotherms and breakthrough curve, jar test for an optimum dose of coagulant, and settling Experiments.	**L4**	1, 2, 3, 4, 6
CO3	To develop the ability to plan and perform filtration experiments, understand the significance of breakpoint chlorination to plot particle size distribution curve, able to analyze, interpret, and infer the laboratory data.	**L4**	1, 2, 3, 4, 6

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

Course Syllabus:

Sl. No.	List of Experiments/ Programs	No. of Hours
1	Water treatment process Laboratory – Introduction to the laboratory / equipment / instruments and applications. Precision and Accuracy, Significant numbers. Sample collection preservation techniques.	3
2	Dissolved oxygen (DO)	3
3	Aeration Process for Fe removal. Aeration for improving DO (continuous monitoring) – linkage with two film theory	6
4	Determination of colour and metals in water	3
5	Water Softening – Determination of initial and final concentration for parameters – Total hardness, TDS, Alkalinity, etc.	3
6	Jar Test apparatus for Optimum coagulant (Natural and chemical) dose Determination	3
7	Types of Settling - Column study with different salts (aluminium and copper)	3
8	Filtration Process - Single Media and Dual Media Filters. Particle size distribution analysis, Determination of Effective Size and Uniformity Coefficient	3
9	Batch Adsorption – GAC, Natural Adsorbents, Isotherms and Breakthrough curves & interpretations.	3
10	Chlorine demand, Available chlorine, and Break Point Chlorination Curve Residual chlorine in the water distribution system (Near OHT and in different user taps)	3
11	Household Water Treatment Units – Groundwater, RO treated water, and Bottled water quality analysis	6
12	Field visit to the water treatment plant	3
13	CIE final assessment	3

Text Books:

- Kanwaljit Kaur, (2007), Handbook of Water and Wastewater Analysis
- D. R., Khanna, R. Bhutiani, (2008), Laboratory Manual of Water and Wasteland Analysis

Reference Books:

- 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
- AWWA (2012), "Standard Methods for Examination of Water and Wastewater", 21st Edition

Journals/Magazines:

- Water Resources Management.
- Journal of Water Resources Planning and Management.
- Journal of the American Water Resources Association (JAWRA)

Web/Digital resources:

- **https://cpcb.nic.in/**
- **http://cgwb.gov.in/Documents/WQ-standards.pdf**
- https://cpcb.nic.in/https://cpcb

Course Articulation:

Course Outcomes	Program Outcomes											Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	3	3	3
CO2	3	3	3	3	3	3	-	-	-	3	-	3	3	3
CO3	3	3	3	3	3	3	-	-	-	3	-	3	3	3

High – 3, Medium – 2, Low – 1

<table>
<tr><td colspan="6">DEPARTMENT: HUMANITIES</td></tr>
<tr><td colspan="2">Course Code:
24HU510 / 24HU610</td><td colspan="4">Course Title CONSTITUTION OF INDIA & PROFESSIONAL ETHICS</td></tr>
<tr><td colspan="2">Total Credits: 00
L-15: T-0: P-0: SL and TW-15</td><td colspan="2">SDGs addressed: 1-17</td><td>Course Category: HSMC</td><td>Course Type: Theory</td></tr>
<tr><td rowspan="6">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>15</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>-</td><td>Maximum Marks</td><td>40</td><td>-</td><td>40</td></tr>
<tr><td colspan="2">Self-learning and Term work</td><td>15</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>

Note: *For passing the student must score a Minimum of Marks 20 (CIE)

COURSE PRE-REQUISITE: NIL

COURSE OBJECTIVE:

1. To provide basic information about Indian Constitution.

2. To identify individual role and ethical responsibility towards society.

COURSE OUTCOMES (COs)

By the end of the course, students will be able to:

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Have general knowledge and legal literacy and thereby to tale up competitive examinations.	L2	1
CO2	Remember their Fundamental Rights, DPSP's and Fundamental Duties (FD's) of our constitution	L2	7
CO3	Know about our Union Government, political structure & codes, procedures.	L3	8
CO4	Understand our State Executive & Elections system of India. Remember the Amendments and Emergency Provisions, other important provisions given by the constitution.	L2	8
CO5	Know importance of professional ethical values.	L2	8,9

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Introduction and meaning** Introduction to the constitution of India, The Making of the Constitution and Salient features of the Constitution. Preamble to the Indian Constitutional Fundamental Rights & its limitations. **Self-Learning and Term work** Reading and note making Draw a flow chart of Preamble with its keywords Group Discussion on Making of Constitution. Writs table with real legal remedies	**06**
2	**Fundamental Duties and DPSP, Union executive** Directive principles of State Policy & Relevance of Directive principles of State Policy Fundamental Duties. Union Executives – President, Prime Minister, Parliament, Supreme Court of India. **Self-Learning and Term work** Article index preparation Case law study Apply concepts to real life scenarios.	**06**
3	**State Government, Judiciary and Election Process** State Executives – Governor, Chief Minister, State Legislature, High Court of State. Electoral Process of India, Amendment Procedures, 42nd, 44th, 74th, 76th, 86th, and 91st Amendments. **Self-Learning and Term work** Structure Diagram by memorizing hierarchy of Union, State and local bodies Amendment tracking Mock Parliament. Visit to Law Courts.	**06**
4	**Social Provision, Emergency Provisions** Social Provision for SC & ST Special Provision for Women, Children and Backward Classes, Emergency Provisions. Powers and Functions of Municipalities, Panchayats and Co-operative Societies. **Self-Learning and Term work** Article and Land mark case analysis Case study and discussion on Emergency provisions Poster/Infographic making Build a comparative Panchayat vs. Municipality table Visit/state portal or verified news to find scheme per group	**06**
5	**Professional Ethics** Scope and Aims of Engineering Ethics, Responsibility of Engineers Impediments to Responsibility. Risk, Safety and liability of Engineers, Honesty, Integrity and Reliability in Engineers.	**06**

	Self-Learning and Term work Case Study Review: Analyze Bhopal Gas Tragedy, Challenger Disaster, Chernobyl. Reflect on responsibility, risk, and honesty. Code of Ethics Comparison: Compare IEEE, NSPE, and Institution of Engineers (India) codes. Ethics Diary: Maintain a Semesterly journal on ethical dilemmas encountered in technology/news. Poster making on list of Professional Ethics identify ethical concerns at various work places	

Note: Components in SL and TW shall be assessed in CIE only.

Text Books:

- V.N. Shukla – Constitution of India
- M.P. Jain – 'Indian Constitutional Law'
- "Constitution of India" (for Competitive Exams) - Published by Naidhruva Edutech Learning Solutions, Bengaluru. – 2022.
- "Engineering Ethics", M. Govindarajan, S. Natarajan, V.S. Senthilkumar, Prentice –Hall, 2004.
- R. S. Naagarazan - Professional Ethics and Human Values"

Reference Books:

- M. Laxmikanth- Indian Polity
- D.D. Basu- Introduction to the Constitution of India.
- F.C. Strong – Federalism
- V.D. Mahajan – Modern Government
- D.D. Basu – Shorter Indian Constitutional Law
- Dr. Subhash C. Kashyap – The Framing of India's Constitution
- Caroline Whitbeck- Ethics and the Practice of Engineering.

Journals/Magazines:

- Indian Journal of Constitutional Law (IJCL)
- Yojana (by Government of India) – Monthly magazine with simple explanations of government policies and constitutional aspects.
- Journal of Engineering Education (ASEE).
- IEEE Technology and Society Magazine.

Web/Digital resources:

- The Ministry of Law & Justice (GoI) structured video series https://legalaffairs.gov.in
- "Samvidhaan: The Making of the Constitution of India", https://www.youtube.com/playlist
- Indian Constitution: https://www.youtube.com/watch
- https://www.ijlsi.com/15-separation-of-powers-a-comparative-study-under-india-uk-and-usa-constitution/
- https://www.insightsonindia.com/polity/indian-constitution/salient-features-of-indian constitution/

- https://www.clearias.com/constitution-of-india/
- National Board of Accreditation (NBA) India – outcome-based education resources on ethics.
- AICTE Student Handbook on Professional Ethics
- IEEE Code of Ethics: https://www.ieee.org/about/corporate/governance/ethics.html

SWAYAM/NPTEL:

- Constitutional Government & Democracy in India, Prof. Amitabha Ray (St. Xavier's College, Kolkata) https://onlinecourses.swayam2.ac.in/cec21_hs35/preview
- Constitutional Studies, Prof. Sudhir Krishnaswamy (NLSIU) https://onlinecourses.swayam2.ac.in/cec24_lw17/preview .
- Constitutional Law & Public Administration in India, Prof. Sairam Bhat (NLSIU) https://onlinecourses.nptel.ac.in/noc24_lw05/preview
- "Ethics in Engineering Practice" – IIT Madras (NPTEL). https://onlinecourses.nptel.ac.in/noc21_mg60/preview
- Moral Thinking: An Introduction to Values and Ethics- (IIT Kanpur / NPTEL) https://nptel.ac.in/courses https://archive.nptel.ac.in

Course Articulation:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	-	-	-	-	1	2	-	-	-	2
CO2	-	-	-	-	-	1	2	-	-	-	2
CO3	-	-	-	-	-	1	2	-	-	-	2
CO4	-	-	-	-	-	1	2	-	-	-	2
CO5	-	-	-	-	-	1	2	-	-	-	2

High – 3, Medium – 2, Low – 1

Evaluation Scheme:

Continuous Internal Evaluation – CIE

Event	Event Type	Marks Allotted
CIE – 1	Written Test – 1	15
CIE – 2	Event	10
CIE – 3	Written Test – 2	15

Note:

1. The written test 1 & 2 (CIE – 1 & 3) both will be conducted for 15 marks each in 1 hour duration.
2. The Event (CIE – 2) will be conducted for 10 marks.
3. The Event (CIE – 2) will be skill-based assessment such as Seminars / Technical talks / Case study / hands-on activity / Mini projects / Sci-tech activity / Data analysis.
4. A student must score on an average of 50% i.e., 20 marks out of 40 from all the events (CIE - 1, 2, 3) to gain the eligibility to appear for SEE.
5. The eligibility marks are 20.

6th Semester Syllabus

Department: Environmental Engineering						
Course Code: **24EV610**		*Course Title: Wastewater Treatment Engineering*				
Total Credits: 4 *L-45: T-0: P-30: SL and TW-45*		*SDGs addressed: 3,6,7,9,11,12,15*	*Course Category: PCC*		*Course Type: Theory Integrated with Laboratory*	
Teaching Learning Process		*Total Contact Hours/semester*	*Assessment Weightage and Marks*			
	Lecture	*45*		**CIE**	**SEE**	**Total**
	Tutorial	*-*	*Weightage, %*	*40*	*60*	*100*
	Practical	*30*	*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)

Pre-Requisite: Environmental Chemistry, Environmental Microbiology and Ecology

Course Objective: The course offers comprehensive knowledge of principles and design aspects of wastewater collection, treatment, and disposal systems, updated with the latest technological advancements.

