# 7th Semester

# Syllabus

| *Department: Environmental Engineering* | | | | | | |
|---|---|---|---|---|---|---|
| ***Course Code: 24EV710*** | | ***Course Title: Management Practices in Environmental Engineering*** | | | | |
| ***Total Credits: 4 L-45; T-0; P-30; SL&TW: 45*** | | ***SDGs addressed: 8,9,11,13,16,17*** | ***Course Category: HSMC*** | | ***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 student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**Course Pre-Requisite:** Nil

**Course Objective:** To provide engineering graduates with technical expertise in Environmental Management which enables them to have a career and professional accomplishment in the public or private sector which helps to develop, implement, monitor, and maintain environmental strategies, policies, programs, and systems that promote sustainable development.

**Course Outcomes (COs)**

| CO | Course Outcomes | Highest Level of Cognitive Domain | Working Knowledge |
|---|---|---|---|
| **CO1** | Differentiate between reactive and proactive management, correlate between environment and economy, and indicate the need for organizational structure for effective environmental management. | **L2** | 1,3 |
| **CO2** | Identifies types and levels of management and develops SWOT /SWOC for improved management style. | **L3** | 5,6 |
| **CO3** | Develop efficient personnel management by acquiring skills like time management, interactive leadership style, and human relationships. | **L3** | 5,6 |
| **CO4** | Illustrate the project formulation and apply CPM & PERT for good decision-making and planning appropriately using the carrying capacity concept. | **L3** | 3,4,6 |
| **CO5** | Indicate excellent communication skills and identify the role of non-profit organizations and media in environmental management. | **L2** | 6,7 |

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

**Course Syllabus:**

| Unit No. | Content | Lecture Hours |
|---|---|---|
| 1 | **Introduction:** Proactive and Reactive environmental management. Environment and economy – excludability and rivalry. Continuous and continual improvement. Organizational Structure for Environmental Management at central and state levels. Environmental audits.<br><br>**Self-Learning and Term work**<br>● Adaptive management<br>● Lean Six Sigma concept<br>● Audit - case studies | **08** |
| 2 | **Management Basics & Strategies:** Definitions of management, Functions of management - classification, coordination, Types, and levels of management, TOWS matrix, TQM and environmental protection, ISO 14000 and 18000 series of Standards.<br><br>**Self-Learning and Term work**<br>● Need and importance of management<br>● PDCA model<br>● Case studies | **08** |
| 3 | **Personnel management:** Motivation–importance, need theory-Moslow. Time and man management, factors of production and entrepreneurship. Employee-employer relationship, leadership styles, and situational model, leadership qualities. Communication – elements and objectives, characteristics, barriers, (verbal & nonverbal), downward & upward, factors, and soft skills.<br>**Self-Learning and Term work**<br>● Group roleplay<br>● Importance of listening<br>● Consequences of procrastination | **10** |
| 4 | **Project formulation:** Bar chart & milestone charts, program evaluation & review technique (PERT) & time estimates, Critical path method (CPM) and scheduling, decision matrix – problems. Innovative Formulation of SWM Project Cleaner technologies: cleaner production and prevention of pollution in small businesses, CT and their role in environmental management: limitations. Incorporating cleaner production into EIA.<br>Life cycle assessment into process, zero emissions-the ultimate goal of cleaner production. CP in select red category industries – mining, breweries, pulp, and paper mills. Sugar, Automobile Manufacturing, Milk, and dairy products.<br>**Self-Learning and Term work**<br>● Elements of project formulation<br>● Problems - GANTT chart<br>● Comparison between CPM and PERT | **12** |

| | | |
|---|---|---|
| 5 | **Environmental communication:** Role of institutions, (NGOs, GOs, educational institutions), Politics, Popular Culture, role of public, media. Environmental Research: Need, areas of research, applied and advanced research, premier research organizations. Applications of AI and ML in Management Practices in Environmental Engineering.<br><br>**Self-Learning and Term work**<br>● Environmental Journalism<br>● Environmental awareness<br>● Health communication | **07** |

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

**Text Books:**

- Lohani B. N. ―Environmental Quality Management‖ - South Asian Publishers, New Delhi, 1984.
- Schermerhorn J.R. ―Introduction to Management‖, Tenth Edition, International Student Version, John Wiley and Sons Inc., UK, 2010.
- Richard Welford, ―Corporate Environmental Management‖, Universities Press, 1999.

**Reference Books:**

- Suresh K and Dhameja, ―Environmental Engineering and Management‖, Kataria S. K. and Sons, 2000.
- Peurifoy R. L. ―Construction Planning Equipment and Methods‖, McGraw Hill, 2016.
- Banga, and Sharma, ―Industrial Organization and Engineering Economics‖, Khanna Publishers, 2007.

**Journals/Magazines:**

- Environmental Engineering and Management Journal (tuiasi.ro).
- Journal of Environmental Engineering | ASCE Library.
- Journal of Environmental Management | ScienceDirect.com by Elsevier
- Journal articles on Sciencedirect.com, acs.org, springer link, and Taylor & Francis.

**Web/Digital resources:**

- Lecture Notes | Project Management | Civil and Environmental Engineering | MIT Open Course Ware.
- Environmental management | Lecture notes Environmental Management | Docsity

**Swayam/NPTEL Course:**

- **https://archive.nptel.ac.in/courses/120/108/120108004/**

**Course Articulation:**

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

**High – 3, Medium – 2, Low – 1**

<table>
<tr><td colspan="6">Department: Environmental Engineering</td></tr>
<tr><td colspan="2">Course Code: 24EV721</td><td colspan="4">Course Title: Reclamation of Wastewater</td></tr>
<tr><td colspan="2">Total Credits: 3<br>L-45; T-0; P-30;<br>SL&TW: 45</td><td>SDGs addressed : 2,3,6,9,12,13</td><td colspan="2">Course Category: PEC-V</td><td>Course Type: Theory</td></tr>
<tr><td rowspan="6">Teaching Learning Process</td><td></td><td>Contact Hours/Semester</td><td colspan="3">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:** Wastewater Treatment Engineering

**Course Objective:** The course emphasizes reuse applications of reclaimed water for agricultural, landscape, industrial, potable, and non-potable domestic purposes, potential issues, and their management options.

**Course Outcomes (COs)**

| CO | Course Outcomes | Highest Level of Cognitive Domain | Working Knowledge |
|---|---|---|---|
| **CO1** | Recognize and explain the need and rationale for water reclamation and reuse, analyze the health and environmental concerns related to reclaimed water reuse, and relate waterborne diseases with the possible reclaimed water reuse application | **L4** | **1,2,3** |
| **CO2** | Explain available tertiary treatment technologies for reuse applications identifying the potential contaminants and suggesting state-of-the-art techniques for their qualitative and quantitative measurement to assess market opportunities and conduct economic analysis | **L3** | **3,4,** |
| **CO3** | Compute the impacts of reclaimed water on agricultural and landscape applications and work out its feasibility. Recognize the need for a reuse policy and discuss reclaimed water quality issues. | **L3** | **3,5** |
| **CO4** | Identify the sectors that serve as beneficiaries of reclaimed water; evaluate the water quality issues and suggest management options for industrial | **L3** | **4,5** |

| | | | |
|---|---|---|---|
| | applications of reclaimed water | | |
| **CO5** | Identify the most appropriate technology for using the reclaimed water for artificial groundwater recharge. Examine the direct and indirect use of reclaimed water for potable purposes. | **L3** | **4,5,6** |

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

**Course Syllabus**

| Unit No. | Content | Lecture Hours |
|---|---|---|
| 1 | **Introduction:** Need and prospects, water reclamation and reuse. Water Reuse Innovation and Public Policy: Water management and system and reclamation innovation, water reuse and public policy. Quality Issues and its management.<br><br>**Self-Learning and Term work**<br>● Case study analysis<br>● Technical simulation<br>● Regulation review | **09** |
| 2 | **Water–Reuse Systems:** Health and environmental concerns in water reuse, water-borne diseases; Factors influencing pathogen inactivation; Endocrine disruptors and pharmaceutically active chemicals. Wastewater Reclaim Technologies: Treatment process reliability, advanced wastewater reclamation processes and their combination, Water Harvesting. Public acceptance of water reuse, implementation hurdles, advanced facilities for analysis of reclaimed water quality, market assessment, and economic and financial analysis.<br><br>**Self-Learning and Term work**<br>● Analytical Exercise<br>● debate/discussion<br>● Design project | **11** |
| 3 | **Reuse Applications**<br>**Agriculture and Landscape irrigation**<br>Agronomic and water quality considerations, salinity, sodality, specific ion toxicity, leaching and irrigation requirement, hydraulic loading rate, drainage system, estimation of water needs<br>**Self-Learning and Term work**<br>● Numerical exercise<br>● Simulation/Modelling activity<br>● Debate/panel discussion | **08** |

| | | |
|---|---|---|
| 4 | **Industrial Water Reuse:** Water quality issues and their management options – corrosion, scaling, biological fouling; Cooling tower, makeup and blow down water; boiler system using reclaimed water; Water pinch analysis.<br><br>**Self-Learning and Term work**<br>● Numerical exercise<br>● Simulation/Modelling activity<br>● Design Project | **09** |
| 5 | **Groundwater Recharge with Reclaimed Water:** Rationale, Groundwater recharge methods, water recharge guidelines. Potable Reuse – Indirect and direct.<br><br>**Self-Learning and Term work**<br>● Case study<br>● Simulation/Modelling activity<br>● poster/model making | **08** |

**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
- Takashi Asano, Franklin L. Burton, Harold L. Levering, Ryujiro Tsuchihashi, George Tchobanoglous, (2007) ―Water Reuse – Issues, Technologies, and Application‖, McGraw Hill Company, Copyright by Metcalf & Eddy, Inc.

**Reference Books:**

- Mahajan S. P., (1987), ―Pollution Control in Process industry‖, TMH Co.
- Metcalf and Eddy Inc, (2019): ―Wastewater Engineering, Treatment, and Reuse‖, 4th Edition, Tata McGraw Hill Publishing Co., Ltd.,
- Manivasakam N., (1987). Industrial Effluents- Origin, characteristics, effects analysis, and treatment. Sakthi publications.

