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| **INSTITUTE** | **FACULTY OF TECHNOLOGY** |
| **PROGRAM** | **BACHELOR OF TECHNOLOGY (CIVIL ENGINEERING)** |
| **SEMESTER** | **6** |
| **COURSE TITLE** | **WATER AND WASTEWATER ENGINEERING** |
| **COURSE CODE** | **01CI1622** |
| **COURSE CREDITS** | **4** |

**Objective:**

1. To apply engineering principles to design and operate water and wastewater treatment systems.
2. To analyze performance of treatment processes and distribution/collection systems under varying conditions.
3. To evaluate conventional and advanced technologies for efficiency, sustainability, and cost-effectiveness.
4. To understand & create innovative, data-driven solutions using emerging technologies (AI/ML, modeling/simulation) for smart water and wastewater management.

**Course Outcomes:** After completion of this course, student will be able to:

1. Apply design principles to conventional and advanced water and wastewater treatment units.
2. Analyze treatment plant performance using experimental data, simulation models, and case studies.
3. Evaluate the sustainability, efficiency, and limitations of various treatment technologies.
4. Apply & Analyze AI/ML tools and specialized software for smart treatment system design and optimization.

**Pre-requisite of course:**Basic knowledge of Environmental Pollution and Environmental Engineering.

**Teaching and Examination Scheme**

| Theory Hours | Tutorial Hours | Practical Hours | ESE | IA | CSE | Viva | Term Work |
|---|---|---|---|---|---|---|---|
| 3 | 1 | 0 | 50 | 30 | 20 | 25 | 25 |

| Contents : Unit | Topics | Contact Hours |
|---|---|---|
| 1 | **Fundamentals of Water & Wastewater Treatment** Sources and characteristics of water & wastewater, Oxygen sag curve, Water quality parameters and standards (IS, CPCB, WHO), General layout of water and wastewater treatment plants, Overview of treatment processes (physical, chemical, biological) | 8 |

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| Contents : Unit | Topics | Contact Hours |
|---|---|---|
| 2 | **Conventional Water Treatment Processes**<br>Sedimentation, theory and design principles, Coagulation and flocculation, mixing devices, Filtration (slow sand, rapid sand, pressure filters), design of filters, Disinfection (chlorination, ozone, UV methods), Removal of hardness, iron, manganese, and other organics | 10 |
| 3 | **Wastewater Treatment Processes**<br>Primary treatment: screening, grit chamber, primary sedimentation, Secondary treatment: Activated Sludge Process (ASP), Secondary treatment: Trickling filter, RBC, MBBR, Anaerobic processes (UASB, anaerobic digesters), Tertiary treatment: nutrient removal, advanced filtration, disinfection | 10 |
| 4 | **Advanced & Sustainable Treatment Technologies**<br>Membrane processes: Microfiltration (MF), Ultrafiltration (UF), Nanofiltration (NF), Reverse Osmosis (RO) / Hyperfiltration, Advanced oxidation processes (ozone, UV/H2O2, photocatalysis), Natural treatment systems: constructed wetlands, stabilization ponds, Water reuse, recycling, and resource recovery (biogas, nutrients, energy) | 8 |
| 5 | **Emerging Technologies, AI/ML & Software Applications**<br>Applications of AI/ML in process optimization and predictive maintenance, Digital twins, IoT-based monitoring and smart sensors, Simulation and modeling software (EPANET, SWMM, BioWin, GPS-X etc.), Data analytics, automation (case studies) | 6 |
| **Total Hours** | | **42** |

**Suggested List of Experiments:**

| Contents : Unit | Topics | Contact Hours |
|---|---|---|
| 1 | **Tutorial-1**<br>Case discussion on water quality & treatment units: Analyze real water quality data and identify suitable treatment processes. | 2 |
| 2 | **Tutorial-2**<br>Numerical on sedimentation & clariflocculator design: Solve problems on settling velocity, tank dimensions, and clariflocculator sizing. | 2 |
| 3 | **Tutorial-3**<br>Design problems on screens & grit chambers: Apply design criteria to size bar screens and grit chambers for flow handling. | 2 |
| 4 | **Tutorial-4**<br>Design exercise on membrane/oxidation process: Work out process design steps for membrane filtration or oxidation units for specific contaminants. | 2 |
| 5 | **Tutorial-5**<br>Software simulation (EPANET/SWMM demo); Demonstrate hydraulic modeling for stormwater systems. | 2 |

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**Suggested List of Experiments:**

| Contents : Unit | Topics | Contact Hours |
|---|---|---|
| 6 | **Tutorial-6**<br>Case study analysis on WTP/WWTP: Review an existing water/wastewater treatment plant design and operation. | 2 |
| 7 | **Tutorial-7**<br>Design problem on WTP/WWTP: Prepare a complete process flow and unit design for a water or wastewater treatment plant. | 2 |
| **Total Hours** | | **14** |

**Textbook :**

1 Environmental engineering volume 1 and 2, S.K. Garg, Khanna publisher, 2016

**References:**

1 Environmental engineering volume 1 and 2, Environmental engineering volume 1 and 2, B.C. Punamia, Laxmi publication, 2018

2 Water supply and sanitary engineering, Water supply and sanitary engineering, G.S. Birdie and J.S. Birdie., DHANPAT RAI, 2021

3 Environmental pollution engineering, Environmental pollution engineering, C.S. Rao, Wiley eastern, 2017

**Suggested Theory Distribution:**

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

| Distribution of Theory for course delivery | | | | | |
|---|---|---|---|---|---|
| **Remember / Knowledge** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Higher order Thinking / Creative** |
| 5.00 | 5.00 | 30.00 | 25.00 | 30.00 | 5.00 |

**Instructional Method:**

1 The course delivery method will depend upon the requirement of content and the needs of students. The teacher, in addition to conventional teaching method by white board, may also use any of tools such as collaborative learning, demonstration, role play, Quiz, brainstorming, MOOCs, Active Learning Assignments etc.

2 The internal evaluation will be done based on continuous evaluation of students in the classroom and tutorial sessions.

3 Students will use supplementary resources such as online videos, Swayam, NPTEL videos, e-courses.

**Supplementary Resources:**

1 https://onlinecourses.nptel.ac.in/noc21_ce25/preview

**Supplementary Resources:**

2 https://onlinecourses.nptel.ac.in/noc21_ar13/preview

3 https://onlinecourses.nptel.ac.in/noc21_ce49/preview

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