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Explain the basics of sampling, characterization, and seasonality of wastewater and apply the knowledge of hydraulic elements curve for the design of sewer system	L3	1, 2, 3
CO2	Describe the functioning and design of various domestic wastewater treatment units	L3	3, 4, 6, 9
CO3	Describe the fundamentals of nutrient removal and explain the principles of physio-chemical, biological advanced wastewater treatment systems.	L2	3, 4, 6, 7, 8, 9
CO4	Analyze the characteristics of sludge and suggest disposal options.	L3	1, 2, 3, 7, 8, 9
CO5	Design fecal sludge management and explain recent technologies for wastewater treatment.	L3	1, 2, 3, 7, 8, 9

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Introduction:** Sources of domestic wastewater, Characteristics of wastewater - parameter interlinks. Estimation of dry and wet weather flow, Mass loading, Simple problems. Types of sewerage systems. Hydraulic design of sewers: Self-cleansing and non-scouring velocities, partial flow, and force main, hydraulic elements curve. Sewer Appurtenances: Manholes, inverted siphons. Materials of sewers, laying, joining, and testing. Prefabricated sewer systems. **Self-Learning and Term Work** • Conduct lab testing or data analysis to correlate parameters • Create layout plans for urban sewer networks • Use software like SWMM or EPANET for hydraulic modeling	**09**
2	**Unit Operations and Unit Processes** Objectives, and process flow sheets based on characterization. Chemical and Biological reaction kinetics, Types of reactors. Pumps, screens, equalization, comminution, grit chamber, oil and grease removal, primary sedimentation tank. Secondary sedimentation tank - design criteria and examples. Aerobic, Anoxic, and Anaerobic systems, Suspended and attached growth systems, activated sludge process and modifications, trickling filters, rotating biological contactors, design criteria, and examples. Natural Wastewater Treatment Systems – Wetlands, Septic tanks and soak pits, dispersion trenches. **Self-Learning and Term Work** • Develop flow sheets for domestic, industrial, and mixed wastewater • Model first-order and Monod kinetics for BOD/COD removal • Design reactor configurations for aerobic and anaerobic processes	**09**
3	**Advanced Wastewater Treatment Systems** Need for Advanced Wastewater Treatment Systems, nutrient removal, Electrochemical coagulation, Gas Stripping, DAF, Advanced Oxidation, Electro-dialysis, Ion Exchange, Adsorption, Membrane filtration, Membrane bioreactors, Microbial fuel cells, DEWATS. **Self-Learning and Term Work** • Analyze emerging contaminants (pharmaceuticals, microplastics) • Develop hybrid systems (e.g., MBR + AOP, DEWATS + wetlands) • Conduct life cycle assessment (LCA) and cost-benefit analysis	**09**

4	**Sludge Management** Chemical, biological, and electro-chemical sludge – sources and generation, Quantification and characterization, sludge volume index (SVI), centrifugal settleability index (CSI), alternate uses of sludge, and disposal options. Calorific value estimation from proximate and ultimate analysis data. Sludge Digestion- aerobic and anaerobic, Sludge Drying Bed, Sludge Thickeners, Sludge Filter Press, design criteria and examples. **Self-Learning and Term Work** • Analyze sludge composition and treatment challenges • Design decision matrix for selecting disposal methods • Develop a complete sludge management plan for a city	**09**
5	**Fecal Sludge Management (FSM)** Fecal Sludge- Characteristics, Quantification, FS Value Chain, Containment, Transportation, Collection and Conveyance. Design of a Fecal Sludge Treatment plant; Case studies. Applications of AI and ML in Wastewater Treatment Engineering. **Recent Trends** Genetically modified microorganisms for wastewater treatment – externalities; biosensors, Hybrid Wastewater Treatment Systems, water reclamation facilities. **Self-Learning and Term Work** • Design sludge-to-energy systems (e.g., biogas) • Assess occupational health and safety risks • Develop maintenance protocols and user guides	**09**

Note: Components in SL & TW shall be assessed in CIE Only.

LABORATORY-BASED LEARNING:

No	Topics to be covered	Hours	Expected Skill/Ability
1	Domestic and industrial Wastewater Characterization.	06	Analytical Skill
2	Determination of BOD and other parameters	04	Analytical Skill
3	Determination of COD and other parameters	04	Analytical Skill
4	Coagulation and Flocculation Experiments followed by sedimentation process.	04	Analytical Skill
5	Bench Scale Experiments – Aerobic/anaerobic treatment units	04	Analytical Skill
6	Wastewater Polishing Units - Water Hyacinth, Duckweeds, etc.	03	Analytical Skill
7	Adsorption (batch/column studies) experiments for the removal of color from effluent.	03	Analytical Skill
8	Sludge Analysis – Proximate analysis, ultimate analysis, VSS, VFA, Nitrates & Phosphates.	02	Analytical Skill

TEXT BOOKS

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

REFERENCES

- Quasim, S. R., (1985), "Wastewater Treatment Plants – Planning, Design and Operation", Holt Rinehart and Winston, CBS College Publishing.
- 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.
- Moo-YoungM., AndersonW.A., ChakrabartyA.M., (2007), "Environmental Biotechnology – Principles and Applications," Kluwer Academic Publishers.
- CPHEEO Manual on Wastewater Treatment (Recent Edition)
- CDD manual on Faecal Sludge Management

Journals/Magazines:

- Journal articles in reputed journals indexed by 'Scopus' and 'Web of Science'

Web/Digital resources: Scheduled Rates,

- **Relevant educational videos on YouTube https://www.wef.org/resources/publications/books/wastewater-treatment-fundamentals/**

SWAYAM/NPTEL:

- Wastewater Treatment and Recycling, Prof. Manoj Kumar Tiwari, IIT Kharagpur, https://nptel.ac.in/courses/105105178
- Wastewater management, Dr. M.M. Ghangrekar, IIT Kharagpur, https://nptel.ac.in/courses/105105048
- Physico-chemical processes for wastewater treatment, Prof. Vimal Chandra Srivastava, IIT Roorkee, https://nptel.ac.in/courses/103107212

Reference Books for Laboratory:

- American Public Health Association, American Water Works Association, (2012), Standard Methods for Examination of Water and Wastewater, 21st Edition, APHA.
- Adams and Eckenfelder Jr. W.W. (1974), "Environmental, Process Design Techniques for Industrial Waste Treatment", Nashville (USA), 1974.

Journals/Magazines:

- Water Utility Management International.
- Water Quality Research Journal of Canada.

- International Journal of Environment and Waste Management.
- Journal of Applied Research in Water and Wastewater.

Course Articulation:

COURSE OUTCOMES↓	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	-	-	1	-	-	-	-	-	-	3	2	3
CO2	3	2	1	-	-	1	2	-	-	-	-	3	3	2
CO3	3	2	1	-	-	1	2	-	-	-	-	3	3	2
CO4	3	2	2	-	-	1	1	-	-	-	-	2	3	3
CO5	3	2	2	-	1	1	-	-	-	-	-	3	2	3

High – 3, Medium – 2, Low – 1

Department: Environmental Engineering						
Course Code: **24EV620**		*Course Title: Estimation and Costing*				
Total Credits: 3 *L-45: T-0: P-0: SL and TW-45*		*SDGs addressed: 6,8,9,11,13,15*	*Course Category: PCC*		*Course Type: Theory*	
Teaching Learning Process		*Total Contact Hours/semester*	*Assessment Weightage and Marks*			
	Lecture	*45*		**CIE**	**SEE**	**Total**
	Tutorial	*-*	*Weightage, %*	*40*	*60*	*100*
	Practical	*-*	*Maximum Marks*	*40*	*60*	*100*
	Self-learning and Term Work	*45*	*Minimum Marks*	*20*	*25*	*45**
	Total	*90*				

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

Course Pre-Requisite: Construction Engineering Materials Survey Engineering, Geology and Geotechnical Engineering.

Course Objective: The course prepares the student to understand and apply the essentials of cost estimation and specifications, practice value-based engineering profession, and know the basics of financial aspects.

COURSE OUTCOMES (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Use of the fundamental equations for estimation and specifications of Construction materials	**L3**	1,2,3,4,6,7,9
CO2	Evaluate the quantities of building materials and prepare a budget estimate for a given specification with a schedule of rates.	**L3**	1,2,3,4,6,7,9
CO3	Evaluate detailed specifications of different components of construction and Pipe materials of water supply and sewer system	**L3**	1,2,3,4,6,7,9
CO4	Explain the need for value engineering and its significance in Engineering Practices	**L2**	1,2,3,4,6,7,9
CO5	Use off in an CIA implication including tax and rebates in water and energy sector and explain ender document	**L3**	1,2,3,4,6,7,9

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Introduction and applications in Environmental Engineering Earthwork** –volume by cross-section, spot levels, and contour-calculation of haul, overhaul, and economic haul, lead, and lift. **Specifications for materials:** aggregates, cement, Steel, water supply pipe materials and fittings, sewer materials **Specifications for construction work:** Earthwork, foundation, cement mortar, plain and reinforced concrete, brick masonry, stone masonry, roofing, flooring, plastering, woodwork, water supply Distribution system. Open drains, and sewer line. **Self-Learning and Term Work** • **Understanding Concepts**: Such as earthwork calculations, material properties, and water/sewer system designs. • **Hands-On Applications**: Collaborating in fieldwork, lab testing, or design projects. • **Project-Based Learning**: Dividing tasks like surveying, analysis, and drafting among team members.	**13**
2	**Estimation**: Types of estimates, Methods of working out quantities. **Rate Analysis:** Cement mortar, cement concrete, brick and stone masonry, flooring, plastering, RCC works, doors, windows, and ventilators. Use of current Schedule of Rates. **Self-Learning and Term Work** • Learn to read SoR and abstract estimates • Use estimation software or Excel • Each member works on quantities and rate analysis for assigned part • Collaborate to build full project estimate • Peer review each other's work for errors or improvements • Use spreadsheets or Estimation software collaboratively	**06**
3	Preparation of detailed and abstract estimates for Storeroom, pump house, cascade aerators, sedimentation tank/clariflocculator, distribution system, septic tank, manhole, sewer network systems, storm water drains, Quantification of Steel of various basic components-slab, chejja, lintel, and valve chambers. **Self-Learning and Term Work** • Learning to calculate quantities using formulae and software • CPWD / PWD SoR • AutoCAD (for drawings) • Excel or Estimation Software	**09**
4	**Principles of Value Engineering** Financial Aspects: Purpose. Cost, price, value–different forms of value Balance sheet, Gross income, net income, outgoings – types of	**09**

	outgoings–Capital cost– fixed and variable, time value of money, Net Present Value (NPV), Internal Rate of Return (IRR), Depreciation– methods, sinking fund, cost fixation on the produced commodity. Debt equity (DE), debt service coverage ratio (DSCR). **Self-Learning and Term Work** • **Excel**: For financial modeling (NPV, IRR, cash flows) • **Google Sheets**: For collaborative financial documents • **Case studies**: Government/public infrastructure projects with financial data • **Team readiness** to handle real-world tendering, budgeting, and cost-benefit analysis • **Hands-on skills** in Excel financial modeling, report preparation, and technical presentations	
5	**Fiscal Incentives and penalties for environmental protection**: Tax rebate, Investment and Depreciation allowance, exemption from Tax to capital gains, rebate in cess levied on water consumption and energy. Financial assistance for environmental facilities, Tendering for construction of environmental facilities, Subsidies for environmental facilities. Applications of AI and ML in Estimation and Costing. **Self-Learning and Term Work** • **Income Tax Act**: Sections relevant to depreciation and exemptions (e.g., Sec 35AD, 80-IA) • **State Pollution Control Board** circulars and guidelines • **Green building codes** (e.g., IGBC, GRIHA) for subsidy eligibility • Prepare a joint presentation/report showing both technical and financial feasibility	**08**

Note: Components in SL & TW shall be assessed in CIE Only.

Text books:

- Dutta B.N., (2015), "Estimating and Costing in Civil Engineering"- CBS Publishers and Distributors
- MahajanS.P., (2006), "Civil Estimating & Costing Valuation & Specifications"– Satya Prakashana.

Reference Books:

- Manual on water supply and Treatment", CPHEEO, Ministry of Urban Development, GoI, New Delhi, 2012.
- Current Schedule of Rates (SR)of CPWD, KPWD, Board SR.
- Paneer Selvam, (2005), "Engineering Economics", Eastern Economy Edition.
- Chap-04(moef.gov.in)

Journals/Magazines:

- https://www.iceaaonline.com/publications
- https://web.aacei.org/resources/other-resources/magazines
- https://ieeexplore.ieee.org/document/1092092

Course Articulation:

COURSE OUTCOMES↓	PROGRAMOUTCOMES											PROGRAM SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

High– 3, Medium– 2, Low–1

Department: Environmental Engineering						
***Course Code:* 24EV630**		***Course Title: Environmental Impact Assessment***				
Total Credits: 3 ***L-45: T-0: P-0: SL and TW-45***		***SDGs addressed:1,2,3,6,7, 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	***-***	***Weightage, %***	***40***	***60***	***100***
	Practical	***-***	***Maximum Marks***	***40***	***60***	***100***
	Self-learning and Term Work	***45***	***Minimum Marks***	***20***	***25***	***45****
	Total	***90***				

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

Course Pre-Requisite: Elements of Environmental Engineering, atmospheric environmental Engineering, sources and characterization, water and wastewater treatment, municipal and biomedical waste management.

Course Objective: The course provides knowledge on environmental impact assessment, tools, methods, and the importance of public participation with applications for developmental activities.