**Journals/Magazines:**

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

**Web/Digital resources:**

- https://onlinecourses.nptel.ac.in/noc19_ce32/preview
- https://archive.nptel.ac.in/content/storage2/courses/105101010/downloads/Lecture40. pdf

**SWAYAM/NPTEL:**

- Wastewater Treatment and Recycling, by Prof. Manoj Kumar Tiwari, IIT Kharagpur, https://archive.nptel.ac.in/courses/105/105/105105178/
- Water and Wastewater Engineering, Prof. B.S. Murty, Prof. C. Venkobachar, Prof. Ligy Philip, IIT Madras, https://archive.nptel.ac.in/courses/105/106/105106119/

**Course Articulation:**

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

**High – 3, Medium – 2, Low –1**

| *Department: Environmental Engineering* | | | | | | |
|---|---|---|---|---|---|---|
| ***Course Code: 24EV722*** | | ***Course Title: Industrial Wastewater Treatment Technologies*** | | | | |
| ***Total Credits: 3 L-45; T-0; P-30; SL&TW: 45*** | | ***SDGs addressed : 2,3,6,9,12,13*** | ***Course Category: PEC-V*** | | ***Course Type: Theory*** | |
| ***Teaching Learning Process*** | | ***Contact Hours/Semester*** | ***Assessment Weightage and Marks*** | | | |
| | ***Lecture*** | ***45*** | | **CIE** | **SEE** | **Total** |
| | ***Tutorial*** | ***-*** | ***Weightage, %*** | ***40*** | ***60*** | ***100*** |
| | ***Practical*** | | | | | |
| | ***Self-learning & Term work*** | ***45*** | ***Maximum Marks*** | ***40*** | ***60*** | ***100*** |
| | ***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, Wastewater Treatment Engineering, Environmental Process laboratory exposure.

**Course Objective:** The course provides a strong base of different industrial waste processes, effluent flow and characteristics, approaches to waste minimization, strength, and volume reduction. Also, exposes the student to the areas of toxicity and treatability studies. Makes the student understand the need for process flow sheets with waste streams of different industries.

**Course Outcomes (COs)**

| CO | Course Outcomes | Highest Level of Cognitive Domain | Working Knowledge |
|---|---|---|---|
| **CO1** | Understand the characteristics and effects of industrial wastewater on water and land. Knowledge of monitoring and its protocol. | **L2** | **1,2,3** |
| **CO2** | Understand the need for combined wastewater treatment systems and technical approaches to waste minimization. | **L2** | **3,4** |
| **CO3** | Comprehend the process and treatment flow schemes for selected industries and build up qualitative data on the characteristics of each process effluent. | **L2** | **3,4,5** |
| **CO4** | Understand the process and treatment flow schemes for selected industries including the zero-discharge concept. | **L2** | **3,4,5** |
| **CO5** | Enlighten the performance bench-scale as well as pilot scale treatability studies, for designing real-time treatment facilities and 5-R concepts | **L2** | **4, 5, 6** |

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

**Course Syllabus**

| Unit No. | Content | Lecture Hours |
|---|---|---|
| 1 | **Introduction:** Origin, characteristics, and effects of industrial wastewaters on surface water, land, and sewer. Industrial waste survey. Discharge guidelines and Standards.<br>**Classification of industry:** Red, Orange, White, and Green categories of industries**.**<br>**Variations in Flow and Concentration:** Monitoring and mass load calculations of Effluent**.**<br><br>**Self-Learning and Term work**<br>● Discharge guidelines and standards<br>● field/survey activity<br>● Design/problem solving task | **10** |
| 2 | **Combined Treatment:** Raw Industrial Wastes and Domestic Wastewater after mixing partially or fully. Selection of Treatment Methods- based on characteristics.<br>**Waste Minimization approaches -** Equalization, Neutralization, Volume Reduction, Strength Reduction and Proportioning.<br><br>**Self-Learning and Term work**<br>● Review criteria for selecting treatment based on the wastewater characteristics<br>● Simulation/model work<br>● Case study analysis | **09** |
| 3 | **Process Flow Schemes and Characteristics**: Flow Diagrams, sources, stream identification, and Treatment of Industrial Wastes from - Pulp & Paper, Textile, Tanneries, Pharmaceuticals, Sugar & Distilleries, Dairy, slaughter house, and Food processing. Steel manufacturing, electro-plating, petrochemical, and fertilizer industries.<br><br>**Self-Learning and Term work**<br>● Review CPCB/EPA industry specific discharge standards<br>● Poster/infographic creation<br>● Mini project | **09** |
| 4 | Zero Liquid Discharge concept, cleaner technology, green processes. Sludge handling and disposal, reclamation facilities, Case studies.<br>**Self-Learning and Term work**<br>● Case study Exploration<br>● Regulatory and sustainability concept: Review CPCB/EPA rule on ZLD and sludge disposal<br>● Practice Activity | **08** |

| | | |
|---|---|---|
| 5 | **5R APPROACH** – Reduce, Reuse, Recycle, Recover, Reclaim – for waste minimization.<br>**Toxicity:** Toxicity tests. **Treatability Studies**: Bench and pilot scale studies. Applications of AI and ML in Industrial Wastewater Treatment Technologies.<br><br>**Self-Learning and Term work**<br>● Recent advancement on waste minimization techniques in industries<br>● Group Discussion<br>● Debates/discussion | **09** |

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

**Text Books:**

- Nemerow N. L., (1982), ―Liquid Waste of Industry- Theories, Practice, and Treatment‖, Addison Wesley
- Rao M. N., and Datta A. K., (2003), ―Wastewater Treatment‖, Oxford and IBM Publishers

**Reference Books:**

- Mahajan S. P., (1987), ―Pollution Control in Process industry‖, TMH Co.
- Metcalf and Eddy Inc, (2019): ―Wastewater Engineering, Treatment, and Reuse‖, 4th Edition, Tata McGraw Hill Publishing Co., Ltd.,
- Manivasakam N., (1987). Industrial Effluents- Origin, characteristics, effects analysis, and treatment. Sakthi publications.

**Journals/Magazines:**

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

**SWAYAM/NPTEL:**

- Industrial Wastewater Treatment, By Prof. Alok Sinha and Prof. S K Gupta, IIT, Dhanbad, https://onlinecourses.nptel.ac.in/noc24_ce53/preview

**Course Articulation:**

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

**High – 3, Medium – 2, Low – 1**

| *Department: Environmental Engineering* | | | | | | |
|---|---|---|---|---|---|---|
| *Course Code:24EV723* | | *Course Title: Environmental Sustainability and Social Governance* | | | | |
| *Total Credits: 3 L-45; T-0; P-30; SL&TW: 45* | | *SDGs addressed:6,7, 12,13,16* | *Course Category: PEC-V* | | *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:** 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 also 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 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**<br>ESG and its importance, key environmental, social, and governance issues; stakeholder's influence on ESG performance, ESG risks and Opportunities, The Concept of Sustainability, Environment and Sustainable Development, Environmental Democracy and Climate Change.<br><br>**Self-Learning and Term work**<br>● Corporate Governance<br>● CSR Policy<br>● Data governance and management | **09** |
| **2** | **Environment**<br>Climate & Green House Gas Emissions (GHGs), Energy Management, Water Management, Waste Management, Circular Economy, Hazardous Materials Management, Pesticides & their Management, Packaging Reduction, Logistics Efficiency, Supply Chain Transparency Biodiversity.<br><br>**Self-Learning and Term work**<br>● Mapping SDGs with CSR activities of the company<br>● Brainstorming on Environmental policy<br>● Developing environmental policy | **10** |
| **3** | **Social**<br>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<br><br>**Self-Learning and Term work**<br>● Gender parity ratio<br>● Stakeholder rights<br>● Attrition rate | **09** |
| **4** | **Governance**<br>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.<br><br>**Self-Learning and Term work**<br>● Green supply chain<br>● ESG Investment<br>● Business risk assessment and continuity plan | **09** |

| | | |
|---|---|---|
| **5** | **Environmental Sociology**<br>Environmentalism Around the World: Past and Present, New Social Movements and the Environmental Concerns, Political Ecology and Environmental Movements. Applications of AI and ML in Environmental Sustainability and Social Governance.<br><br>**Self-Learning and Term work**<br>● Emerging mandates and government regulations on sustainability<br>● Global reporting framework<br>● 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 Objectives | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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**

<table>
<tr><td colspan="7">Department: Environmental Engineering</td></tr>
<tr><td colspan="3">Course Code:24EV724</td><td colspan="4">Course Title: Non-point Source Pollution and Management</td></tr>
<tr><td colspan="2">Total Credits: 3 L-45; T-0; P-30; SL&TW: 45</td><td>SDGs addressed:6,7, 12,13,16</td><td colspan="2">Course Category: PEC-V</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, Sources and Characterization, Water Resources Engineering and Management

**Course Objective:** This course aims to provide students with a comprehensive understanding of non-point source (NPS) pollution and effective management strategies.

**Course Outcomes (COs)**

| CO | Course Outcomes | Highest Level of Cognitive Domain | Working Knowledge |
|---|---|---|---|
| **CO1** | Identify and describe the sources and types of non-point source pollution and analyze the impacts of NPS pollution on ecosystems and human health. | **L3** | **1,2,3** |
| **CO2** | Identify and assess the non-point source pollution load from hydrologic components and atmosphere. | **L3** | **2,3,4** |
| **CO3** | Utilize tools and techniques for monitoring and assessing NPS pollution. | **L3** | **3,4,5** |
| **CO4** | Design and evaluate management strategies to reduce NPS pollution. | **L4** | **4,5,6** |
| **CO5** | Explain the role of policies and regulations in managing NPS pollution and engage with community stakeholders to promote sustainable practices. | **L3** | **6,7** |

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

**Course Syllabus:**

| Unit No. | Content | Lecture Hours |
|---|---|---|
| **1** | **Introduction**<br>Overview of NPS pollution and its significance, Key sources of NPS pollution (urban runoff, agriculture, forestry, etc.), Types of NPS pollutants – nutrients, sediment and soil erosion, pesticides and herbicides, pathogens, heavy metals and toxic chemicals, impacts of NPS pollution – aquatic ecosystem, biodiversity, and habitat degradation, human health<br><br>**Self-Learning and Term work**<br>● **Concept Map Tools (e.g., Coggle, MindMup)** – Build a visual model connecting sources → pollutants → impacts<br>● **Excel or Python (optional)** – Analyze simple data on pollutant loads or runoff<br>● USGS and EPA - Case Study Analysis | **08** |
| **2** | **Hydrologic considerations and transport mechanisms**<br>Surface runoff and infiltration, subsurface and Groundwater flow, atmospheric deposition.<br><br>**Self-Learning and Term work**<br>● EPA Hydrologic Models<br>● Excel or Google Sheets for modeling<br>● Python (optional) for simulation | **08** |
| **3** | **Monitoring and assessment techniques**<br>Water quality sampling and analysis, Total Maximum Daily Load (TMDL), modeling tools for assessing NPS pollution, GIS, and remote sensing applications<br><br>**Self-Learning and Term work**<br>● Get familiar with models like **SWAT (Soil and Water Assessment Tool)**, **HSPF**, and **GWLF**<br>● HSPF Manual, EPA TMDL Overview, *Standard Methods for the Examination of Water and Wastewater* (APHA)<br>● **GIS Exercise**: Use free GIS tools like QGIS with sample datasets to map land use or pollutant sources, QGIS Tutorials, USGS Remote Sensing Primer | **08** |
| **4** | **Best Management Practices and innovative approaches to NPS management**<br>Agricultural BMPs (cover crops, buffer strips, nutrient management, precision agriculture, and other smart farming techniques)<br>Urban BMPs (Urban low-impact development - green infrastructure, stormwater management, constructed wetlands, and bioreactors)<br>Forestry BMPs (riparian buffers, controlled logging) | **08** |

| | | |
|---|---|---|
| | **Self-Learning and Term work**<br>● Urban BMPs / Low Impact Development (LID)<br>● USDA NRCS Conservation Practices<br>● EPA Green Infrastructure Guide<br>● State forestry BMP manuals | |
| **5** | **Policy and Regulatory Frameworks**<br>Overview of national and international policies (e.g., Clean Water Act), Role of government agencies and NGOs in NPS management Strategies for public engagement and awareness, Role of community-based organizations and local stakeholders. Applications of AI and ML in Non-point sources Pollution and Management.<br><br>**Self-Learning and Term work**<br>● Constructed Wetlands<br>● Education Campaigns<br>● **Use of Social Media and Public Events:** To increase visibility and spread information. | **07** |

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

**Text Books:**

- Holly V. Campbell, (2018) Nonpoint Source Pollution - A Multidisciplinary Perspective, Taylor & Francis Group.
- Abrar Yousuf, Manmohanjit Singh (2019), Watershed Hydrology, Management and Modeling, CRC Press

**Reference Books:**

- Novotny, V., and Chesters, G., (1981), ―Handbook of Non-point Pollution‖, ―Sources and Management - Van Nostrand Reinhold Company.

**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.sciencedirect.com/topics/earth-and-planetary-sciences/nonpoint-source- pollution

**SWAYAM/NPTEL:**

- Water Resources and Watershed Management, By Dr. Harish Gupta, University College of Engineering, Osmania University, Hyderabad.
- Watershed Hydrology, By Prof. Rajendra Singh, IIT Kharagpur.

## Course Articulation:

| Course Outcomes | Program Outcomes | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO 2 | 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 |
| CO2 | 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 |

**High – 3, Medium – 2, Low-1**

| *Department: Environmental Engineering* | | | | | | |
|---|---|---|---|---|---|---|
| ***Course Code:24EV731*** | | ***Course Title: Energy and Environment*** | | | | |
| ***Total Credits: 3 L-45; T-0; P-30; SL&TW: 45*** | | ***SDGs addressed: 7,12,13,14*** | ***Course Category: PEC-VI*** | | ***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:** Elements of Electrical Engineering, Elements of Environmental Engineering

**Course objective:** The course imparts knowledge on different types of energy sources, energy scenarios, alternative energy resources, and associated environmental impacts.

**Course Outcomes (COs)**

| CO | Course Outcomes | Highest Level of Cognitive Domain | Working Knowledge |
|---|---|---|---|
| **CO1** | Summarize environmental resources, energy necessity, and energy crisis and distinguish between renewable and non-renewable energy. | **L2** | **1,2** |
| **CO2** | Explain the hydroelectric and tidal energy production along with their impacts on the environment. | **L2** | **2,3** |
| **CO3** | Explain the necessity and implications of solar and wind energy in the present context and compare know-how of energy production. | **L2** | **2,3,4** |
| **CO4** | Describe geothermal and nuclear energy aspects along with their environmental effects. | **L2** | **2,3** |
| **CO5** | Explain the availability, uses, and generation of natural and biogas as energy supplements and illustrate appropriate methods for societal use and current knowledge on hybrid systems. | **L3** | **3,4,5** |

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

**Course Syllabus:**

| Unit No. | Content | Lecture Hours |
|---|---|---|
| 1 | **Introduction to Energy Sources**: Global Energy- policy factors for sustainable energy systems. Indian Energy Scenario: Energy Consumption, needs and crisis.<br>**Biomass:** Introduction; First, second, and third generation feedstock and related technologies. Biomass conversion technologies - wet and dry processes – implication on economics.<br>**Biofuels –** properties, performance, and emission characteristics.<br>**Self-Learning and Term work**<br>● Calculate $CO_2$ emission reduction achievable by replacing fossil fuel with a biofuel<br>● Review government policies and incentives for biofuels in India<br>● Case studies Analysis | **08** |
| 2 | **Hydropower:** Site selection for hydroelectric power plants, classification, Mechanism of hydro energy production, Components, and classification of hydropower plants.<br>**Tidal Energy:** Tides and waves as a source of renewable energy, Tides and tidal energy production, World and Indian tidal energy scenario, OTEC (Ocean Thermal Electric Conversion).<br><br>**Self-Learning and Term work**<br>● World and Indian Hydro and tidal energy scenario<br>● Poster/infographic creation<br>● debate/discussion | **08** |
| 3 | **Solar Energy:** Solar constants, physical principles of conversion. Concentrators and their associated Environmental impacts, Solar energy economics—photovoltaic cell calculation, financing—subsidy policies, and regulations, solar vehicles and their economic and environmental implications.<br>**Wind Energy:** Basic principles and components of wind energy conversion system. Energy production from wind, Wind energy computation.<br><br>**Self-Learning and Term work**<br>● Analyse economic and environmental benefits Vs challenges (efficiency, cost, scalability)<br>● Study India‘s wind potential zones<br>● Problem solving/computation task | **08** |
| 4 | **Geothermal Energy:** Geothermal sources, uses, types, and arrangements for hybrid plants<br>**Nuclear Energy:** reactor mechanism. Breeding reactors, types of nuclear waste and disposal, environmental impacts.<br>**Natural gas:** Res**ource**s, composition, classification, and comparison of different gas turbine power plants and environmental impacts. Co- generation and tri-generation, waste-to-energy approaches - incineration, pyrolysis and gasification. | **12** |

| | | |
|---|---|---|
| | **Energy Audit** - Purpose, methodological approaches. Audit methods employed in energy-intensive industries.<br><br>**Self-Learning and Term work**<br>● Energy Audit: Techniques - walk through audit, monitoring, load analysis, energy balance<br>● Case study discussion - Indian waste to energy plants<br>● Perform cost benefit analysis of installing co-generation and tri-generation in an industrial unit | |
| **5** | **Recent Trends**: Hybrid energy systems, Energy from biomass wastes, energy forecasting tool (LEAP), Alternative Energy in Transport—fuels, electric vehicles, green initiatives.<br>**Fuel cells:** Types, fuel processing, design concepts, Characterization and durability of fuel cells. Hydrogen as fuel from water – hazard analysis. Energy storage systems - Thermal energy storage systems. Energy savings. Smart grids. Pump storage schemes.<br><br>**Self-Learning and Term work**<br>● Understand about green initiatives - hybrid vehicles, carbon credits, FAME scheme in India<br>● Team Exercise: create a mock energy forecast scenario (e.g., India;s renewable share by 2035 using assumed data)<br>● Simulation/case study | **09** |

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

**Text Books:**


- Mathur A. N., and Rathore, N. S., (1990), ―Renewable Energy and Environment‖, Proceedings of the National Solar Energy, Himanshu Publications, Udaipur.
- Rao and Parulekar B. B., (1977), ―Energy Technology – Non-conventional, Renewable and Conventional‖, 2nd edition, Khanna Publishers.


**Reference Books:**


- Robert A. Ristinen, Jack P.Kraushaar, (2006). ―Energy and the Environment‖
- Reza Toossi., (2008). Energy and the Environment: Sources, Technologies, and Impacts.
- De B. K., (2017). Energy Management audit & Conservation, 2nd Edition, Vrinda Publication.
- Saha, H., Saha, S.K., and Mukherjee, M.K., (1990), ―Integrated Renewable Energy for Rural Development‖, Proceedings of the National Solar Energy Convention, Calcutta, India.
- The Energy Research Institute (TERI), New Delhi, Publications. Ministry of Environment and Forests, Government of India, Annual Reports.
- Turner, W. C., Doty, S. and Truner, W. C., (2012). Energy Management Handbook, 7th edition, Fairmont Press.
- Murphy, W. R., (2016). Energy Management, Elsevier.
- Smith, C. B., (2016). Energy Management Principles, Pergamum.