COURSE OUTCOMES (COs)

CO	Course Outcomes	Highest Level Of Cognitive Domain	Working Knowledge
CO1	Explain the need for impact analysis of developmental activities on environmental systems and the basic requirements of the EIA process.	L2	1,2,3,4
CO2	Describe the recent guidelines/notification about EIA, the significance of NABET, and the role of NGT in EIA activities.	L2	1,2,3,4
CO3	Examine the impact of given projects on environmental attributes using EIA tools/techniques and propose EMP/DMP.	L3	1,2,3,4,6,7,8,9
CO4	Analyze the impact of developmental activity using simulation models and describe the process and significance of public participation.	L4	1,2,3,4,6,7,8,9
CO5	Relate the types of audits and carry out environmental audits for a given Scenario.	L4	1,2,3,4,6,7,8,9

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Introduction -** Definition, Purpose, and Scope of EIA, Types of EIA. Evolution of EIA in India and other countries. The EIA process, Chapter contents in EIA, Procedural and methodological Limitations. EMP in NDS reports. **Self-Learning and Term Work** • Site visualization • SWOT analysis • Matrix building: Match EIA types to project categories and regulatory needs	**13**
2	**Guidelines and Regulations** – EPA, EIA Notification of 2006 and subsequent amendments, EC practices in India, terms of reference – Standard and additional for EIA/EMP report for projects/activities, MoEF&CC guidelines on siting of industries, ecologically sensitive areas, NABET accreditation for EIA consultants, Role of National Green Tribunal in EIA. EIS. **Self-Learning and Term Work** • Comparative analysis: Pre- and post-amendment case studies • Stakeholder mapping: Identify roles and responsibilities in EC approval • Gap analysis: Compare actual EIA reports against issued ToRs	**06**
3	**Methodologies & Techniques in EIA** - Adhoc, checklist, matrix, overlays, networks, Battle Environmental Evaluation Systems (BEES), Cost-Benefit Analysis (CBA), brainstorming, fuzzy, Delphi technique, **Contents of EIA** -Structure of EIA, Onsite and Offsite Emergency Plan, Environmental Management Plan (EMP), and Disaster Management Plan (DMP). **Self-Learning and Term Work** • Matrix method: Leopold matrix, interaction matrices; scoring systems • Build a modular EMP for a hypothetical industrial project • Disaster Management Plan (DMP): Risk scenarios, preparedness, recovery strategies, integration with national frameworks	**09**
4	**Environmental Attributes** - Value function plots and standards for Environmental attributes - Air, water, land; Simulation models. Impacts on Socioeconomic aspects, biodiversity. **Public participation in EIA** - Need, objectives, elements, and framework for public participation – step-by-step procedure. **Self-Learning and Term Work** • Standard comparison: Evaluate Indian vs. international	**09**

	standards (e.g., CPCB vs. EPA) • Impact matrix creation: Link project activities to socioeconomic and ecological outcomes • Study on Public Hearing Scripts	
5	**Post EIA activities** - EIA audit –Types and auditing procedure **EIA case studies** – Category A, B1 and B2. Applications of AI and ML in Environmental Impact Assessment. **Self-Learning and Term Work** • Conduct a mock audit for a sample project using real EMP conditions • Evaluate EMP effectiveness • Stakeholder Simulation: Reenact public hearing or EC appraisal for a selected case	**08**

Note: Components in SL & TW shall be assessed in CIE Only.

Text books:

- Anjaneyulu Y., and Manickam V. "Environmental Impact Assessment Methodologies", 3rd Edition, B S Publications, 2020.
- Raman N. S, Gajbhiye A. R. and Khandeshwar S. R. "Environmental Impact Assessment".1st Edition, IK International Publications Pvt. Ltd. 2014.
- Rau and Wooten, "Environmental Impact Assessment" Handbook, 1981.
- Jain R. K, Urban L. V, Stacey G. S. "Environmental Impact Analysis – A New Dimension in Decision Making", Van Nostrand Reinhold Co, 1977.

Reference Books:

- Anji Reddy and Mareddy, "Environmental Impact Assessment theory and practice" 1st Edition, B S Publications, 2019.
- Glasson J., Therivel Riki, Chadwick Andrew, "Introduction to Environmental Impact Assessment", Oxford Brookes University 2012/ 4th edition.
- Clark Bisett B.C and Tomlinsan P, "Perspective on Environmental Impact Assessment", Allied Publishers, 1985.
- Canter L, "Environmental Impact Assessment", McGraw Hill, 1995.
- EIA notifications and Publications, MoEF & CC, GoI

Journals/Magazines:

- Journals - Science Direct, acs.org.

Web/Digital resources:

- Teacher_manual_master_EIA.pdf (iitr.ac.in).
- IV-II-EIAM-UNIT-II.pdf (gpcet.ac.in).
- Sec_E_Topic_1.PDF (iaia.org).
- EIA Reader (ethernet.edu.et)

SWAYAM/NPTEL:

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

Course Articulation:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	-	-	-	3	3	-	-	3	3	3	-	3
CO2	3	3	3	-	-	3	3	-	-	3	3	3	2	2
CO3	3	3	3	3	3	3	3	-	-	-	-	2	1	2
CO4	3	3	3	3	3	3	3	-	2	3	3	-	2	2
CO5	3	3	-	3	-	3	3	1	2	-	3	2	1	1

High– 3, Medium– 2, Low–1

Department: Environmental Engineering						
Course Code: 24EV640		*Course Title: Transport of Environmental Pollutants and Modelling*				
Total Credits: 3 *L-45: T-0: P-0: SL and TW-45*		*SDGs addressed: 6,9,12,13,14,*		*Course Category: PCC*		*Course Type: Theory*
Teaching Learning Process		*Total Contact Hours/semester*	*Assessment Weightage and Marks*			
	Lecture	*45*		**CIE**	**SEE**	**Total**
	Tutorial	*-*	*Weightage, %*	*40*	*60*	*100*
	Practical	*-*	*Maximum Marks*	*40*	*60*	*100*
	Self-learning and Term Work	*45*	*Minimum Marks*	*20*	*25*	*45**
	Total	*90*				

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

Course Pre-Requisite: Air Pollution, Wastewater Treatment, Environmental Chemistry and its Applications and Hydrology.

Course Objective: Student builds an understanding and application knowledge of various physical phenomena, chemical and biological processes, and their influence on the fate and transport of a variety of pollutants in water, soil, and air compartments.

COURSE OUTCOMES (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Illustrate the fate and transport of pollutants with case studies. Derive related equations with analytical solutions.	**L3**	2,4,6,7,8,9
CO2	Correlation of the mathematical models and prediction of pollutants (conservative and non-conservative) concentrations in lakes and rivers under steady-state conditions with suitable numerical exercises.	**L3**	2,4,6,7,8,9
CO3	Explain the concept of mixing zones 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**	2,4,6,7,8,9
CO4	Design and compare stratified and completely mixed lake systems with mathematical equations to compute pollutant distribution in lake, Ocean, and estuarine systems.	**L2**	2,4,6,7,8,9
CO5	Derive 1-D groundwater model considering the influenci processes and applying the various prediction models f prediction of groundwater quality.	**L3**	2,4,6,7,8,9

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Introduction** to Modelling and Transport Processes, Process Dynamics, Mass Balance Approach, Material Balance Relationship, Chemical transformations, and Photochemical transformation. **Self-Learning and Term Work** • Use simulation tools like COMSOL or MATLAB to visualize models,Use tools like Aspen Plus or MATLAB in team projects. • Simulate photoreaction rates using MATLAB or Python. • Present case studies	**06**
2	**Mechanics of Mass Transport:** Diffusive and Convective Mass Transport. Fick's Law of Diffusion, Combined Convective-Diffusion Equations for 1 and 2 Dimensions. Analytical Solutions for 1-D & 2-D Cases, Simple Problems. **Self-Learning and Term Work** • COMSOL tutorials or Python-based diffusion simulators • MATLAB, Python (NumPy, Matplotlib), Excel • MIT OCW – "Transport Processes	**13**
3	Principal Components of DO analysis, Sources and Sinks of DO, Effects of Oxygen Demanding Waste, Bacteria and Nutrients, Streeter–Phelp's Equation and Expression for Critical Point, 2-D models, Mixing zone concept – types of outfall and mixing regimes, Simple Problems **Self-Learning and Term Work** • EPA Guidelines • DO varies in **both longitudinal and vertical directions** (e.g., in estuaries or lakes) • Excel, MATLAB, Python for plotting DO curves. • EPA WASP or QUAL2K for more advanced simulations	**09**
4	Description of Water Quality Processes in Natural Water Bodies: Lake (stratified and completely mixed), Estuary, and Coastal Regions. **Self-Learning and Term Work** • QUAL2K or WASP • Excel or Python for simple DO/salinity modeling • NOAA Ocean Service, EPA Water Quality Models	**09**
5	**Groundwater Quality**: Material Balance Relationship, Basic differential equations with analytical solutions for the 1-D case. **Air quality modelling:** Gaussian plume model – for a point source. Gaussian dispersion coefficient, Downwind ground-level concentration computation, maximum ground-level concentration. Applications of AI and ML in Transport of Environmental Pollutants and Modelling.	**08**

	Self-Learning and Term Work • Excel, Python, MODFLOW • USEPA AERMOD documentation	

Note: Components in SL & TW shall be assessed in CIE Only.

Text Books:

- Schnoor J.L., (1997), "Environmental Modelling – Fate and Transport of Pollutants in Water, Air, and Soil", John Wiley and Sons.
- Thomann R.V., & Mueller M. J., (1987), "Principles of Water Quality Modelling and Control", Harper & Row Publishers.
- Metcalf & Eddy Inc, (2019), "Wastewater Engineering, Treatment and Reuse"- 3rd Edition, Tata Mc Graw Hill Publishers Co. Ltd, New Delhi.

Reference Books:

- Freeze R.A. and Cherry J.A., (1979), "Groundwater", Prentice Hall, New Jersey
- Weber W.J., (1972), "Physico - Chemical Processes for Water Quality", John Wiley & Sons,
- Fischer H. B., List E.J., Koh R.C.Y., Imberger J., Brooks N.H., (1979), "Mixing in Inland and Coastal Waters", Academic Press Inc.

Journals/Magazines:

- Journal articles on Sciencedirect.com, acs.org, springer link, and Taylor & Francis.

SWAYAM/NPTEL:

- Wastewater treatment and recycling
- Transport of pollutants in the environment.

Course Articulation:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	3	3	-	3	-	-	3	3	3
CO2	3	3	3	3	3	3	3	-	3	-	-	3	3	3
CO3	3	3	-	3	-	3	3	-	3	-	-	3	3	3
CO4	3	3	3	3	3	3	3	-	3	-	-	3	3	3
CO5	3	3	3	3	3	3	3	-	3	-	-	3	3	3

High – 3, Medium – 2, Low – 1

<table>
<tr><td colspan="7">Department: Environmental Engineering</td></tr>
<tr><td colspan="3">Course Code: 24EV651</td><td colspan="4">Course Title: Environmental Systems Optimization</td></tr>
<tr><td colspan="2">Total Credits: 3
L-45: T-0: P-0: SL and TW-45</td><td>SDGs addressed: 9, 11, 12, 15</td><td colspan="2">Course Category:
PEC -III</td><td colspan="2">Course Type: Theory</td></tr>
<tr><td rowspan="6">Teaching Learning Process</td><td></td><td>Total Contact Hours/semester</td><td colspan="4">Assessment Weightage and Marks</td></tr>
<tr><td>Lecture</td><td>45</td><td></td><td>CIE</td><td>SEE</td><td>Total</td></tr>
<tr><td>Tutorial</td><td>-</td><td>Weightage, %</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Practical</td><td>-</td><td>Maximum Marks</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Self-learning and Term Work</td><td>45</td><td rowspan="2">Minimum Marks</td><td rowspan="2">20</td><td rowspan="2">25</td><td rowspan="2">45*</td></tr>
<tr><td>Total</td><td>90</td></tr>
</table>

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

Course Pre-Requisite: Engineering Mathematics, Water Treatment and Supply Engineering, Municipal and Bio-Medical Waste Management

Course Objective: The student appreciates the knowledge gained on this course as it emphasizes the importance of optimization techniques, linear programming, numerical search methods and simulation as applied to environmental engineering problems.

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Describe the need for optimization studies and state, construct, and classify optimization problems with and without constraints	L3	2, 3, 4, 6, 8, 9
CO2	Explain single and multi-variable optimization techniques and state their applications to environmental engineering problems and graphical solutions	L3	2, 3, 4, 6, 7, 8, 9
CO3	Apply various techniques to solve linear programming problems	L3	2, 3, 5, 6, 7, 8
CO4	Apply transportation problem methods for solving linear programming problems with related applications to Wastewater Reuse and Solid Waste Management.	L3	2, 3, 4, 6, 7, 8, 9
CO5	Describe numerical search methods and apply simulation techniques for developmental activities	L3	1, 2, 3, 4, 6, 8, 9

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	Introduction: Definition and engineering applications of optimization. Optimization Problems – Statement, formulation, classification, and special cases. **Self-Learning and Term Work** • Formulation of single and multi variables equations	**06**
2	Classical Optimization Techniques: Graphical Solution Single variable optimization, Multivariable optimization with no constraints (Hessian matrix), with equality constraints (Lagrange multiplier) and with inequality constraints (Kuhn-tucker) - Statement of theorem without proof, Pivot operation for the solution of simultaneous equation, **Self-Learning and Term Work** ● Different types of matrices ● Solution of matrices	**13**
3	Linear programming: Simplex and Two-phase method, Big-M technique, Duality in Linear programming. Application of Linear Programming: Problems on Air Pollutant Transport, Water and Wastewater Treatment Problems. **Self-Learning and Term Work** • Understand the **Linear Programming formulation** • Pivot operation	**09**
4	Transportation Problem: Definition, Transportation array, Applications, Solution by Northwest Corner rule and Vogels Approximation methods, Applications to Wastewater Reuse and Solid Waste Management. **Self-Learning and Term Work** • Different types of collection systems of solid waste	**09**
5	Numerical Search Methods: Elimination Methods, Dichotomous Search, and Fibonacci methods. Simulation: Basic concepts, Development, Simulation process, Pre-simulation, and Developmental activities, Operational activities, Sensitivity analysis, and Parametric analysis. Applications of AI and ML in Environmental Systems Optimization. **Self-Learning and Term Work** • Basic concept of numerical analysis • Types of simulation	**08**

Note: Components in SL & TW shall be assessed in CIE Only.