**SWAYAM/NPTEL**

- Renewable Energy Engineering: Solar, Wind and Biomass Energy systems, IIT Guwahati by Prof. Vaibhav Vasant Goud and Prof. R Anadalakshmi, https://onlinecourses.nptel.ac.in/noc22_ch27/preview

- Technologies for Clean and Renewable Energy Production, IIT Roorkee by Prof P Mondal. https://archive.nptel.ac.in/noc/courses/noc20/SEM2/noc20-ch37/

**Journals/Magazines:**

- Journal articles in reputed journals indexed by _scopus‘ and _web of science‘

**Web/Digital resources:**

- https://archive.nptel.ac.in/courses/103/107/103107157/
- https://www.youtube.com/watch?v=C-1lGYlmGFc/
- https://www.youtube.com/watch?v=kvQyZt3UguY/

**Course Articulation:**

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

**High – 3, Medium – 2, Low – 1**

| *Department: Environmental Engineering* | | | | | | |
|---|---|---|---|---|---|---|
| *Course Code:24EV732* | | *Course Title: Instrumentation and Automation in Environmental Engineering* | | | | |
| *Total Credits: 3 L-45; T-0; P-30; SL&TW: 45* | | *SDGs addressed: 3,6,9,11,12,13* | *Course Category: PEC-VI* | | *Course Type: Theory* | |
| *Teaching Learning Process* | | *Contact Hours/Semester* | *Assessment Weightage and Marks* | | | |
| | *Lecture* | *45* | | **CIE** | **SEE** | **Total** |
| | *Tutorial* | - | *Weightage, %* | *40* | *60* | *100* |
| | *Practical* | - | | | | |
| | *Self-learning & Term work* | *45* | *Maximum Marks* | *40* | *60* | *100* |
| | *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, Engineering Chemistry

**Course Objective:** The course provides exposure to the students on various aspects of analytical instruments for analyzing organic and inorganic compounds in water, wastewater, and air samples and also the application of sensors in real-time data monitoring and dissemination in Environmental Engineering applications.

**Course Outcomes (COs)**

| CO | Course Outcomes | Highest Level of Cognitive Domain | Working knowledge |
|---|---|---|---|
| **CO1** | Characterize a liquid sample based on its ability of absorption and emission of light. | **L2** | **1,3** |
| **CO2** | Determine the physicochemical properties of liquid samples using electrical methods and luminescence properties | **L2** | **1,3** |
| **CO3** | Identify and quantify based on the separation of mixtures into their constituent components, gaseous and microbial components in ambient air and vehicle exhaust. | **L4** | **1,3,4** |
| **CO4** | Analyze the structure, surface morphology, composition, and functional elements of solid/liquid samples | **L4** | **1,3,4** |
| **CO5** | Explain the application of automatic sensors for online real-time monitoring and facilities for data dissemination | **L3** | **3, 5, 6** |

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

**Course Syllabus**

| Unit No. | Content | Lecture Hours |
|---|---|---|
| 1 | **Introduction:** Need for instrumentation and automation.<br>**Principles of optical spectroscopy:** Electromagnetic spectrum, Beer-Lambert's law, absorption instruments, colorimeters - working principle, components, and applications.<br>**Spectrophotometers:** spectroscopy, absorption spectroscopy, spectrophotometers - working principle, components, and applications.<br>**Atomic spectrometry** - working principle, components, and applications - Atomic absorption spectrometry, atomic emission spectrometry, Mass spectrometry, ICP-MS measurements.<br><br>**Self-Learning and Term work**<br>● Hands on Demonstration<br>● Perform a mock dataset analysis of absorbance Vs Concentration and plot calibration curves<br>● Experimental simulation. | **09** |
| 2 | **Luminescence** - working principle, components, and applications - Fluorescence, phosphorescence, chemiluminescence.<br>**Electroanalytical methods -** Redox process, electrode and electrode potentials, electrochemical cells. Potentiometry and Conductometry, Electrophoresis - Basic, technique, types.<br><br>**Self-Learning and Term work**<br>● Group demo/case study: Analyse real world application - eg: fluorescent dyes in wastewater tracking, chemiluminescence biosensors for pollutants<br>● Creative Activity: Team design an application poster<br>● debate/discussion/demonstration | **08** |
| 3 | **Chromatography:** fundamental concepts and applications, Gas chromatography, Liquid chromatography, thin layer chromatography<br>**Gas analyzer:** VOC analyzer, Automatic exhaust gas analyzer, Microbial air sampler.<br><br>**Self-Learning and Term work**<br>● Practical Simulation/Case study<br>● Integration task<br>● Monitoring and analysis/field activity | **09** |
| 4 | **Microscopy** - working principle, components, and applications - Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy.<br>**Thermal analysis** - heat capacity, thermal conductivity, TGA<br>**Other instrumental methods:** Flame photometers, Ion-meter, FTIR, XRD. | **09** |

| | | |
|---|---|---|
| | **Self-Learning and Term work**<br>● Hands-on/simulation exercise<br>● Data analyse: TGA, FTIR, XRD<br>● poster/infographic creation | |
| **5** | **Sensors:** Basic concepts - sensors to determine physicochemical characteristics of water and wastewater (pH, conductivity, ORP, DO, turbidity, heavy metals, water level, and discharge)<br>Online monitoring devices for liquid and air samples, and data dissemination. SCADA in water and wastewater systems. Applications of AI and ML in Instrumentation and Automation in Environmental Engineering.<br><br>**Self-Learning and Term work**<br>● Sensor application: group comparison task<br>● Mini project: smart water treatment plant which include: online monitoring, sensors application and SCADA integration<br>● Explore examples: online monitoring devices and automated wastewater monitoring system | **10** |

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

**Text Books:**

- Khandpur R. S., (1989), Handbook of Analytical Instruments TMH publication, New Delhi.
- Randy D. Down P.E., Jay H. Lehr., (2004), Environmental Instrumentation and Analysis Handbook.

**Reference Books:**

- Donald J. Peitrzyk, Clyde W. Frank. 2012. Analytical Chemistry, Second Edition, Academic Press
- Willard, H H, Merritt L L, Dean J A, Settle F A. 1988. Dean Instrumental methods of analysis by, CBS Publications 7th Edition.
- Olga Korostynska, Alex Mason (Editors) Advanced Sensors for Real-Time Monitoring Applications, MDPI Books, Switzerland.
- Holler S. J. & Nilman T. A. 2019. Principles of Instrumental analysis. Saunders College Publications 5th Edition.
- Subhas Chandra Mukhopadhyay, Alex Mason (Editors), 2013, Smart Sensors for Real- Time Water Quality Monitoring, Springer-Verlag Berlin Heidelberg.

**Journals/Magazines:**

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

**Web/Digital resources:**

- Videos on YouTube
- Coursera

**SWAYAM/NPTEL:**

- Environmental Quality Monitoring & Analysis, Dr. R. Ravi Krishna, IIT Madras, https://nptel.ac.in/courses/103106162

**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 | - | - |
| CO2 | 3 | - | - | - | - | - | - | - | - | - | - | 3 | - | 3 |
| CO3 | 3 | 3 | - | 1 | 2 | - | 2 | - | - | - | - | 3 | 3 | 3 |
| CO4 | 3 | 3 | 1 | - | 2 | - | 2 | - | - | - | - | - | 3 | 3 |
| CO5 | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 3 | - |

**High – 3, Medium – 2, Low – 1**

| *Department: Environmental Engineering* | | | | | | |
|---|---|---|---|---|---|---|
| ***Course Code:24EV733*** | | ***Course Title: Environmental Forensics*** | | | | |
| ***Total Credits: 3 L-45; T-0; P-30; SL&TW: 45*** | | ***SDGs addressed: 3,6,9,11,13,14, 15,16*** | ***Course Category: PEC-VI*** | | ***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, Wastewater Engineering, Solid waste management, Environmental management, Life cycle analysis.

**Course Objective:** This course is a combination of analytical and environmental chemistry which enhances the knowledge of students involved in field analytical studies, data interpretation, and modeling connected with the attribution of pollution events to their causes.

**Course Outcomes (COs)**

| CO | Course Outcomes | Highest Level of Cognitive Domain | Working knowledge |
|---|---|---|---|
| **CO 1** | Understand associated terminology and analyze toxicity estimates of Important priority contaminants. | **L2** | **1, 2, 3** |
| **CO 2** | Evaluate sampling protocols for forensic analysis and interpretation of data. | **L2** | **4, 6,7,8,9** |
| **CO 3** | Understand the forensics characterization of hazardous materials and real-time case studies. | **L2** | **6, 7, 8, 9** |
| **CO 4** | Understand the various EF techniques and data analysis with different analytical equipment. | **L2** | **6, 7, 8, 9** |
| **CO 5** | Evaluate recent trends in EF and the use of critical thinking skills in EF. | **L4** | **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 forensics**- Definition, terminology. Role of the Environmental forensic engineer/scientist. Forensic geochemistry, Health forensics, Forensic toxicology. Toxicity and risk estimate of priority environmental contaminants and fate. EF past, present, and future. Simple problems.<br><br>**Self-Learning and Term work**<br>● What are common environmental contaminants should focus on?<br>● Inter relationship between Environmental Forensics and Forensic geochemistry, Health forensics, Forensic toxicology<br>● Explain the Toxicity and risk estimate of priority contaminants and fate | **06** |
| 2 | **Legal and forensic sampling**, and analysis for priority parameters for court submissions. Portable separation devices for forensic analysis. Models involving pollutant transport links with EF covering all environmental attributes. Biosensors in forensic analysis. Environmental forensic characterization. Multivariate statistical analysis. Microbial evidences. Reverse engineering for environmental crimes. Forensic traces and Nano-materials. Interpretation of forensic data.<br><br>**Self-Learning and Term work**<br>● Standards for admissibility: EPA, ISO, ASTM, NABL, MoEFCC guidelines<br>● Coupling EF with LCA (Life Cycle Assessment) and risk models<br>● Reconstruct illegal discharge from industrial data | **11** |
| 3 | **Environmental forensics characterization** – Hazardous materials, POPs, PAHs, e-waste forensics. Case studies on forensic investigations of water pollution and solid wastes. Forensic tracking of leaking underground storage Tanks (LUST).Food forensics, oil spill forensics.<br><br>**Self-Learning and Term work**<br>● Map contamination zones, simulate sampling, analyze risks<br>● Use GIS to trace illegal e-waste routes<br>● Identify illegal dumping using forensic clues | **06** |
| 4 | **Environmental forensic techniques -** Fingerprinting tools and techniques, Touch microbiome. Analytics: Ion chromatography-mass spectrometry-proteomix, Imaging tools, two-dimensional GC, atomic force microscopy, molecular spectrum fusion analysis, Laser-induced breakdown spectroscopy (LIBS), Fourier transform infrared total attenuated reflectance spectroscopy (FTIR ATR). Forensic applications of desorption electrospray ionization mass Spectrometry (DESI-MS). | **10** |

| | | |
|---|---|---|
| | **Self-Learning and Term work**<br>● Analyze mock samples using chemical and isotopic markers<br>● Identify unknown residues using spectral libraries<br>● Interpret complex chromatograms from environmental mixtures | |
| 5 | **Recent trends:** Forensic investigations feedback–strengthening legal boundaries. Electrochemical strategies for detecting forensic drugs. Blending biomedical forensics with environmental forensics. Tracing back to source approaches. Environmental crime reconstruction–3D forensic science. Enantiomeric fractions in EF. Micro-extractions in forensic toxicology. Critical thinking skills in EF. Next-generation sequencing technology. Forensic Solutions. EF of micro-plastics. Applications of AI and ML in Environmental Forensics.<br><br>**Self-Learning and Term work**<br>● Map microplastic pollution and trace sources<br>● Analyze past cases, propose forensic method improvements<br>● Biomedical–Environmental Case Study | **06** |

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

**Text Books:**

- Environmental forensics–Principles and applications. Robert D Morrison. C RC press, 1999.
- Practical environmental forensics Process and case histories. Sullivan, Agardy, and Traub. Environmental Engineering series. 2001.

**Reference Books:**

- Introduction to environmental forensics second edition. Brian l. Murphy and Robert D. Morrison., 2007
- Resource guide for the investigation of environmental crimes., central Virginia environmental crimes task force., 2005
- Applications of environmental forensics., Brian l. Murphy., 1997
- Environmental Forensics for Persistent Organic Pollutants., Gwen O'Sullivan and Court Sandau., 2014
- Pollution Crime Forensic Investigation Manual Volume I of II., Environmental Security Sub-Directorate., 2014
- Pollution Crime Forensic Investigation Manual Volume II of II., Environmental Security Sub-Directorate., 2014
- Guidelines on Environmental Forensics for Enforcement, 2016., Dr. Abdul Rahman Mahmud
- Practical environmental forensics., Patrick J. Sullivan, Franklin J. Agardy, and Richard K. Traub,2001

**Journals/Magazines –**

- Read the latest articles of Environmental Forensics at ScienceDirect.com, Elsevier's leading platform of peer-reviewed scholarly literature

**Course Articulation:**

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

**High – 3, Medium – 2, Low – 1**

| *Department: Environmental Engineering* | | | | | | |
|---|---|---|---|---|---|---|
| ***Course Code: 24EV734*** | | ***Course Title: Environmental Health and Safety in Industries*** | | | | |
| ***Total Credits: 3 L-45; T-0; P-30; SL&TW: 45*** | | ***SDGs addressed: 3, 8, 9, 11, 12, 13, 16 & 17*** | ***Course Category: PEC–VI*** | | ***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 Prerequisite:** Elements of Environmental Engineering – Sources and characterization

**Course Objective:** The course educates about the health hazards and the safety measures to be followed in the industrial environment and describes the industrial legislations (Factories Acts, Workmen's Compensation, and other laws) enacted for the protection of employee health at the workplace, to compare prevention and control of Occupational Health diseases, accidents/emergencies, and other hazards.

**Course Outcomes (COs)**

| CO | Course Outcomes | Highest Level of Cognitive Domain | Working Knowledge |
|---|---|---|---|
| **CO1** | Understand the health hazards, exposure pathways, and toxic substances, and their effects. | **L2** | **1, 3, 5** |
| **CO2** | Demonstrate the workplace safety and safety systems and an in-depth knowledge of the safety technologies | **L2** | **4, 6, 7** |
| **CO3** | Understand on need for training and education of EHS. | **L2** | **5, 6, 7** |
| **CO4** | Explain Safety, Health & Environment related to ISO standards, accidents/emergencies, and other hazards | **L3** | **4, 6, 7, 8** |
| **CO5** | Describe the Management Information System and related case studies. | **L2** | **7, 8, 9** |

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

**Course Syllabus:**

| Unit No. | Content | Lecture Hours |
|---|---|---|
| **1** | **Industrial Health and Hygiene:** Occupational health hazard, classification of health hazards. Properties of dangerous chemicals, dust, gases, fumes, mists, vapors, smoke, and aerosols - health effects. Exposure pathways and human responses to hazardous and toxic substances, biochemical action of toxic substance and toxicity, type and degrees of toxic effects, Physiology of work, and occupational diseases. Hierarchy of control measures for occupational health risks. Role of personal protective equipment and the selection criteria. Effects of noise, radiation, and excessive stress on humans, control methods, and attenuation.<br><br>**Self-Learning and Term work**<br>● Case study<br>● Quiz<br>● Poster | **10** |
| **2** | **Workplace Safety and Safety Systems**<br>Features of the satisfactory design of work premises Heating, ventilation, and air conditioning (HVAC). Safe installation and use of electrical supplies. Fire safety and first aid provisions.<br>Safe systems of work for manual handling operations. Control methods to eliminate or reduce the risks arising from the use of work equipment. Procedures and precautionary measures for handling hazardous substances. Contingency arrangements for events of serious and imminent danger.<br><br>**Self-Learning and Term work**<br>● Case study<br>● Quiz<br>● Poster | **10** |
| **3** | **Education and Training**<br>Importance of the provision of information, instructions, training, and supervision. Mock drills, safety operations and protocols Factors to be considered in the development of effective training programs. Awareness of occupational diseases in various industries and control measures. Principles and methods of effective training. Feedback and evaluation mechanism.<br><br>**Self-Learning and Term work**<br>● Case study<br>● Quiz<br>● Poster | **9** |

| | | |
|---|---|---|
| **4** | **Monitoring for Safety, Health & Environment**<br>Occupational Safety, Health, and Environment Management System, Bureau of Indian Standards on Safety and Health: 14489 – 1998 and 15001 – 2000, ILO and EPA Standards. Principles of Accident Prevention: Definition: Incident, accident, injury, dangerous, occurrences, unsafe acts, unsafe conditions, hazards, error, oversight, mistakes, etc.<br><br>**Self-Learning and Term work**<br>● Case study<br>● Quiz<br>● Poster | **8** |
| **5** | **Management Information System**<br>Sources of information on Safety, Health, and Environment Protection. Compilation and collation of information, Analysis & use of modern methods of programming, storing, and retrieval of MIS for Safety, Health, and Environment. **Case studies:** Safety in Chemical Industries; Safety in Petroleum Refinery, Mining, and Petrochemical Industry; Safety in Construction and Cement Industry; Safety in Thermal power plants. Applications of AI and ML in Environmental health and Safety in Industries.<br><br>**Self-Learning and Term work**<br>● Case study<br>● Quiz<br>● Poster | **8** |

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

**Text Books:**


- Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995
- Effective Environmental, Health, and Safety Management Using the Team Approach by Bill Taylor, Culinary and Hospitality Industry Publications Services. 2005.
- The Facility Managers Guide to Environmental Health and Safety by Brian Gallant, Government Inst Publ., 2007.


**Reference Books:**


- Slote. L, Handbook of Occupational Safety and Health, John Willey and Sons, NewYork.2019.
- Heinrich H.W, Industrial Accident Prevention, Mc Graw Hill Company, NewYork,1980.

**Journals/Magazines:**

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

**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:24EV74P* | | *Course Title: Industrial Training/Internship/ Technical Seminar* | | | | |
| *Total Credits: 2 L-45; T-0; P-30; SL&TW: 45* | | *SDGs addressed: 6,9,12,13* | *Course Category: PWC* | | *Course Type: Project work* | |
| *Teaching Learning Process* | | *Contact Hours/Semester* | *Assessment Weightage and Marks* | | | |
| | *Lecture* | - | | **CIE** | **SEE** | **Total** |
| | *Tutorial* | | *Weightage, %* | *100* | *-* | *-* |
| | *Practical* | | *Maximum Marks* | *40* | *-* | *40* |
| | *Self-learning & Term work* | | | | | |
| | *Total* | | *Minimum Marks* | *20* | *-* | *20* |

**Course Pre-Requisite: NIL**

**Course Objective:** This lab course provides students with hands-on experience and exposure to innovative solutions that address social, industrial, and environmental challenges, fostering a culture of innovation and quality control.

**Course Outcomes (COs)**

| CO | Course Outcomes | Highest Level of Cognitive Domain | Working Knowledge |
|---|---|---|---|
| **CO1** | Understand environmental problems in industries and organizations | L4 | 1,2,3 |
| **CO2** | Establish intricate links between laboratory activities to address industrial problems. | L4 | 3,4,5 |
| **CO3** | Provides adequate input for developing practical solutions for innovative Research with creative thinking. | L4 | 4,5,6 |

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

**Course delivery**

- Environmental problems for attributes: air, noise, water, and land in industry and related environmental policies.
- Life Cycle Assessment (LCA)
- Lab scale studies for identified problems in industries.
- Use of Laboratory experimental results for industrial application.
- Water and Energy balance and operation and maintenance cost
- Manufacturing, sources of pollution, and treatment process
- Solid and Hazardous waste management
- Environmental Health and Safety, emergency, and disaster preparedness in Industries.
- Modification of existing pollution control systems and retrofit.

- Scale-up of laboratory experiments for implementation in pilot and real-scale conditions.
- EIA and Audits.
- Documentation protocols in industries
- Incremental/disruptive innovations for exercising environmental control.

***Note: The student group can choose from the above content for Industry-Institute Interaction Program & Innovative Research depending on the research needs. The student group should give two progress presentations and submit the final report endorsed by the guide.***

**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 | - | - | 3 | 3 | 3 | 3 |
| CO2 | 3 | - | - | - | 2 | - | - | 3 | 2 | - | 3 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | - | - | 2 | 3 | - | 2 | 3 | 3 | 3 | 3 |

**High – 3, Medium – 2, Low – 1**

| *Department: Environmental Engineering* | | | | | | |
|---|---|---|---|---|---|---|
| ***Course Code:** 24EV750P* | | ***Course Title:** Project Work Phase - 1* | | | | |
| ***Total Credits: 2 L-45; T-0; P-30; SL&TW: 45*** | | ***SDGs addressed:4,9, 12,17*** | ***Course Category: PWC*** | | ***Course Type:** Mini Project* / Project work | |
| ***Teaching Learning Process*** | | ***Contact Hours/Semester*** | ***Assessment Weightage and Marks*** | | | |
| | ***Lecture*** | | | **CIE** | **SEE** | **Total** |
| | ***Tutorial*** | | ***Weightage, %*** | ***100*** | ***-*** | ***-*** |
| | ***Practical*** | | ***Maximum Marks*** | ***40*** | ***-*** | ***40*** |
| | ***Self-learning & Term work*** | | | | | |
| | ***Total*** | | ***Minimum Marks*** | ***20*** | ***-*** | ***20*** |

**Course Pre-Requisite: NIL**

**Course Objective:** The project work trains the students to carry out a literature review, identify the Gaps/problems, devise workable objectives and methodology, conduct the investigation following Engineering ethics, and analyze, interpret, and present the findings and thus develop creative thinking, Planning, time management, leadership qualities, and managerial skills.