Text Books:

- Rao. S. S., (1984), Optimization Techniques, Wiley.
- Rich L. G., (1973), Environmental Systems Engineering, McGraw Hill.

Reference Books:

- CPHEEO. Manual on Water Supply and Treatment.
- Jewell T. K., (1986), "A Systems Approach to Civil Engineering Planning and Design", Harper & Row, New York.
- Ravindran A., 2008, Operations Research Methodologies, CRC Press
- Taha, H. A. (1976), "Operations Research: An Introduction, 8th ed., Prentice Hall
- Novotny & Chesters, (1981), "Handbook of Non-point Pollution Sources and Management", Van Nostrand & Reinhold Publication

Journals/Magazines:

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

Web/Digital resources:

- **https://ir.library.louisville.edu/cgi/viewcontent.cgi?article=4059&context=etd**
  SWAYAM/NPTEL:
- **https://nptel.ac.in/courses/111105039**

Course Articulation:

Course Outcomes ↓	Program Outcomes											PROGRAM SPECIFIC OUTCOMES		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	2	-	-	-	-	-	-	3	2	3
CO2	3	2	3	2	2	-	-	-	-	-	-	3	2	3
CO3	3	3	2	3	3	-	-	-	-	-	-	3	2	3
CO4	3	3	3	2	3	-	-	-	-	-	-	3	2	3
CO5	3	3	3	2	3	-	-	-	-	-	-	3	2	3

High – 3, Medium – 2, Low – 1

Department: Environmental Engineering						
Course Code: 24EV652		*Course Title: Environmental Nanotechnology*				
Total Credits: 3 L-45: T-0: P-0: SL and TW-45		*SDGs addressed: 6,7,9,14,15*	*Course Category: PEC –III*		*Course Type: Theory*	
Teaching Learning Process		*Total Contact Hours/semester*	*Assessment Weightage and Marks*			
	Lecture	*45*		*CIE*	*SEE*	*Total*
	Tutorial	*-*	*Weightage, %*	*40*	*60*	*100*
	Practical	*-*	*Maximum Marks*	*40*	*60*	*100*
	Self-learning and Term Work	*45*	*Minimum Marks*	*20*	*25*	*45**
	Total	*90*				

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

Course Pre-Requisite: First-year Engineering Chemistry, Environmental Chemistry Theory and Laboratory, Engineering Physics, and Engineering Mechanics.

Course Objective: To understand the principles and applications of nanotechnology in Environmental protection and remediation

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Analyze the properties and behavior of nanomaterials in environmental systems.	**L2**	1,2
CO2	Design and evaluate nanotechnology-based solutions for environmental remediation and pollution control.	**L3**	2,3,5
CO3	Assess the properties and characterization methods for environmental implications and sustainability of nanotechnology applications.	**L3**	1,2,3
CO4	Apply nanotechnology principles to develop innovative solutions for environmental challenges.	**L3**	1,2,3,6
CO5	Critically evaluate the current state of knowledge and emerging trends in environmental nanotechnology.	**L3**	1,2,3,6,7,8,9

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

Course Syllabus:

UNIT No.	Content	Lecture Hours
1	**Introduction to Environmental Nanotechnology** - Definition and scope of environmental nanotechnology - Importance of nanotechnology in environmental protection - Nanomaterials and their properties - Applications of nanotechnology in environmental remediation - Case studies of successful environmental nanotechnology implementations. **Self-Learning and Term Work** • Regulatory frameworks and ethical considerations • **SWOT analysis:** Nanotech vs. traditional environmental technologies • **Lab simulation:** Virtual synthesis and characterization of nanomaterials	**06**
2	**Synthesis of Nanomaterials method** - Top-down approaches - lithography, etching - Bottom-up approaches chemical vapor deposition - sol-gel processing, Co-precipitation - Green synthesis methods - biological synthesis, hydrothermal synthesis. **Self-Learning and Term Work** • **Technique comparison:** Create a decision matrix for selecting synthesis methods based on application • **Poster session:** Showcase green synthesis pathways and their applications • **Eco-audit:** Compare environmental footprints of green vs. conventional methods	**13**
3	**Properties of Nanomaterials** - Physical properties of Nanomaterials: - Size and shape - Surface area and porosity - Crystal structure and phase - Optical properties - absorption, fluorescence, phosphorescence - Magnetic properties - magnetization, coercivity, remanence - Mechanical properties -strength, toughness, elasticity - Chemical properties of nanomaterials: - Composition and purity Characterization techniques for nanomaterials TEM, XRD, FTIR **Self-Learning and Term Work** • **Mini-presentation:** "Why shape matters in nanotech applications" • **Design challenge:** Create a porous nanomaterial for water purification • **Technique comparison:** Create a matrix of capabilities and limitations	**09**

4	**Nanotechnology for Water Treatment** - Overview of water pollution and the role of nanotechnology in water treatment - Nanomaterials for water treatment -nanoparticles, nanostructured membranes - Nanotechnology-based water treatment processes - nanofiltration, nano adsorption- Case studies of nanotechnology in water treatment - Design and operation of nanotechnology-based water treatment systems **Self-Learning and Term Work** • **Problem mapping:** Identify local water pollution sources and match them to nano-solutions • **Lab simulation:** Model pollutant removal using Langmuir and Freundlich isotherms • **Design criteria:** flow rate, residence time, pollutant load, energy consumption	**09**
5	**Environmental Implications and Sustainability of Nanotechnology** - Environmental implications of nanotechnology - toxicity, fate, and transport of nanomaterials. Sustainability considerations in environmental nanotechnology - life cycle assessment, green synthesis. -Future directions and challenges in environmental nanotechnology. Applications of AI and ML in Environmental Nanotechnology. **Self-Learning and Term Work** • **Risk mapping:** Identify potential exposure routes in a nano-enabled water treatment plant • **Comparative audit:** Evaluate two synthesis routes for environmental footprint • **Roadmap creation:** Design a strategic plan for responsible nanotech development	**08**

Note: Components in SL & TW shall be assessed in CIE Only.

Text Books:

- K. Sharma et.al., (2017) Environmental Nanotechnology
- S. K. Goyal et.al., (2019) Nanotechnology for Environmental Sustainability

Reference books

- Environmental Nanotechnology: 1st Edition By M. H. Fulekar, Bhawana Pathak
- Environmental Nanotechnology Volume 5: 37 (Environmental Chemistry for a Sustainable World) by Nandita Dasgupta, Shivendu Ranjan

Journal/magazines:

- Journal of Water and Environmental Nanotechnology
- International Journal of Applied Nanotechnology
- https://www.frontiersin.org/journals/nanotechnology/sections/environmental-nanotechnology

Web/Digital Resources:

- Environmental Protection Agency (EPA) - Nanotechnology
- National Nanotechnology Initiative (NNI) - Environmental Applications

Swayam NPTEL course:

- https://onlinecourses.swayam2.ac.in/cec24_cy03/preview

Course Articulation:

Course Outcomes ↓	Program Outcomes											PROGRAM SPECIFIC OUTCOMES		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	2	-	-	-	-	-	2	3	2	3
CO2	3	2	3	2	2	-	-	-	2	-	3	3	2	3
CO3	3	3	2	3	3	-	2	-	3	-	-	3	2	3
CO4	3	3	3	2	3	-	3	-	-	-	2	3	2	3
CO5	3	3	3	2	3	-	-	-	-	-	3	3	2	3

High – 3, Medium – 2, Low – 1

<table>
<tr><td colspan="7">Department: Environmental Engineering</td></tr>
<tr><td colspan="3">Course Code: 24EV653</td><td colspan="4">Course Title: Environmental Justice and Pollution Control</td></tr>
<tr><td colspan="2">Total Credits: 3
L-45: T-0: P-0: SL and TW-45</td><td>SDGs addressed: 6,7,9,11,12,13,14, 15,16</td><td colspan="2">Course Category: PEC- III</td><td colspan="2">Course Type: Theory</td></tr>
<tr><td rowspan="6">Teaching Learning Process</td><td></td><td>Total Contact Hours/semester</td><td colspan="4">Assessment Weightage and Marks</td></tr>
<tr><td>Lecture</td><td>45</td><td></td><td>CIE</td><td>SEE</td><td>Total</td></tr>
<tr><td>Tutorial</td><td>-</td><td>Weightage, %</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Practical</td><td>-</td><td>Maximum Marks</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Self-learning and Term Work</td><td>45</td><td rowspan="2">Minimum Marks</td><td rowspan="2">20</td><td rowspan="2">25</td><td rowspan="2">45*</td></tr>
<tr><td>Total</td><td>90</td></tr>
</table>

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

Course Pre-Requisite: Environmental Studies, Constitution of India

Course Objective: The course provides a strong base of the concepts and scope of environmental law and individuals. It imparts basic knowledge about the environment and its allied problems to influence people's access to a clean, safe, and productive environment.

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Understand the Indian Law system and individual duties and responsibilities	**L2**	1,4,,6,7,8,9
CO2	Describes the Environmental Protection Act and corporate responsibility in safeguarding and development of the environment	**L2**	1,4,5,6,7,8,9
CO3	Understand the powers of the authorities in the mitigation of pollution necessity of the protection of the Environment in the conservation of resources.	**L3**	1,4,5,6,7,8,9
CO4	To understand the recent national and international laws and amendments	**L3**	1,4,5,6,7,8,9
CO5	Awareness of the mitigation, protection, and preventive regulations of water and air attribute	**L3**	1,4,5,6,7,8,9

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Introduction**- Environmental justice, Jurisprudence, Indian Legal system. Precautionary Principle: Polluter Pays Principle; Public Trust Doctrine; Community rights. Right To Environment – A Basic Human Right: A Constitutional Law Perspective Concept and classifications of human rights and duties, Human rights and duties, Correlation of rights and duties/responsibilities, Environment, Resources and Human Rights. **Self-Learning and Term Work** • Professionals need to stay current on **laws, ethics, and global best practices**. • Use online tools: UN SDG portal, environmental law journals, webinars • **Collaborative research** for sustainable solutions (e.g., eco-design, green infrastructure) such as Joint forest management involving local communities and government, Public-private partnerships in sustainable energy, NGO + legal + community efforts in environmental justice.	**06**
2	**Environmental Protection Act**, Common Property Resources (CPRs), Environmental safeguards relating to Development -EIA, Clean Development Mechanism, Corporate Environmental Responsibility, and ISO. **Self-Learning and Term Work** • Joint environmental monitoring and auditing • Public consultations and participatory governance	**13**
3	**Environmental Principles of Governance:** Water Pollution and Control Laws, Air (Prevention and Control of Pollution) Act, 1981, Use of Forest Land for Non-Forest purposes; Forest Policies and Acts, The Biological Diversity Act, 2002—Protection of Wildlife - the Wildlife (Protection) Act Law Relating to Waste Management- Transboundary Act, Municipal Solid Wastes, E- Wastes, Biomedical Wastes, Plastic Waste Management, Role of various institutions like pollution Control Boards **Self-Learning and Term Work** • NGT website • Follow international news on **climate agreements** and environmental summits (COP meetings) • **Collaboration Involves:** • **Government departments** (MoEFCC, Forest Dept., CPCB	**09**
4	**Traditional, Common, and Criminal Law Remedies for Environmental Protection**- Common law, Law of Nuisance, Tort law, Laws relating to Trespass, Negligence, Indian penal code, Strict liability, liability Insurance Act, NGT.	**09**

	Self-Learning and Term Work • NGT website • **NGOs & conservationists** • **Government departments** (MoEFCC, Forest Dept., CPCB	
5	**Emerging trends in environmental law and policies**. – Water pollution and Control Laws – Surface and groundwater, Air Prevention and Control Act. **Self-Learning and Term Work** • Read landmark judgments (e.g., M.C. Mehta cases) • **Government departments** (MoEFCC, Forest Dept., CPCB) • **Local communities** (tribal rights, Joint Forest Management) • **NGOs & conservationists**	**08**

Note: Components in SL & TW shall be assessed in CIE Only.

Text Books:

- Shibani Ghosh (ed), Indian Environmental Law: Key Concepts and Principles (2019)
- Usha Tandon et al (ed), Biodiversity: Law, Policy, and Governance (2018).
- Geetanjoy Sahu, Environmental Jurisprudence and the Supreme Court: Litigation, Interpretation, Implementation (2014)

Reference Books:

- S C Shastri, Environmental Law**:** Eastern Book Company publications (2024).
- Geetanjoy Sahu, Environmental Jurisprudence and the Supreme Court: Litigation, Interpretation, Implementation (2014)
- International Environmental Law - Text, Cases and Materials, Malgosia Fitzmaurice, Professor of International Law, Queen Mary University of London, Meagan S. Wong, Lecturer, School of Law, University of Essex and Joseph Crampin, U.K, Elgar Publications. (2022)

SWAYAM/NPTEL:

- Sairam Bhat and M. K. Ramesh, National Law School of India University, "Constitution of India and Environmental Governance", https://onlinecourses.nptel.ac.in/noc20_lw02
- Bharti Kumar, National Law University, Delhi, "Environmental Law", https://onlinecourses.swayam2.ac.in/cec20_ge12

Web/Digital Resources:

- The Oxford Handbook of Environmental and Natural Resources Law in India - **https://doi.org/10.1093/oxfordhb/9780198884682.001.0001**

Course Articulation:

Course Outcomes↓	Program Outcomes											PROGRAM SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	-	3	3	3	3	3	3	3	3	3
CO4	3	3	-	3	-	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

High – 3, Medium – 2, Low – 1

<table>
<tr><td colspan="7">Department: Environmental Engineering</td></tr>
<tr><td colspan="2">Course Code: 24EV654</td><td colspan="5">Course Title: Disaster Management</td></tr>
<tr><td colspan="2">Total Credits: 3
L-45: T-0: P-0: SL and TW-45</td><td colspan="2">SDGs addressed: 3, 9, 11, 13</td><td colspan="2">Course Category:PEC- III</td><td>Course Type: Theory</td></tr>
<tr><td rowspan="6">Teaching Learning Process</td><td></td><td>Total Contact Hours/semester</td><td colspan="5">Assessment Weightage and Marks</td></tr>
<tr><td>Lecture</td><td>45</td><td></td><td>CIE</td><td>SEE</td><td>Total</td></tr>
<tr><td>Tutorial</td><td>-</td><td>Weightage, %</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Practical</td><td>-</td><td>Maximum Marks</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Self-learning and Term Work</td><td>45</td><td rowspan="2">Minimum Marks</td><td rowspan="2">20</td><td rowspan="2">25</td><td rowspan="2">45*</td></tr>
<tr><td>Total</td><td>90</td></tr>
</table>

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

Course Pre-Requisite: Environmental Studies

Course Objective: The course provides a basic conceptual understanding of disasters, their types, impacts, and vulnerability assessment for disaster management. Emergency response, preparedness, and mitigative measures stressing the role of modern engineering and information technology. The course also supplements details on the legal framework with recent case studies.

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Able to state and classify various disaster types and identify their cause-effect relationships.	L2	1, 5
CO2	Apply knowledge of 'vulnerability assessment' and identify mitigation measures, early warning, forecasting systems, and response plans	L3	4, 5
CO3	Comprehend knowledge for disaster preparedness measures and use of modern technologies in disaster management.	L5	4, 7
CO4	Understand the role of various organizations in the effective management of disaster.	L5	6, 7
CO5	Analyze various case studies on natural and man-made disasters with initiatives for managing and understanding the policies and legislation of disaster management.	L4	8

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

Course syllabus

Unit No.	Content	Lecture Hours
1	Introduction to Hazard, Risk, Vulnerability and Disaster, types of disasters: Natural and man-made disasters, general causes and effects. Natural disasters - Drought, Floods, Earthquakes, Volcanoes, Landslides, Cyclones, Tsunami, forest fires and Heat waves. Man-made - Air accidents, Rail and Road accidents, Industrial accidents, Chemical and Biological attacks, War and terrorism, accidental oil spills on land and water. Nuclear and Space Debris. **Self-Learning and Term Work** • Case study review on all types of disasters • Disaster dairy - summarizing and reviewing disaster related articles, journals. • Take quiz on disaster and types	**06**
2	Identification, assessment of Risk and Vulnerability, types of Vulnerability, and Strategic Development for vulnerability reduction. Disaster Management Cycle, Scope and Need of DM. Impact of disaster on development. Disaster Prevention and Mitigation: Earthquake, Cyclone, Landslide, flood and rail, road and air accidents, industrial disasters. Disaster prediction, forecasting, and early warning systems. **Self-Learning and Term Work** • List activities in disaster management cycle for local disasters • Conduct basic Vulnerability Assessment of your surrounding • Explore GDACS website and report on recent global disaster alert	**13**
3	Pre-disaster planning for earthquakes, cyclones, epidemic outbreaks, drought, flood, famine, forest fire, and industrial accidents. Disaster-resistant constructions. Rehabilitation, reconstruction, and recovery. Building by-laws and adaptation. Environmental Management Plans (on-site and off-site) and Disaster Management Plans (DMP). GIS and Remote sensing for Disaster Management. Information Technology (IT) and Unmanned aerial vehicles in disaster management. **Self-Learning and Term Work** • Hands on experience of GIS/Arc GIS/QGIS softwares • Study and understand local building byelaws • Review local disaster management plan (DMP)	**09**
4	Role of Different Organizations / Institutions: Role of Information, Education, Communication (IEC) and Training; Role of Government, International and NGO's, Geographers/managers on Disaster Management. Resource management, Emergency response plan (ERP). Community-based disaster risk reduction plan. Capacity building programs and major requirements for coping with disaster. GDAC	**09**

	Self-Learning and Term Work • Create awareness on disasters and its impact in your local area. • Visit and list activities of local NGO's in disaster management • Prepare ERP for your institution	
5	Disaster Legislation in India: National Policy on Disaster Management, Disaster Management Act and Code. Case studies: Bhopal gas tragedy, Meuse Valley, Chornobyl, Fukushima, Tsunami, Forest fires, Wayanad landslide, COVID-19, and recent episodes. Applications of AI and ML in Disaster Management. **Self-Learning and Term Work** • Report preparation on recent local disasters • Understand the local Rules Law for disaster management • Quiz, group discussion, field visit	**08**

Note: Components in SL & TW shall be assessed in CIE Only.

Text books

- Peter R. J. Trim, "An Integrative Approach to Disaster Management and Planning", Emerald Group Publishing Ltd., 2004.
- Ramesh R. Rao, Jon Eisenberg, and Ted Schmitt, Editors, Committee on Using Information Technology to Enhance Disaster Management, National Research Council "Improving Disaster Management: The Role of IT in Mitigation, Preparedness, Response, and Recovery", The National Academies Press, Washington D. C.

References

- Committee on Disaster Research in the Social Sciences: Future Challenges and Opportunities, "Facing Hazards and Disasters- Understanding Human Dimensions" Division on Earth and Life Studies, The National Academies Press, Washington, D. C. 2006.
- Committee on the Effective Use of Data, Methodologies, and Technologies to Estimate Sub-National Populations at Risk, National Research Council, "Tools and Methods for Estimating Populations at Risk from Natural Disasters and Complex Humanitarian Crises", The National Academies Press, Washington, D. C. 2007.
- Committee on Planning for Catastrophe. "A Blueprint for Improving Geospatial Data, Tools, and Infrastructure, National Research Council, "Successful Response Starts with a Map: Improving Geospatial Support for Disaster Management", The National Academies Press, Washington, D. C. 2007.
- Patricia Jones Kershaw and Byron Mason. "The Indian Ocean Tsunami Disaster: Implications for U.S. and Global Disaster Reduction and Preparedness - Summary ", The National Academies Press, Washington, D. C. 2005.
- UNEP Report. "Environmental Management and Disaster Preparedness" Lessons Learnt from the Tokyo Typhoon (Typhoon 23 of 2004) in Japan. 2005.
- UNEP Report, "Environmental Management and Disaster Preparedness" Building a multi-stakeholder partnership.

Journal/Magazines

- NIDM Disaster and Development Journal

- Down To Earth magazine

Web/Digital resources

- https://nidm.gov.in/
- https://ndma.gov.in/
- https://ksdma.karnataka.gov.in/english
- https://www.mha.gov.in/division_of_mha/disaster-management-division

SWAYAM/NPTEL

- Disaster Recovery and Build Back Better from IIT Roorkee
- Natural Hazards- Part 1 from IIT Kanpur
- Disaster Management from University of Hyderabad

Course Articulation:

COURSE OUTCOMES↓	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	3	-	-	-	3	3	3	3
CO2	3	3	3	3	-	3	3	-	3	3	3	3	-	3
CO3	3	3	3	3	3	3	3	-	3	3	3	-	3	-
CO4	3	3	3	-	3	3	3	1	-	-	3	3	-	-
CO5	3	3	-	-	-	-	3	-	-	-	3	3	-	3

High – 3, Medium – 2, Low – 1

<table>
<tr><td colspan="7">Department: Environmental Engineering</td></tr>
<tr><td colspan="3">Course Code: 24EV661</td><td colspan="4">Course Title: Global Warming and Climate Change</td></tr>
<tr><td colspan="2">Total Credits: 3
L-45: T-0: P-0: SL and TW-45</td><td>SDGs addressed: 7,11,13,14,15</td><td colspan="2">Course Category: PEC-IV</td><td colspan="2">Course Type: Theory</td></tr>
<tr><td rowspan="6">Teaching Learning Process</td><td></td><td>Total Contact Hours/semester</td><td colspan="4">Assessment Weightage and Marks</td></tr>
<tr><td>Lecture</td><td>45</td><td></td><td>CIE</td><td>SEE</td><td>Total</td></tr>
<tr><td>Tutorial</td><td>-</td><td>Weightage, %</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Practical</td><td>-</td><td>Maximum Marks</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Self-learning and Term Work</td><td>45</td><td rowspan="2">Minimum Marks</td><td rowspan="2">20</td><td rowspan="2">25</td><td rowspan="2">45*</td></tr>
<tr><td>Total</td><td>90</td></tr>
</table>

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

Course Pre-Requisite: Environmental Studies.

Course Objective: The course emphasizes the history of the earth's climate, 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 knowledge of climate change mitigative measures, emission trading and monitoring

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Reviewing Earth's climate change identifying the causes for climate change. Introduces the climate change models and their application.	L2	1, 2
CO2	Describe the impacts of climate change on various environmental compartments. Stresses the need for vulnerability assessment and its approach.	L3	1, 3
CO3	Explain the Indian scenario of climate change and its impact. Reviews various impact predictive models.	L5	6,8
CO4	Describe emission trading and the consequences of emission trading.	L5	4, 8
CO5	Highlight the need for monitoring and enforcing agencies, and their role and responsibilities in mitigating climate change	L4	6, 7

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

Course syllabus:

Unit No.	Content	Lecture 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** ● Climate change and positive feedback loop ● Consequences of climate change ● Climate driven disasters and tipping points, thresholds	**08**
2	**Climate change impacts**: Impacts of climate change on the 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** ● Small Island Countries and Climate refugees ● Vulnerability Index ● Assessing vulnerability using IPCC framework	**12**
3	**Mitigation**: Mitigation measures for climate change, CDM and case studies Climate change and India, impacts, sectoral and regional vulnerability in India, Evaluation of model simulation over India. **Self-Learning and Term Work** ● Climate change adaptation strategies for water sector ● Climate change adaptation strategies for Public Health ● Sustainable agriculture	**09**
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, and consequences of emission trading. **Self-Learning and Term Work** ● Carbon capture and storage ● Cost of climate Inaction ● Stern report	**09**
5	**Monitoring and enforcement**: Domestic enforcement process, nature of international enforcement process, economic enforcement, current enforcement self, program Effectiveness, global responsibilities for controlling climatic change. Applications of AI and ML in Global Warming and Climate Change.	**07**

	Self-Learning and Term Work • Paris agreement • Sustainable development goals • National Action Plan on Climate Change (India)	

Note: Components in SL & TW shall be assessed in CIE Only.