**Course Outcomes (COs)**

| CO | Course Outcomes | Highest Level of Cognitive Domain | Working Knowledge |
|---|---|---|---|
| **CO1** | Conduct a systematic review of literature, identify research gaps, and define objectives and scope of work | L4 | **1,2,6** |
| **CO2** | Develop skills in terms of design, conducting investigations, and data analytics | L4 | **3,4,5** |
| **CO3** | Develop oral and written communication skills for report preparation, paper publication, and technical presentation | L4 | **6,7** |

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

- Each team shall be associated with a faculty member serving as an internal guide to supervise the mini project.
- If the team is conducting the project work in an industry or an organization an external guide is to be chosen from the industry or organization (along with an internal guide) with the approval of the Head of the Department

- The team will work with the project guide /supervisor towards the identification of the problem through a systematic literature review and finalize the objectives and scope of work.
- The team is expected to come out with detailed specifications, methodology, resources required, critical issues, and **any other issues related to the design, and implementation of the project should be provided in consultation with Guide.**
- The team should submit the proposal within ten working days from the commencement of the semester to the Head of Department after due approval from the guide.
- The student will work with the project guide/supervisor towards the identification of the problem through a systematic literature review and will finalize the objectives and scope of work.
- The student will present a synopsis and submit the same to the Department Under- Graduate Committee (DUGC) after due approval from the guide.
- The student will present the work progress as part of the review during the 1st phase of the project work.
- The DUGC and guide will jointly evaluate the student performance.
- The team is expected to exert responsibility for the design, development, and testing of the proposed work as per the schedule.
- The team should present an interim progress review as per the department calendar of events.
- Completed MINI projects/project work phase -1 documentation should be in the form of a report and the report should be submitted to the department at the end of the semester.
- The report should include an Abstract, Content sheets, an Introduction chapter with objectives, a literature review chapter, a materials and methodology chapter, a results and discussion chapter, summary, and a conclusion followed by a reference list and appendix if any.
- The team should make a final presentation at the end of the semester as per the department Calendar of events.

**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 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 |

**High – 3, Medium – 2, Low –1**

# 8th Semester

# Syllabus

<table>
<tr><td colspan="7">Department: Environmental Engineering</td></tr>
<tr><td colspan="2">Course Code: 24EV811</td><td colspan="5">Course Title: Green Technology</td></tr>
<tr><td colspan="2">Total Credits: 3<br>L-45; T-0; P-0; SL&TW: 45</td><td>SDGs addressed:<br>6,7,8,9,12,13</td><td colspan="2">Course Category:<br>PEC -VII</td><td colspan="2">Course Type:<br>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 student must score a Minimum of 45 Marks (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 green technological principles and practices to address environmental challenges and promote sustainability.

**Course Outcomes (COs)**

| CO | Course Outcomes | Highest Level of Cognitive Domain | Working Knowledge |
|---|---|---|---|
| **CO1** | Understand the concepts and principles of green technology and sustainable development | **L2** | **1, 6** |
| **CO2** | Evaluate and analyze renewable energy technologies and their applications. | **L3** | **3, 4** |
| **CO3** | Design and develop green buildings using energy-efficient systems and sustainable materials | **L3** | **3, 4, 5** |
| **CO4** | Develop cleaner production and treatment mechanisms for pollution prevention. | **L4** | **3, 4, 5** |
| **CO5** | Design and implement suitable energy-efficient systems and processes. | **L4** | **5, 6, 7** |

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

**Course Syllabus**

| Unit No. | Course Content | Hours Lecture |
|---|---|---|
| **1** | Definition and Scope of Green Technology. Principles and Concepts of Sustainable Development. Environmental Challenges and the Need for Green Technology. Life Cycle Assessment and Environmental Impact Analysis. Green Technology Innovations and Applications.<br>**Self-Learning and Term work**<br>● Case study on sustainable practices<br>● Literature survey on LCA<br>● Executive summary of EIA reports - mitigative measures | 07 |
| **2** | Green Fuels – Definition-benefits and challenges – comparison of green fuels with conventional fossil fuels concerning environmental, economic, and social impacts- public policies and market-driven initiatives. Biomass energy: Concept of biomass energy utilization, types of biomass energy, conversion processes, Wind Energy, energy conversion technologies, their principles, equipment, and suitability in the Indian context; tidal and geothermal energy. Solar Energy Systems and Technologies. Hydroelectric Power Systems and Technologies.<br>**Self-Learning and Term work**<br>● Hydrogen as alternate fuel<br>● 4 generations of biofuel<br>● Case study of green fuel implemented in the country | 10 |
| **3** | Principles of Green Building Design. Energy-Efficient Building Systems and Techniques. Sustainable Building Materials and Technologies. Green Building Certification Systems (e.g., LEED, GRIHA). Case Studies on Green Building Projects<br>**Self-Learning and Term work**<br>● Purpose of Green Building Rating Systems<br>● Energy Conservation Building Code<br>● Integrated Energy Policy | 09 |
| **4** | Cleaner development technologies: Definition – Importance – Historical evolution – mechanism - Principles of Cleaner Production–Benefits–Promotion – Barriers – Role of Industry, Government and Institutions – clean development mechanism, reuse, recovery, recycle, raw material Substitution-Wealth from waste, case studies, carbon credits, carbon trading, carbon sequestration, eco-labeling.<br>**Self-Learning and Term work**<br>● Case studies on zero waste management<br>● Case studies on zero liquid discharge<br>● Drawbacks of waste to wealth technology | 10 |

| | | |
|---|---|---|
| **5** | Energy-efficient systems and processes: Energy efficient motors, energy-efficient lighting, control and selection of luminaries; biofuels, fuel cells-working, selection of fuels, green manufacturing systems, selection of recyclable and environment-friendly materials in manufacturing, design, and implementation of sustainable green production systems.<br>**Self-Learning and Term work**<br>● Field survey on energy efficient systems<br>● Star rating of various appliances used in campus<br>● Star rating of various appliances used at home | 09 |

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

**Text Books:**

- "Green Technology: An Introduction" by M.O. Garg and Anu Garg
- "Sustainable Development and Green Technology" by P. Ramesh Babu
- "Green Building: Concepts and Techniques" by Raja Rizwan Hussain

**Reference Books:**

- "Green Building: Guidebook for Sustainable Architecture" by Michael Bauer
- Jay Warmke, Annie Warmke, Green Technology, Educational Technologies Group, 2009.
- "Renewable Energy Technologies: A Practical Guide for Beginners" by Chetan Singh Solanki

**Journals/Magazines:**

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

**Web/Digital resources:**

- Green Building Standards and Certification Systems, **https://www.wbdg.org/resources/green-building-standards-and-certification-systems**
- Introduction to clean technology **https://link.springer.com/chapter/10.1007/978-94-011-1312-0_6**
- Energy efficiency technologies and benefits **https://www.unido.org/sites/default/files/2009-02/Module12_0.pdf**

**SWAYAM/NPTEL:**

- Sustainable Energy Technology by Dr. Sayak Banerjee, IIT Hyderabad. Technologies For Clean and Renewable Energy Production by Prof. P. Mondal, IIT Roorkee.

## Course Articulation:

| Course Outcomes | Program Outcomes | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | - | - | - | - | 3 | - | - | - | - | 3 | 3 | - | - |
| CO2 | 3 | - | 3 | 2 | - | 3 | 3 | - | 3 | - | 3 | 3 | 2 | 3 |
| CO3 | 3 | - | - | - | - | 3 | - | - | - | - | - | 3 | - | - |
| CO4 | 3 | 2 | 3 | - | - | 3 | 3 | 2 | 3 | - | 3 | 3 | - | 3 |
| CO5 | 3 | - | 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: 24EV812</td><td colspan="4">Course Title: Application of Statistics in Environmental Engineering</td></tr>
<tr><td colspan="3">Total Credits: 3<br>L-45; T-0; P-0; SL&TW: 45</td><td>SDGs addressed: 6,11,12,13,16</td><td colspan="2">Course Category: PEC - VII</td><td>Course Type: Theory</td></tr>
<tr><td rowspan="6">Teaching Learning Process</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 student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**Course Pre-Requisite:** Engineering Mathematics

**Course Objective**: The student will have an overall understanding of statistics, types, and applications for effective management of environmental data. It covers a wide range of statistical aspects including data characteristics and grouping, correlation & regression, probability, testing hypotheses, and time series analysis.