Text Books:

- Shukla, P. R., et al. (2004), "Climate Change and India: Vulnerability Assignment and Adaption "– University Press.
- Konrad Soyez, and Hartmut Grabl, (2008), "Basic Facts, Evaluation and Technological Options"-Springer Publications

Reference Books:

- Climate Change: Impacts, Vulnerabilities and Adaptation in Developing Countries UNFCC 2007. https://unfccc.int/resource/docs/publications/impacts.pdf
- Climate Change: Evidence and Choices -The National Academy of Sciences; The Royal Society National Academies Press http://www.nap.edu/catalog.php?record_id=18730
- IPCC Reports to date

Journal/Magazines

Research articles in Scopus and Web of Science database are highly recommended for knowledge enhancement

Swayam/NPTEL

- An Introduction to Climate Dynamics, Variability and Monitoring - By Prof. Sayak Banerjee | IIT Hyderabadhttps://onlinecourses.nptel.ac.in/noc24_ce100/preview
- Introduction to Climate Change-By Dr. V. Venkat Ramanan | Indira Gandhi National Open University (IGNOU), New Delhi https://onlinecourses.swayam2.ac.in/nou21_ge37/preview
- Climate change (Lecture 40) https://www.youtube.com/watch?v=zQi3C_eZkLs

Course Articulation:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	3	3	-	-	-	-	1	-	-
CO2	3	3	3	-	-	3	3	-	-	-	-	2	2	-
CO3	3	-	-	3	-		3	-	-	-	3	2	2	-
CO4	3	-	-	-	-	3	-	-	-	-	3	2	-	2
CO5	3	3	3	-	-	-	3	-	-	-	-	2	-	2

High – 3, Medium – 2, Low – 1

Department: Environmental Engineering						
Course Code: 24EV662		***Course Title: Advanced Wastewater Treatment Technologies***				
Total Credits: 3 L-45: T-0: P-0: SL and TW-45		***SDGs addressed: 3, 6, 9, 12***	***Course Category: PEC-IV***		***Course Type: Theory***	
Teaching Learning Process		***Total Contact Hours/semester***	***Assessment Weightage and Marks***			
	Lecture	***45***		**CIE**	**SEE**	**Total**
	Tutorial	***-***	***Weightage, %***	***40***	***60***	***100***
	Practical	***-***	***Maximum Marks***	***40***	***60***	***100***
	Self-learning and Term Work	***45***	***Minimum Marks***	***20***	***25***	***45****
	Total	***90***				

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

Course Pre-Requisite: Wastewater Treatment Engineering

Course Objective: The course covers in depth the advanced and hybrid wastewater treatment systems for the removal of nutrients, toxic organics, inorganic and trace contaminants, as well as sludge handling and disposal practices. It allows the student to understand design criteria and design the various advanced wastewater treatment processes.

COURSE OUTCOMES (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Acquire knowledge of residual pollutants in the effluent of conventionally treated wastewater and their removal by various advanced processes.	**L2**	1,2,3
CO2	Describe different combinations of hybrid reactor systems and design them for a given situation.	**L2**	3,4,6,9
CO3	Apply the knowledge of nutrient removal using advanced wastewater treatment process design.	**L3**	3,4,7,8,9
CO4	Familiarize with the handling and disposal methods of both biological and chemical sludge from wastewater treatment facilities and comprehend the knowledge of recent advanced technologies. Apply design principles in designing the facilities.	**L2**	3,7,8,9
CO5	Discuss the need for the application of environmental biotechnology for wastewater treatment. Differentiate in-situ and ex-situ bioremediation processes. Design Membrane bioreactors using design principles. Review the option of using wastewater for other purposes.	**L3**	3,7,8,9

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Advanced Wastewater Treatment Systems:** Residuals in treated wastewater and their removal**,** Gas Stripping, DAF, Advanced Oxidation, Electro dialysis, Ion Exchange and Adsorption, Micro and Ultra Filtration **Self-Learning and Term Work** • Practical Relevance • Case study analysis • Mini project	**06**
2	**Hybrid Wastewater Treatment Systems:** Need for upgrading treatment plants, Possible Combinations of Physicochemical and Biological Processes. Electrochemical coagulation, UASB and Anaerobic filters, multistage anaerobic filters. **Self-Learning and Term Work** • Comparative analysis • Design/problem solving activity • Experimental /model work	**13**
3	**Nutrients' Removal from Wastewaters:** Nitrification and denitrification, physicochemical and biological phosphorus removal, SBR. **Self-Learning and Term Work** • Comparative learning • Group seminars/presentation • Experimental learning/demonstration	**09**
4	**Sludge:** Chemical Sludge – Sources and generation, types, characterization, recovery of metals, and alternate uses **Biological sludge** – Sources and generation, characterization, utilization possibilities – compost **Self-Learning and Term Work** • Characterization of sludge • poster/infographic • Experimental/model work	**09**
5	**Recent Trends** Environmental Biotechnology - genetically engineered microorganisms for wastewater treatment, bioremediation, biosensors, membrane bioreactors (MBR), and power generation from wastewater. Applications of AI and ML in Advanced Wastewater Treatment Technologies.	**08**

	Self-Learning and Term Work • Fundamental of environmental biotechnology • design/problem solving task • debate/discussion	

Note: Components in SL & TW shall be assessed in CIE Only.

Text Books:

- Metcalf & Eddy Inc, (2003), "Wastewater Engineering, Treatment and reuse"- 4th Edition, Tata McGraw Hill Publishers Co. Ltd, New Delhi
- Karia, G.L., and Christian, R.A., (2006) "Wastewater Treatment: Concepts And Design Approach"– Prentice – Hall of India

Reference Books:

- Syed R. Qasim, (1999), "Wastewater treatment plants: planning, design, and operation" - 2nd edition, CRC Press LLC
- Moo-Young M., Anderson W.A., Chakrabarty A.M., (2007), "Environmental Biotechnology – Principles and Applications," Kluwer Academic Publishers.

Journals/Magazines:

Journal articles in reputed journals indexed by 'Scopus' and 'Web of Science'

Web/Digital resources:

- Relevant educational videos on YouTube
- https://www.wef.org/resources/publications/books/wastewater-treatment-fundamentals/

SWAYAM/NPTEL:

- Treatment and Recycling, by Prof M K, Tiwari, IITKharagpur,
- Wastewater Treatment and Recycling, Prof. Manoj Kumar Tiwari, IIT Kharagpur, https://nptel.ac.in/courses/105105178
- Physico-chemical Processes for wastewater Treatment, by V C Srivastava, IIT Roorkee, https://archive.nptel.ac.in/courses/103/107/103107212/

Course Articulation:

COURSE OUTCOMES↓	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	-	-	1	-	-	-	-	-	-	3	3	3
CO2	3	3	-	-	-	-	2	-	-	-	-	3	3	3
CO3	3	3	2	-	-	2	2	-	-	-	-	3	3	3
CO4	3	3	2	-	-	2	2	-	-	-	-	3	3	3
CO5	3	3	2	-	1	2	-	-	-	-	-	3	3	3

High – 3, Medium – 2, Low – 1

Department: Environmental Engineering						
Course Code: 24EV663		***Course Title: Environmental Economics***				
Total Credits: 3 L-45: T-0: P-0: SL and TW-45		***SDGs addressed: 6,8,9,11,12,13,15***	***Course Category: PEC-IV***		***Course Type: Theory***	
Teaching Learning Process		***Total Contact Hours/semester***	***Assessment Weightage and Marks***			
	Lecture	***45***		**CIE**	**SEE**	**Total**
	Tutorial	***-***	***Weightage, %***	***40***	***60***	***100***
	Practical	***-***	***Maximum Marks***	***40***	***60***	***100***
	Self-learning and Term Work	***45***	***Minimum Marks***	***20***	***25***	***45****
	Total	***90***				

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

Course Pre-Requisite: NIL

Course Objective: The course enables students to maintain a balance between economic development and environmental quality to achieve environmental balance. Environmental economists explore the various socio-economic possibilities to reduce pollution and controversial issues related to the environment and their sustainable management to uplift the standard of living.

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Explain the economic impacts of environmental projects.	L2	2
CO2	Analyze the Cost-Benefit analysis for environmental projects.	L4	4
CO3	Examine the economics of waste management and recycling.	L4	4
CO4	Understand the influence of industrial and economic policies on pollution control.	L2	2
CO5	Identify the need for Environmental evaluations & apply the various techniques.	L4	4

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

Course Syllabus:

Unit No.	Content	Hours Lecture
1	**The Economic Approach:** Introduction -The Human–Environment Relationship Environmental Problems and Economic Efficiency- Property Rights- Externalities as a Source of Market Failure- An Efficient Role for Government. Ethics, Economics, and The Environment: Introduction- Naturalist moral philosophies Libertarian moral philosophy- Utilitarianism- Criticisms of utilitarianism- Inter temporal distribution. **Self-Learning and Term Work** • **Case Study Review** – Case studies on how externalities and property rights influence environmental decision-making (e.g., pollution control, deforestation, or river water sharing). • **Group Discussion/Debate** – Debate on ethical perspectives such as utilitarianism vs. libertarian philosophy in addressing environmental problems. • **Collaborative Assignment** – Preparing a short report in teams, analyzing how government policies (like carbon tax or subsidies) address market failures due to environmental externalities.	**06**
2	**Evaluating Trade-Offs: Benefit-Cost Analysis:** Normative Criteria for Decision Making Evaluating Predefined Options: Benefit-Cost Analysis- Finding the Optimal Outcome Relating Optimality to Efficiency- Applying the Concepts- Valuation of environment. **Self-Learning and Term Work** • Case Study Analysis – Evaluate a real environmental project (e.g., metro rail, hydroelectric dam, or solid waste management system) through cost–benefit analysis. • Group Exercise – Identify and compare valuation methods for environmental resources (market price method, replacement cost, travel cost, etc.) and present findings. • Team Presentation – Work in groups to illustrate trade-offs between economic growth and environmental sustainability using a decision-making framework.	**13**
3	**Recyclable Resources:** An Efficient Allocation of Recyclable Resources- Factors Mitigating Resource Scarcity- Market Imperfections- Disposal Cost and Efficiency. The Disposal Decision- Corrective Public Policies **Self-Learning and Term Work** • **Case Study Review** – Analyze successful municipal or industrial recycling programs (e.g., plastic, e-waste, or paper recycling) and discuss their economic efficiency. • **Group Assignment** – Evaluate disposal decisions for different types of waste (hazardous, biodegradable, recyclable) and suggest corrective policies. • **Team Activity** – Develop a comparative chart on market imperfections affecting recycling efficiency and propose measures to ontrol	**09**

4	**Economics Of Pollution Control: Introduction**- A Pollutant Taxonomy - Defining the Efficient Allocation of Pollution- Stock Pollutants- Fund Pollutants- Market Allocation of Pollution-Efficient Policy Responses- Cost-Effective Policies for Uniformly Mixed Fund Pollutants -Defining a Cost-Effective Allocation- Cost-Effective Pollution-Control Policies -Cost-Effective Policies for Non-uniformly Mixed Surface Pollutants- The Single-Receptor Case- The Many-Receptors Case- Other Policy Dimensions- The Revenue Effect- Responses to Changes in the Regulatory Environment- Price Volatility- Instrument Choice under Uncertainty- Product Charges: An Indirect Form of Environmental Taxation **Self-Learning and Term Work** • Case Study Exploration – Study and present examples of pollution-control instruments such as carbon tax, emission trading, or product charges, highlighting their effectiveness. • Group Discussion – Debate the advantages and limitations of market-based vs. command-and-control approaches in achieving pollution reduction. • Collaborative Exercise – Prepare a comparative analysis of stock pollutants and fund pollutants, suggesting cost-effective policy responses for each.	**09**
5	**Need for environmental valuations**: Methods of economic valuation of the environment (concepts) - methods based on market prices in productivity technique, change in income technique, replacement technique, preventive technique, relocation technique. Surrogate method-travel cost and hedonic, simulated method or survey method-contingent valuation method. Limitation of environmental valuation. Applications of AI and ML in Environmental Economics. **Self-Learning and Term Work** • Case Study/Survey – Conduct a small survey or secondary data analysis using contingent valuation or travel cost method for a local environmental resource (e.g., park, lake, or forest). • Group Assignment – Compare different valuation techniques (productivity, replacement, preventive, hedonic pricing) and identify their strengths and limitations. • Team Presentation – Prepare a report on how environmental valuation supports policy decisions in projects like water resource management, biodiversity conservation, or infrastructure planning.	**08**

Note: Components in SL & TW shall be assessed in CIE Only.

Text Books:

- Dixon J., Economic Analysis of Environmental Impacts, Earthscan Publications, 1994
- Tietenberg Tom and Lyne Lewis, Environmental Economics and Policy, Pearson Higher Education, 2009
- Tietenberg Tom and Lyne Lewis, Environment and Natural Resources Economics, Prentice Hall, 2011

Reference Books:

- Principles Of Environmental Economics, ecology, and public policy - Ahmed M.Hussen
- Turner R.K., Pearce D., and Batman I, Environmental Economics, The Johns Hopkins University Press, 1993
- Winpeny J T, Values for the Environment: A Guide to Economic Approach – Overseas Development Institute, London, HMOS, 1991.
- John D, Scura L F, Carpenter R A and Sherman P B Economic Analysis of Environmental Impacts -, Earthscan Publications Ltd., London 1995.

Journals/Magazines:

- Journal articles on Sciencedirect.com, acs.org, springer link and Taylor & Francis.
- Journal of Development Economics
- Journal of Environmental Planning and Management.
- Journal of Environmental Economics and Policy.
- Journal of Environmental Economics and Management.