**Course Outcomes (COs)**

| CO | Course Outcomes | Highest Level of Cognitive Domain | Working Knowledge |
|---|---|---|---|
| **CO1** | Describe the different forms of data, characteristics of data and its grouping, and frequency analysis. | **L3** | **1, 3** |
| **CO2** | Identify the skewness of the data, moving average, and weighted mean concepts | **L2** | **2, 3** |
| **CO3** | Summarize and evaluate the data distribution using random and non-random sampling, variance, probability, and probability distribution | **L3** | **3, 4** |
| **CO4** | Interpret different types of correlation coefficients for a given set of data using linear, non-linear, and multiple regression techniques | **L3** | **3, 5** |
| **CO5** | Use of time series analysis of data to establish trend and seasonal variations and methods of testing hypotheses | **L3** | **5, 6** |

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

**Course Syllabus:**

| Unit No. | Content | Hours Lecture |
|---|---|---|
| **1** | Introduction; Sample and Population; Discrete and Continuous; Collection, Arranging, and Presentation of data; Sturge's rule; Frequency grouping; Frequency and relative frequency distribution; Cumulative frequency. Frequency polygon; Ogives; Problems.<br>**Self-Learning and Term work**<br>● Use Excel or Google Sheets for arranging/presenting.<br>● Plot graphs by hand first, then use tools (Excel, Desmos).<br>● Excel, Google Sheets, Python (pandas, matplotlib) | 09 |
| **2** | Characteristics of Distributions: Central Tendency – Averages: Arithmetic mean, Scatter Diagrams; (Ungrouped data & Grouped data); Median (Ungrouped data & Grouped data); Mode (Ungrouped data & Grouped data); Skewness; Geometric mean; Weighted mean; Moving averages – equations to river hydraulics; Problems.<br>Characteristics of Distributions: Dispersion – Range; Interquartile Range; Variance; Standard Deviation (Population & Sample); Bessel's correction; Mean Deviation; Coefficient of Variation; Problems.<br>**Self-Learning and Term work**<br>● Plot scatter diagrams, box plots, and time-series graphs using Excel or GeoGebra.<br>● Python (NumPy, pandas, matplotlib) – Advanced analysis<br>● Desmos / GeoGebra – Graphs<br>● R (optional) – Statistical computing | 09 |
| **3** | Probability distributions: Binomial distribution – derivation; Poisson distribution – derivation; Normal distribution – errors, Gauss function, Area under normal curve, Use of normal probability distribution table; Problems. Sampling and Sampling Distributions: Types – random and non-random.<br>**Self-Learning and Term work**<br>● Use Python/Excel to plot distributions for different values of p and n.<br>● Python Libraries: numpy, scipy.stats, matplotlib, seaborn | 09 |
| **4** | Correlation and Regression Analysis: Correlation coefficient; Multiple correlation coefficient; Simple linear regression; Multiple regression equation; Estimation using regression line; Determination of linear variables-Method of Least Squares; Standard error of estimate; Time Series; Problems<br>**Self-Learning and Term work**<br>● Visualize correlations using scatter plots (Excel / Python / Desmos).<br>● Use Excel's Data Analysis ToolPak or Python (scikit-learn).<br>● SPSS / R: For formal statistical analysis. | 09 |

| | | |
|---|---|---|
| **5** | Testing Hypotheses: Concepts; Null hypothesis; Level of Significance; Degrees of Freedom; Hypothesis testing - Chi-Squared test; F distribution; t-test; Analysis of Variance (ANOVA); Problems.<br>Applications of AI and ML in Statistical data analysis<br>**Self-Learning and Term work**<br>● Perform t-tests on small sample data in Excel or Python<br>● Use interactive tools like StatQuest or Desmos | 09 |

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

**Text Books:**

- Adam M. Neville and John B. Kennedy, (1966), "Basic Statistical Methods for Engineers and Scientists", 2nd Edition, IEP
- Richard I. Levin and David S. Rubin, "Statistics for Management" (2020), Prentice Hall of India Pvt. Ltd., New Delhi.

**Reference Books:**

- George E. P. Box, William G. Hunter, and J. Stuart Hunter, "Statistics for Experiments - An Introduction to Design, Data Analysis, and Model Building", John Wiley & Sons.

**Journals/Magazines:**

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

**Web/Digital Resources**

- **https://unstats.un.org/unsd/environment/envpdf/UNSD_VietNam_Workshop/FundEnvStat.pdf**
- **https://youtu.be/GhyFKDUjn5A**

**Swayam/NPTEL Course:**

- Engineering Statistics by Prof. Manjesh Hanawal, IIT Bombay.
- Biostatistics and Mathematical Biology by Dr. Felix Bas, Central University of Punjab, Bathinda

**Course Articulation:**

| Course Outcomes | Program Outcomes | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO2 | PO 3 | PO 4 | PO 5 | PO 6 | PO7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PSO 1 | PSO 2 | PSO 3 |
| CO1 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 | 2 | 3 | 2 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 | 2 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 | 2 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 | 2 | 3 | 2 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 3 | 3 | 3 | 2 | 3 | 2 |

High – 3, Medium – 2, Low – 1

| *Department: Environmental Engineering* | | | | | | |
|---|---|---|---|---|---|---|
| ***Course Code: 24EV813*** | | ***Course Title: Corporate Social Responsibility Compliance*** | | | | |
| ***Total Credits: 3<br>L-45; T-0; P-0; SL&TW: 45*** | | ***SDGs addressed: 6,13,14,15,17*** | ***Course Category: PEC -VII*** | | ***Course Type: Theory*** | |
| ***Teaching Learning Process*** | | ***Contact Hours/Week*** | ***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 student must score a Minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**Course Pre-Requisite:** Environmental Social Governance

**Course Objective:** Upon completion of this course, students will be able to design and implement comprehensive CSR strategies that integrate environmental, social, and governance considerations, and communicate their impact to stakeholders through effective reporting and disclosure practices, while ensuring compliance with global frameworks, standards, and regulatory requirements.

**Course Outcomes (COs)**

| CO | Course Outcomes | Highest Level of Cognitive Domain | Working Knowledge |
|---|---|---|---|
| **CO1** | Define and explain the concept of CSR, its evolution, and its importance in business | **L2** | **7, 8** |
| **CO2** | Environmental Responsibility - Assess and develop strategies to reduce environmental impacts and promote sustainable practices in organizations. | **L2** | **5, 6** |
| **CO3** | Social Responsibility - Develop and implement policies and practices that promote labor standards, human rights, diversity, equity, and inclusion in organizations. | **L2** | **3, 4, 5** |
| **CO4** | Ethical Governance and Compliance - Design and implement ethical decision-making processes, transparency, and accountability measures to ensure compliance with laws and regulations. | **L2** | **9** |

| | | | |
|---|---|---|---|
| **CO5** | Implementation and Reporting - Develop and communicate CSR strategies, goals, and performance metrics to stakeholders through effective reporting and disclosure practices. | **L2** | **5, 6** |

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

**Course Syllabus:**

| Unit No. | Content | Hours Lecture |
|---|---|---|
| **1** | **Introduction to CSR Compliance -** Definition and evolution of CSR - Business case for CSR - Global frameworks and standards - ISO 26000, UN Global Compact - Regulatory requirements and legal considerations - CSR in the digital age - The role of stakeholders in CSR - CSR and risk management - CSR reporting and transparency.<br>**Self-Learning and Term work**<br>● CSR Policy<br>● CSR implications on business<br>● Socially conscious and environmentally sustainable marketing | 08 |
| **2** | **Environmental Responsibility -** Environmental impact assessment and management - Sustainable practices and operations - Climate change and carbon footprint reduction - Resource conservation and waste management - Biodiversity and ecosystem protection - Water stewardship - Environmental justice and equity - Green technology and innovation.<br>**Self-Learning and Term work**<br>● Extreme climate events<br>● Disaster capitalism<br>● CSR implications on global supply chain | 10 |
| **3** | **Social Responsibility -** Labor standards and human rights - Diversity, equity, and inclusion - Community engagement and development - Supply chain management and procurement practices - Human trafficking and modern slavery - Child labor and youth employment - Indigenous rights and cultural heritage - Social impact assessment and measurement.<br>**Self-Learning and Term work**<br>● Zero tolerance for child or forced labor<br>● Anti-discrimination policies<br>● Case study of Unilever implementing strict labor standards across its supply chain. | 10 |

| | | |
|---|---|---|
| **4** | **Ethical Governance and Compliance -** Ethical decision-making and leadership - Transparency and accountability - Anti-corruption and bribery - Data privacy and security – Whistle blowing and speak-up culture - Conflict of interest and ethics in decision-making - Board diversity and oversight - Compliance program development and implementation.<br>**Self-Learning and Term work**<br>● Ethical AI development in governance<br>● Principles of ethical leadership<br>● Visit a nearby industry and prepare a write up on ethical governance practices specific to that industry | 08 |
| **5** | **Implementation and Reporting** - CSR strategy development and integration - Performance metrics and monitoring - Reporting and disclosure - GRI, SASB - Stakeholder engagement and communication - CSR and integrated reporting - Digital reporting and data visualization - Assurance and verification of CSR reports - CSR communication and storytelling.<br>Application and AI and ML in CSR activity<br>**Self-Learning and Term work**<br>● Hebbal Lake rejuvenation, case study of Infosys<br>● Reading case study - Sustainability Report by Wipro<br>● Reading case study - Sustainability Report by JK Tires | 09 |

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

**Textbooks:**

- "Corporate Social Responsibility: Doing the Most Good for Your Company and Your Cause" by Philip Kotler and Nancy Lee
- "CSR and Sustainability: From Green to Gold" by Peter A. Soyka
- "The CSR Revolution: How the Triple Bottom Line Can Help Your Business" by John Elkington 4. "Corporate Social Responsibility: A Very Short Introduction" by Jeremy Moon
- "Sustainable Value: How the World's Leading Companies Are Doing Well by Doing Good" by Stuart L. Hart

**Reference Books:**

- "ISO 26000:2010 - Guidance on Social Responsibility"
- "UN Global Compact: The Ten Principles"
- "GRI Standards: Sustainability Reporting"
- "SASB Standards: Sustainability Accounting"
- "The CSR Reporting Handbook" by Robert G. Eccles and George S. Serafeim

**Journals:**

- Journal of Corporate Social Responsibility
- Sustainability
- Business Ethics Quarterly
- Journal of Business Ethics 5. Corporate Social Responsibility and Environmental Management

**Web/Digital Resources:**

- Master Course in Corporate Social Responsibility (CSR), Corporate Social Responsibility, Climate Change, Environmental, Social and Governance, Sustainability, CSR Created /offered by: Jose Prabhu

**Swayam NPTEL Course:**

- Corporate social responsibility by Prof. Aradhna Malik, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc21_mg54/preview
- Corporate social responsibility by Prof. Aradhna Malik, IIT Kharagpur. https://elearn.nptel.ac.in/shop/nptel/corporate-social-responsibility/?v=c86ee0d9d7ed

**Course Articulation:**

| Course Outcomes | Program Outcomes | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO2 | PO 3 | PO 4 | PO 5 | PO 6 | PO7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PSO 1 | PSO 2 | PSO 3 |
| CO1 | 3 | 3 | 3 | - | - | 3 | 3 | - | - | - | - | 2 | - | 2 |
| CO2 | 3 | - | - | - | - | 3 | 3 | - | 3 | - | 3 | 3 | 3 | - |
| CO3 | 3 | - | - | - | - | 3 | - | - | 3 | - | - | - | - | 1 |
| CO4 | 3 | - | - | - | - | - | - | 3 | 3 | 3 | - | - | - | 1 |
| CO5 | 3 | 3 | - | - | 3 | - | 3 | - | - | 3 | - | 3 | 3 | 3 |

High – 3, Medium – 2, Low – 1

| *Department: Environmental Engineering* | | | | | | |
|---|---|---|---|---|---|---|
| ***Course Code: 24EV814*** | | ***Course Title: Operation and Maintenance of Environmental Facilities*** | | | | |
| ***Total Credits: 3 L-45; T-0; P-0; SL&TW: 45*** | | ***SDGs addressed: 3,6,9,12,13,16*** | ***Course Category: PEC-VII*** | | ***Course Type: Theory*** | |
| ***Teaching Learning Process*** | | ***Contact Hours/Week*** | ***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 student has to score a minimum of 45 Marks (CIE+SEE: 20 + 25 or 21 + 24)**

**Course Pre-requisite:** Water Treatment and Supply Engineering, Wastewater Treatment Engineering, Atmospheric Environmental Engineering

**Course Objective:** The course encompasses intricate aspects regarding the operation and maintenance of environmental facilities.