Web/Digital resources:

- Lecture-Notes-part_One-10-3.pdf (sfu.ca)
- 84cb78a7213448a (msuniv.ac.in)
- Environmental & Natural Resource Economics (2-downloads) (bu.edu.eg)

SWAYAM/NPTEL:

- Environmental Economics by Prof. Ravindra Kumar B, DOS in Economics and Research Tumkur University.
- Introduction to Environmental Economics by Prof. Diptimayee Nayak, Prof. S.P. Singh, IIT Roorkee.

Course Articulation:

Course Outcomes↓	**Program Outcomes**											**PROGRAM SPECIFIC OUTCOMES**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	1	-	2	3	2	1	1	-	3	2	1
CO2	3	3	3	2	2	2	3	2	1	1	-	3	3	2
CO3	3	3	3	2	2	3	3	2	2	1	-	3	3	2
CO4	2	2	2	2	1	2	3	2	2	1	-	2	2	1
CO5	3	3	3	2	2	2	3	2	2	1	-	3	3	2

High – 3, Medium – 2, Low – 1

Department: Environmental Engineering						
***Course Code:* 24EV664**		***Course Title: Occupational Safety and Health***				
Total Credits: 3 ***L-45: T-0: P-0: SL and TW-45***		***SDGs addressed: 3, 8, 9, 11, 12, 13, 16 & 17***	***Course Category: PEC-IV***		***Course Type: Theory***	
Teaching Learning Process		***Total Contact Hours/semester***	***Assessment Weightage and Marks***			
	Lecture	***45***		**CIE**	**SEE**	**Total**
	Tutorial	***-***	***Weightage, %***	***40***	***60***	***100***
	Practical	***-***	***Maximum Marks***	***40***	***60***	***100***
	Self-learning and Term Work	***45***	***Minimum Marks***	***20***	***25***	***45****
	Total	***90***				

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

Course Pre-Requisite: Elements of Environmental Engineering – Sources and Characterization

Course Objective: This course enables students to learn the basic principles of safety, the OSH act, and national policy. It stills knowledge on cause-effect relationships of accidents at workplaces, the need for economics & ergonomics, hazard identification and control aspects, and fire prevention and control. Workplace health-related issues are also covered.

COURSE OUTCOMES (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Explain the safety principles, right-to-know laws, accident causation, and its theories at the workplace.	L2	**1, 3 & 5**
CO2	Design the ergonomics concepts to address specific problems with appropriate strategies.	L3	**4, 6 & 7**
CO3	Identify hazards, and various techniques and prepare preventive plans for various hazardous industries with remedial measures and worker compensation.	L3	**5, 6, & 7**
CO4	Illustrate product safety by acquiring knowledge on various aspects of fire types with prevention and protection.	L2	**4, 6, 7 & 8**
CO5	Illustrate the Health and Safety Considerations at different workplaces considering the ISO series of standards and Corporate Social Responsibility	L2	**7, 8 & 9**

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Introduction:** History and development, Occupational Safety and health act, Occupational Safety, and Health Administration, right-to-know laws, principles of safety and safety triangle, introduction to Factories Act 1948. Key elements and review of health and safety policies. **Accident:** causation, Accident Investigation – types, the process of investigations and reporting. Theories of Accidents: Domino, human factor, System theory, Behavioral theory, Depression, Obesity, and accident causation. **Self-Learning and Term Work** • Read sample accident investigation reports. • Review sections relevant to worker health, safety, and welfare. • Groups debate: *Are current safety policies sufficient?*	**09**
2	**Ergonomics**: Definition, factors associated with physical stress, worksite analysis program, hazard prevention and control. Specific ergonomic problems and problem-solving strategies, economics of ergonomics, visual ergonomics. **Self-Learning and Term Work** • Study how reducing ergonomic hazards lowers absenteeism, compensation costs, and improves productivity. • One plays a worker reporting discomfort, another acts as an ergonomist recommending solutions. • Groups debate: *Is investment in ergonomic workplace design worth the cost?*	**09**
3	**Occupational Hazard and Compensation:** Hazard identification, hazard analysis, human error analysis in causation with hazard analysis, fault tree analysis, and problems. Emergency response, decision for action, purpose, and considerations. Worker compensation-Legislation, Insurance, and cost-reduction strategies. Material Safety Data Sheets (MSDS) **Self-Learning and Term Work** • Study legislations related to worker safety (Factories Act, Employee Compensation Act). • Groups analyze real accident compensation cases. • Teams design a cost-effective safety program (training, PPE, awareness posters).	**09**

4	**Fire Prevention and Protection:** Fire development and its severity, the effect of enclosure, the need for early detection of fire, extinguishing fire, Fire risk assessment, and fire emergency plan. Fire safety programs. Electrical Safety, Product Safety – Technical Requirements of Product safety. Electrical safety program, Product Safety, and Liability – Product liability law, Developing and Evaluating the product safety program, Quality management, and record keeping. **Self-Learning and Term Work** • Learn basics of quality management systems (ISO standards). • One team acts as manufacturer, another as consumer, third as safety auditors. • Teams design a **safety checklist** for a new product (e.g., small household appliance).	**09**
5	**Occupational Health:** Health and safety considerations, personal protective equipment, effects of exposure and treatment for metal working trades, municipal solid waste, epoxy resins, and foundries. Recent Trends: Concept and Significance of ISO standards and internal auditing. ISO 14000 series, ISO 45000. Corporate social responsibility and its rating, Introduction to BBS. Impact of Automation on the workplace, Human-robot interaction, total safety management. International guidelines for OSHA. Applications of AI and ML in Occupational Safety and Health. **Self-Learning and Term Work** • Study **International OSHA guidelines** and their adaptation in India/global industries. • One team acts as auditors, another as company managers; simulate an ISO 45001 audit. • Divide into groups (India, US, EU, Japan). Each presents differences in OSHA/international guidelines.	**09**

Note: Components in SL & TW shall be assessed in CIE Only.

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.

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.

Journals/Magazines:

- Safety: Safety + Health Magazine (safetyandhealthmagazine.com)
- Occupational Health & Safety Magazine Digital Edition -- Occupational Health & Safety (ohsonline.com)
- Industrial Health & Safety Review | Fire Industry Magazine | Safety Magazine India | Security Magazine India | Life Safety Magazine | Occupational Health Safety Magazine (isrmag.com)
- Journal articles on Sciencedirect.com, acs.org, springer link, and Taylor & Francis.

Web/Digital resources:

- Microsoft Word - lecnote_fm_template.doc (cartercenter.org)
- I (pria-academy.org)
- 7278484 (osti.gov)

SWAYAM/NPTEL:

- Safety and Risk Analytics by Prof. Jhareswar Maiti, IIT Kharagpur.
- Safety in Construction by Prof. J. Uma Maheswari, IIT Delhi
- Introduction to Human Factors and Ergonomics by Vivek Kant, Ph.D., IIT Bombay

Course Articulation:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1	3	-	2	2	3	1	2	2	3	3	2
CO2	3	1	3	2	3	-	-	2	3	-	2	3	3	1
CO3	3	3	2	-	2	3	3	1	-	3	3	3	3	3
CO4	2	3	1	3	3	1	-	-	2	2	2	1	3	-
CO5	3	-	3	-	3	3	3	3	1	1	-	1	2	3

High – 3, Medium – 2, Low – 1

Department: Environmental Engineering						
Course Code: 24EV671OE		***Course Title: Environmental Health and Safety***				
Total Credits: 3 L-45: T-0: P-0: SL and TW-45		***SDGs addressed:3, 8, 9, 11, 12, 13, 16 & 17***	***Course Category: OEC -III***		***Course Type: Theory***	
Teaching Learning Process		***Total Contact Hours/semester***	***Assessment Weightage and Marks***			
	Lecture	***45***		**CIE**	**SEE**	**Total**
	Tutorial	***-***	***Weightage, %***	***40***	***60***	***100***
	Practical	***-***	***Maximum Marks***	***40***	***60***	***100***
	Self-learning and Term Work	***45***	***Minimum Marks***	***20***	***25***	***45****
	Total	***90***				

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

Course Pre-Requisite: Environmental Studies

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)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Define and explain the concept of environmental health and safety and its importance in the workplace.	**L2**	**1, 3 & 5**
CO2	Identify and assess environmental hazards and develop strategies for risk management and control.	**L2**	**4, 6 & 7**
CO3	Recognize and mitigate occupational health hazards and develop strategies for prevention and control.	**L2**	**5, 6, & 7**
CO4	Design and implement effective safety management systems that meet regulatory requirements and industry standards.	**L3**	**4, 6, 7 & 8**
CO5	Develop and implement environmental sustainability initiatives that meet regulatory requirements and support business continuity.	**L2**	**7, 8 & 9**

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Introduction to Environmental Health and Safety** - Definition and scope of environmental health and safety - Importance of environmental health and safety in the workplace - Key regulations and standards - OSHA, EPA - Role of environmental health and safety professionals - History of environmental health and safety - International perspectives on environmental health and safety - International standards and best practices **Self-Learning and Term Work** • Case study • Quiz on Key regulations and standards • Poster/safety symbols	**09**
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 and Term Work** • Case study on specific industries • Quiz • Poster related to PPE's	**09**
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 and Term Work** • Case study • Quiz • Poster related to PPE's	**09**
4	**Safety Management Systems** - Key components of safety management systems (e.g. policy, procedures, training) - Implementing and maintaining safety management systems - Auditing and evaluating safety management systems - Case studies of effective safety management systems - Safety culture and leadership - Safety management systems in small and medium-sized enterprises - Safety management systems in high-risk industries. **Self-Learning and Term Work** • Case study • Quiz • Poster's	**09**

5	**Environmental Sustainability and Compliance** - Environmental sustainability principles and practices - Compliance with environmental regulations (e.g. waste management, emissions) - Environmental auditing and reporting - Case studies of environmental sustainability initiatives in the workplace - Climate change and business continuity planning - Environmental sustainability in the supply chain - Environmental sustainability reporting. Applications of AI and ML in Environment Health and Safety. **Self-Learning and Term Work** • Case study • Quiz • Poster's	**09**

Note: Components in SL & TW shall be assessed in CIE Only.

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.

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.

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:

Course Outcomes↓	Program Outcomes											PSO's		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	2	1	1	2	2	2	2	2	2
CO2	3	2	1	2	2	1	1	1	3	2	2	2	3	2
CO3	3	3	2	3	2	1	1	1	3	2	3	2	2	3
CO4	1	1	1	1	2	2	1	3	3	3	2	2	3	2
CO5	3	2	2	3	2	3	2	3	2	3	3	2	2	2

High – 3, Medium– 2, Low– 1

Department: Environmental Engineering						
Course Code:24EV672OE		***Course Title: Environmental Social Governance***				
Total Credits: 3 L-45: T-0: P-0: SL and TW-45		***SDGs addressed: 6,7,12,13,16***	***Course Category: OEC-III***		***Course Type: Theory***	
Teaching Learning Process		***Total Contact Hours/semester***	***Assessment Weightage and Marks***			
	Lecture	***45***		**CIE**	**SEE**	**Total**
	Tutorial	***-***	***Weightage, %***	***40***	***60***	***100***
	Practical	***-***	***Maximum Marks***	***40***	***60***	***100***
	Self-learning and Term Work	***45***	***Minimum Marks***	***20***	***25***	***45****
	Total	***90***				

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

Course Pre-Requisite: NIL

Course Objective: The course imparts a thorough understanding of Environmental Social Governance, its importance, risks, and opportunities. It helps to study Management practices on energy and water, and it deals with various environmental issues locally and globally.

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Able to state ESG importance, risks, and opportunities, Environmental sustainability and development.	**L2**	**7, 9**
CO2	Apply the knowledge of Management practices on energy and water; describe various environmental issues locally and globally.	**L3**	**2, 5, 6**
CO3	Comprehend the lessons learned from Environmental Sociology, its response to Environmental Issues and social responsibility.	**L3**	**1, 7, 9**
CO4	Recognize the role of governance in Environmental sustainability and its development practices.	**L3**	**4, 7**
CO5	Dealing with Environmental Sociology, social movements in and around the world, and its environmental concerns.	**L3**	**7, 8**

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Introduction** ESG and its importance, key environmental, social, and governance issues; stakeholders' influence on ESG performance, ESG risks and Opportunities, The Concept of Sustainability, Environment and Sustainable Development, Environmental Democracy and Climate Change. **Self-Learning and Term Work** ● Corporate Governance ● CSR Policy ● Data governance and management	**09**
2	**Environment** Climate & Green House Gas Emissions (GHGs), Energy Management, Water Management, Waste Management, Circular Economy, Hazardous Materials Management, Pesticides & its Management, Packaging Reduction, Logistics Efficiency, Supply Chain Transparency Biodiversity. **Self-Learning and Term Work** ● Mapping SDGs with CSR activities of the company ● Brainstorming on Environmental policy ● Developing environmental policy	**10**
3	**Social** Introductory to Environmental Sociology, Emergence of Environmental Sociology, Sociology's Response to Environmental Issues and Recent Trends in Environmental Sociology, People Management, Diversity & Inclusion, Health, Safety & Wellbeing, Social Responsibility Culture, Ethics & Fair Operating Practices, Human Rights & Modern Slavery, Community Involvement. **Self-Learning and Term Work** ● Gender parity ratio ● Stakeholder rights ● Attrition rate	**9**
4	**Governance** Sustainability Purpose, Sustainable Sourcing, Operations, Reporting, SDG Alignment, Resource, Property and Resource Governance Regimes, Governing Common Pool Resources, Collective Action for Governing the Commons: Theoretical Approaches, Governing Forests as Common Property; Governing Water as Common Property. **Self-Learning and Term Work** ● Green supply chain ● ESG Investment ● Business risk assessment and continuity plan	**09**

5	**Environmental Sociology** Environmentalism Around the World: Past and Present, New Social Movements and Environmental Concerns, Political Ecology and Environmental Movements. Applications of AI and ML in Environmental Social Governance. **Self-Learning and Term Work** ● Emerging mandates and government regulations on sustainability ● Global reporting framework ● Eco-Colonialism: Green Policies and Global Inequality	**08**

Note: Components in SL & TW shall be assessed in CIE Only.