**Course Outcomes (COs)**

| CO | Course Outcomes | Highest Level of Cognitive Domain | Working Knowledge |
|---|---|---|---|
| **CO1** | Understands the need for O & M, basic principles, learn organization structure, work plan scheduling, and the necessity of automation in environmental facilities | **L2** | **3, 4** |
| **CO2** | Identity operational problems and develop a plan for corrective measures of water supply and treatment facilities | **L4** | **4, 5** |
| **CO3** | Explain the operational problems and provide corrective measures for wastewater collection and treatment facilities | **L4** | **3, 4, 5** |
| **CO4** | Develop sufficient knowledge of operational problems and remedial measures of air pollution control equipment | **L4** | **4, 6** |
| **CO5** | Gains knowledge on O&M of sanitary and hazardous waste disposal facilities. | **L4** | **5, 6** |

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

**Course Content:**

| Unit No. | Content | Hours Lecture |
|---|---|---|
| **1** | **Operation, Maintenance & Management:** Aims, Basic Principles, Data Base Facilities, Drawings, Detailed Plans, Record Keeping, Organizational Structure, Work Planning and Scheduling, Operation Manuals. Training needs and planning. Automation in O & M of Water and Wastewater systems. O & M costing for environmental facilities.<br>**Self-Learning and Term work**<br>● Principle mapping: Match O&M principles to real-world scenarios<br>● Importance of data integrity and traceability<br>● Work scheduling simulation: Assign tasks and timelines using Gantt tools | 09 |
| **2** | **Water Supply Facilities**<br>Operational Problems and Corrective Measures for Intakes, pumps, rising mains, Distribution System - Loss of carrying capacity in pipes, Projection of Pipe Break Rates, Leak Detection and Control. Appurtenances – Valves, Hydrants, and Fittings.<br>**Water Treatment Facilities**<br>Operational Problems and Corrective Measures for Screens, Aeration Unit, Sedimentation Tank, Clariflocculator, tube settlers, Pulsators, Filtration, Disinfection units and advance treatment units.<br>**Self-Learning and Term work**<br>● Emergency response to a major pipeline burst or pump failure<br>● Build and annotate treatment flow diagrams with failure points and corrective actions<br>● Learn standard operation procedures | 09 |
| **3** | **Wastewater Collection Facilities:** Operational Problems and Corrective Measures in Sewer Network, Inspection Methods, Safety Methods, Appurtenances and Pumps.<br>**Wastewater Treatment Facilities:** Operational Problems and Corrective Measures for Screening, Grit chamber, aeration tanks, trickling filters and bio-towers, SBR and Membrane techniques, settling tanks, Sludge Thickener, sludge digesters, sludge drying beds, Disinfection units. Operation & Maintenance of Fecal Sludge Treatment Plant.<br>**Self-Learning and Term work**<br>● Appurtenance Mapping: Create a schematic of appurtenance locations and functions | 09 |

| | | |
|---|---|---|
| | ● Process Flow Mapping: Annotate treatment flow diagrams with failure points and corrective actions<br>● Maintenance Checklists | |
| **4** | **Air Pollution Control Facilities:** Operational Problems and Corrective Measures for Gravity Settlers, Cyclone Separators, Bag Filters, Scrubbers, Electrostatic Precipitators, and Gaseous Emission Control Devices – Absorption Beds and Adsorption Columns, Thermal Oxidizers, Incinerators.<br>**Self-Learning and Term work**<br>● Maintenance planning: Develop inspection and cleaning schedules<br>● Failure analysis: Investigate causes of premature bag failure<br>● Performance audit: Evaluate collection efficiency and energy consumption | 09 |
| **5** | **O & M of disposal facilities:** Operational Problems and Corrective Measures for engineering landfill, hazardous and biomedical waste disposal facilities.<br>**Recent trends**: Preventive and predictive O&M strategies, online monitoring of Environmental quality parameters.<br>Application of AI and ML in operation and maintenance of Environmental facilities<br>**Self-Learning and Term work**<br>● Slope failure simulation: Use geotechnical models to assess risk and mitigation<br>● Regulatory mapping: Align facility operations with national/international standards<br>● Interdisciplinary response drill: Coordinate between O&M, environmental, and health teams | 09 |

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

**Text Books:**


- Metcalf & Eddy Inc, (2014), "Wastewater Engineering, Treatment and reuse"-4th Edition, Tata McGraw Hill Publishers Co. Ltd, New Delhi
- Hammer, M.J., (2013), "Water and Wastewater Technology–SI Version" -2nd Edition, John Wiley and Sons.
- William L Neumann, (1997) "Industrial Air Pollution Control Systems" – McGraw- Hill Professional.
- Walski, T.M. (1987), "Analysis of Water Distribution Systems" – CBS Publications, New Delhi.
- Raju, B. S. N., (1991), "Water Supply and Wastewater Engineering" – Tata McGraw-Hill Publishing Co. Ltd.

**Reference Books:**

- Training Manual on O&M for Municipal Staff", Asian Development Bank, Government of Karnataka.
- CPHEEO, (1999), "Manual on water supply and Treatment", Ministry of Urban Development, GoI, New Delhi.
- CPHEEO, (2013), "Manual on Sewerage and Sewage Treatment", Ministry of Urban Development, GoI, New Delhi.
- Manual on Solid Waste Management" – CPHEEO (2016)

**Journals/Magazines:**

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

**Web/ Digital resources:**

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

**SWAYAM/ NPTEL:**

- Water Quality Management Practices by IIT Kharagpur
- Water and wastewater treatment by IIT Roorkee
- Physico-chemical processes for wastewater treatment by IIT Roorkee

**Course Articulation:**

| Course Outcomes | Program Outcomes | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO2 | PO 3 | PO 4 | PO 5 | PO 6 | PO7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PSO 1 | PSO 2 | PSO 3 |
| CO1 | 3 | 3 | - | 3 | 3 | - | - | - | - | - | 3 | 3 | - | 3 |
| CO2 | 3 | 3 | – | 3 | 3 | - | - | - | - | - | 3 | 3 | - | 3 |
| CO3 | 3 | 3 | - | 3 | 3 | - | - | - | 1 | - | 3 | 3 | 1 | 3 |
| CO4 | 3 | 3 | - | 3 | 3 | - | - | - | - | - | 3 | 3 | - | 3 |
| CO5 | 3 | 3 | - | 3 | 3 | - | - | - | 1 | - | 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: 24EV82P</td><td colspan="5">Course Title: Project Work Phase - II</td></tr>
<tr><td colspan="2">Total Credits: 10<br>L-0; T-0; P-20; SL&TW: 00</td><td>SDGs addressed: 4,6,8,9,12,13,17</td><td colspan="2">Course Category: PWC</td><td colspan="2">Course Type: Project work</td></tr>
<tr><td rowspan="6">Teaching Learning Process</td><td></td><td>Contact Hours/Week</td><td colspan="4">Assessment Weightage and Marks</td></tr>
<tr><td>Lecture</td><td>-</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>20</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></td></tr>
<tr><td>Total</td><td>300</td><td>Minimum Marks</td><td>20</td><td>25</td><td>45*</td></tr>
</table>

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

**Course Pre-Requisite:** Environmental Engineering subjects

**Course Objective:** The project work trains the students to carry out literature review, identify the Gaps/problems, devise workable objectives and methodology, conduct the investigation following Engineering ethics, and analyze, interpret, and present the findings and thus develop technical creative thinking, planning, time management, leadership qualities and managerial skills.

**Course Outcomes (COs)**

| CO | Course Outcomes | Highest level of Cognitive Domain | Working Knowledge |
|---|---|---|---|
| **CO1** | Conduct a systematic review of technical literature, identify research gaps, and define objectives and scope of work | **L4** | **3, 4, 5** |
| **CO2** | Develop skills in terms of design, conducting investigations and data analytics | **L4** | **3, 4, 5** |
| **CO3** | Develop oral and written communication skills for report preparation, paper publication, and technical presentation | **L4** | **6, 7** |

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

**Course Syllabus:**

- Each student shall be associated with a faculty member serving as his/her guide to supervise the dissertation work.
- Periodic progress review presentations of the project work shall be according to the

calendar of events scheduled by the University.

- The student will work with the project guide/supervisor towards the identification of the problem through a systematic literature review and will finalize the objectives and scope of work.
- The student will present a synopsis and submit the same to the Department Under-Graduate Committee (DUGC) during the 1st phase and after due approval from the guide.
- During the 2nd phase, students will present the work progress as part of a review of the project work.
- The DUGC and guide will jointly evaluate the student performance.

**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 | 3 | - | - | - | - | 3 | 1 | 3 | 3 | 3 | 3 |
| **CO2** | 3 | 3 | 2 | 3 | 2 | - | - | - | 3 | - | 3 | 3 | 3 | 3 |
| **CO3** | - | - | - | 3 | 2 | 1 | 1 | 1 | 3 | - | 3 | 3 | 3 | 3 |

High – 3, Medium – 2, Low – 1