Text Books:

- Gieseke T (2020), "Collaborative Environmental Governance Frameworks", Taylor & Francis Ltd.
- John Hill, "Environmental, Social and Governance (ESG) Investing", Academic Press, Elsevier.
- Matthew W. Sherwood and Julia Pollard (2019), "Responsible Investing An Introduction to Environmental, Social, and Governance Investments", Reviewer's Book watch, Oregon.

Reference Books:

- Magdalena Ziolo (2021), "Adapting and Mitigating Environmental, Social, and Governance Risk in Business", IGI global.
- Prakash Chand Kandpal (2018), "Environmental Governance in India" SAGE Texts.

Journals/Magazines:

- Journal articles on Sciencedirect.com, acs.org, springer link and Taylor & Francis.

Web/Digital Resources:

- Carbon Accounting for ESG Professionals 101, Udemy www.Udemy.com

Swayam NPTEL Course:

- Business and Sustainable Development by Prof. Trupti Mishra, School of management, IIT Bombay https://onlinecourses.nptel.ac.in/noc21_mg94/preview

Course Articulation:

Course Outcomes ↓	Program Outcomes											Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	3	-	-	-	3	-	-	-	-	3	3	-
CO2	3	3	3	-	-	-	3	-	-	-	-	3	3	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	1
CO4	-	-	-	-	-	-	1	-	-	-	-	-	-	1
CO5	-	-	-	-	-	-	-	1	-	-	-	2	-	2

High – 3, Medium – 2, Low – 1

Department: Environmental Engineering						
Course Code:24EV673O E		***Course Title: Industrial Pollution and its Prevention***				
Total Credits: 3 L-45: T-0: P-0: SL and TW-45		***SDGs addressed: 3, 6, 7, 9, 11, 12, 13, 14, 15***	***Course Category: OEC–III***		***Course Type: Theory***	
Teaching Learning Process		***Total Contact Hours/semester***	***Assessment Weightage and Marks***			
	Lecture	***45***		**CIE**	**SEE**	**Total**
	Tutorial	***-***	***Weightage, %***	***40***	***60***	***100***
	Practical	***-***	***Maximum Marks***	***40***	***60***	***100***
	Self-learning and Term Work	***45***	***Minimum Marks***	***20***	***25***	***45****
	Total	***90***				

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

Course Pre-Requisite: Environmental Studies

Course Objectives: Conceptualize the importance of implementing pollution prevention methods in industries and encourage sustainable development.

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Identify the major sources and types of industrial pollution and explain the environmental and health impacts of industrial pollution.	**L2**	**1, 3**
CO2	Analyze and evaluate pollution control technologies.	**L3**	**5, 6, 7**
CO3	Analyze and evaluate pollution prevention technologies and strategies.	**L3**	**4, 5, 7, 8**
CO4	Apply regulatory frameworks and standards to control industrial pollution; design and implement a waste management plan.	**L3**	**7, 9**
CO5	Promote sustainable industrial practices and community engagement.	**L3**	**4, 5, 9**

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

Course Syllabus:

Unit No.	Content	Lecture Hours
1	**Fundamentals of environmental pollution and prevention** Significance of industrial, Types and categories of industries contributing to pollution, types of industrial pollutants – air, water, and soil pollutants, environmental and health impacts	**10**

	Self-Learning and Term Work • List and classify industries according to size and type • Create a table matching pollutants to their source and affected environment medium • Map the pollutant source and possible control points on chart	
2	**Pollution control technologies** Air pollution control technologies, water pollution control technologies, Solid and Hazardous waste management, green chemistry and engineering **Self-Learning and Term Work** • Draw a typical wastewater treatment plant of industries and label the process involved. • List and identify the solid waste items generated from various sources • Identify pollution sources in your surroundings and suggest remedial measures	**10**
3	**Pollution prevention strategies.** Source reduction and process modification, cleaner productions and sustainable practices, LCA and eco-design **Self-Learning and Term Work** • Read articles on cleaner production at industries • Draw simple LCA diagram for common products • Find eco design products and report its features	**10**
4	**Regulatory framework and standards** National and international regulations (For example, Environmental Protection Act, ISO 14001), role of government agencies, compliance and enforcement mechanisms, implementation and auditing of Environmental Management Systems **Self-Learning and Term Work** • Create a organizational flow chart for CPCB and SPCB • Study and understand Energy Audit Report available online • Compare and make a table for national and international Environmental Regulations	**08**
5	**Industrial case studies and best practices** Analysis of successful industrial pollution prevention case studies (For example, Green rating projects, Responsible care programs, and other case studies on sustainable initiatives by industries/companies), community awareness and engagement. Applications of AI and ML in Industrial Pollution Control. **Self-Learning and Term Work** • Report preparation on green rating projects at industries. • Identification of industries locally with a sustainable initiatives	**07**

	• Design a basic awareness poster for the local community on pollution prevention and sustainable living.	

Text Books

- S.C. Bhatia, Pramod Kumar and Sarvesh Devaraj (2017). Industrial Pollution and Its Control (Volume I & II). Wood head Publishing India Pvt. Ltd.
- Harry Freeman (1994). Industrial Pollution Prevention Handbook (1st Edition). MacGraw Hill Inc.
- Ryan Dupont, Kumar Ganesan and Louis Theodore (2016). Pollution Prevention: Sustainability, Industrial Ecology and Green Engineering (2nd Edition). CRC Press.
- S.C Bhatia (2003). Managing Industrial Pollution (1st Edition). Macmillan.
- H. Panda (2011) The Complete Guide on Industrial Pollution Control (1st Edition). Asia Pacific Business Press Inc.
- Ireneusz Zbicinski (2006) Product Design and Life Cycle Assessment (1st Edition) Baltic University Press.

Reference books

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

Journals/Magazines:

- Journal of Cleaner Production
- Environmental Engineering Science
- Journal of Hazardous Materials
- Waste Management

Web/Digital Resources:

- https://cpcb.nic.in/
- https://css.umich.edu/sites/default/files/publication/CSS95-01.pdf
- https://www.taylorfrancis.com/books/mono/10.1201/9781315368436/pollut ion-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
- Product design and life cycle assessment:

SWAYAM/NPTEL:

- Environmental Pollution and Control offered by IIT Kharagpur.
- Industrial Pollution Control offered by IIT Madras
- Waste Management and Treatment Technologies offered by IIT Roorkee

Course Articulation:

Course Outcomes↓	Program Outcomes											Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	3	3	-	-	-	-	3	-	3
CO2	3	3	-	3	3	-	3	-	-	2	-	3	-	-
CO3	3	3	1	3	3	-	3	-	-	-	-	3	2	3
CO4	3	3	-	-	3	-	3	-	-	-	2	-	2	3
CO5	3	-	-	-	-	3	3	-	1	2	2	-	-	-

High – 3, Medium – 2, Low – 1

Department: Environmental Engineering						
***Course Code:* 24EV68L**		***Course Title: Design and Drawing of Environmental Systems***				
Total Credits: 1.5 L-0: T-0: P-45		***SDGs addressed:4,6,11,14,15,17***	***Course Category: PCCL***		***Course Type: Laboratory***	
Teaching Learning Process		***Total Contact Hours/semester***	***Assessment Weightage and Marks***			
	Lecture	***-***		**CIE**	**SEE**	**Total**
	Tutorial	***-***	***Weightage, %***	***40***	***60***	***100***
	Practical	***45***	***Maximum Marks***	***40***	***60***	***100***
	Self-learning and Term Work	***-***	***Minimum Marks***	***20***	***25***	***45****
	Total	***45***				

Note:*For passing the student must score a Minimum of 45 Marks (CIE+SEE: 20+25or21+24)

Course Pre-Requisite: Computer knowledge, Water treatment and supply Engineering, Wastewater Treatment Engineering, Atmospheric Environmental Engineering.

Course Objective: The course reinforces design aspects, drawing skills, and capabilities to prepare Engineering drawings of water supply, wastewater collection, and treatment facilities along with air pollution control equipment.

Course Outcomes (COs)

CO	Course Outcomes	Highest Level of Cognitive Domain	Working Knowledge
CO1	Explain the basics of drawing and design of water treatment and Supply components.	**L6**	**1,2,3,4,6,7,9**
CO2	Carryout design and drawing of conventional and decentralized wastewater treatment systems.	**L6**	**1,2,3,4,6,7,9**
CO3	Draw typical drawings for storm and air pollution control equipment.	**L6**	**1,2,3,4,6,7,9**

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

Course Syllabus:

Week	Content	Contact Hours
1	**Introduction to Auto Cad software:** Cartesian Coordinate system, Draw commands, Isometric views, Interactive input method, Principle of Planning of building, elevation, foundation substructure.	**3**
2	**Introduction to Basic Excel:** The Excel environment, Entering and editing data, modifying a worksheet, Using functions, Charts, Range names, and Filter dates, Pivot Tables, Selected Functions.	**3**

3	Drawing basics, use of scales, One BHK and Two BHK Plan, Elevation and Section	**3**
4	**Design and drawing of water supply scheme:** Bellmouth canal and river/ Reservoir intakes	**3**
5	**Design and drawing of water supply scheme:** Cascade aeration Unit. Clari- Flocculator, Tube settler	**3**
6	**Design and drawing of water supply scheme:** Rapids and filters	**3**
7	**Design and drawing of water supply scheme:** Layout of water supply system–and house service connection	**3**
8	**Wastewater treatment facilities:** Screens and Grit Chamber	**3**
9	**Wastewater treatment facilities:** Settling Tank. Trickling Filter	**3**
10	**Wastewater treatment facilities:** Anaerobic Digester and Sludge Drying Beds, Stabilization Pond	**3**
11	**Wastewater treatment facilities:** Septic Tank, Dispersion Trench, and Soak Pit.	**3**
12	**Stormwater drains design:** Typical drawings on street inlet (V, L, and Box/trapezoidal) drains.	**3**
13	**Air Pollution Control Systems:** Typical drawings on Settling Chambers, Bag Filter and Cyclone Separator.	**3**
14	Hydraulic Profile of Conventional Water Treatment Plant, Conventional Wastewater Treatment System.	**3**
15	Laboratory Test	**3**

Text Books:

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

Reference Books:

- CPHEEO Manual on "Water Supply and Treatment" Ministry of Urban Development, Government of India, New Delhi.
- Raju, B.S.N., (1995), "Water Supply and Wastewater Engineering", Tata McGraw Hill Pvt. Co. Ltd., New Delhi.
- Quasim S.R., (1985), "Wastewater Treatment Plants– Planning, Design and Operation", Holt Rine Hart and Winston, CBS College Publishing.
- Hammer M.J., (2013), "Water and Wastewater Technology", SI Version, Second Edition, John Wiley, and Sons.
- Quasim Syed R., (1985), **"**Wastewater Treatment Plants–Planning, Design and Operation" Holt Rine Hart and Winston, CBS College Publishing.

- CPHEEO Manual, **"**Sewerage & Sewage Treatment", Government of India.
- Sincero A.P. and Sincero G.A., (2014), **"**Environmental Engineering: A Design Approach" Prentice Hall of India.
- Wark. K., Warner and Davis W.T., (1998), **"**Air Pollution its Origin and Control**",**

Web/Digital resources:

- https://youtu.be/kP-L7NaATwE

Course Articulation:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES											PROGRAM SPECIFIC OUTCOMES		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	2	2	1	3	3	3	2	1	3	2	-
CO2	2	3	-	3	2	-	2	2	1	-	3	2	3	3
CO3	3	-	2	1	1	2	-	2	-	2	-	-	2	-

High– 3, Medium– 2, Low–1