# GUJARAT TECHNOLOGICAL UNIVERSITY

**Program Name: Master of Engineering**

**Level: PG**

**Branch: Chemical Engineering**

**Subject Code: ME02030031**

**Subject Name: Wastewater Treatment and Design**

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|---|---|
| w.e.f. Academic Year: | A.Y. 2024-25 |
| Semester: | 2 |
| Category of the Course: | Professional Elective Course |

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|---|---|
| **Prerequisite:** | A foundational knowledge of environmental engineering, chemical process engineering, and microbiology is essential to understand the principles of wastewater treatment and the associated processes. |
| **Rationale:** | This course equips students with the skills to design, evaluate, and optimize wastewater treatment systems, ensuring compliance with environmental standards. By integrating theory with practical applications, it prepares students to address real-world challenges in water management, contributing to sustainable practices and environmental protection. |

**Course Outcome:**

After Completion of the Course, Student will be able to:

| No | Course Outcomes |
|---|---|
| 01 | Explain the Characteristics and Regulatory Frameworks for Wastewater Management |
| 02 | Analyze and Apply Principles of Wastewater Treatment Processes |
| 03 | Design Key Wastewater Treatment Units |
| 04 | Evaluate Advanced and Specialized Wastewater Treatment Solutions |

**Teaching and Examination Scheme:**

| Teaching Scheme (in Hours) | | | Total Credits L+T+(PR/2) | Assessment Pattern and Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Tutorial/ Practical | | |
| L | T | PR | C | ESE (E) | PA/ CA (M) | PA/CA(I) | ESE (V) | |
| 3 | 0 | 2 | 4 | 70 | 30 | 20 | 30 | 150 |

**Course Content:**

| Unit No. | Content | No. of Hours | %of Weightage |
|---|---|---|---|
| 1. | **Introduction to Wastewater Treatment:** Sources and Types of Wastewater: Domestic, industrial, and combined wastewater, Characteristics of Wastewater: Physical, chemical, and biological | **4** | **9** |

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|---|---|---|---|
| | parameters, Regulatory Frameworks: National and international wastewater discharge standards. | | |
| 2 | **Principles of Wastewater Treatment:** Overview of Treatment Processes: Preliminary, primary, secondary, and tertiary treatment, Biological Treatment: Aerobic and anaerobic processes, microbial degradation pathways, Chemical Treatment: Coagulation, flocculation, and oxidation processes etc, Selection of Treatment System, Function of treatment Plant Units | **6** | **14** |
| 3 | **Design of Preliminary and Primary Treatment Units:** Essential Prerequisites, Design of Sump and Pump Wells of pumping station, Design of Approach channel, Design of Screen chamber, Design of Grit chambers, Aerated grit chambers, Oil and Grease Trap Design of Primary settling tank, Design of Flotation systems | **10** | **22** |
| 4 | **Design of Secondary Treatment Systems:** Activated Sludge Process: Design of aeration tanks and secondary clarifiers, Trickling Filters and Rotating Biological Contactors: Working principles and design, Sequencing Batch Reactors (SBRs) and Membrane Bioreactors (MBRs): Applications and design aspects, Anaerobic Treatment Systems: Upflow anaerobic sludge blanket (UASB) reactors, digesters. | **10** | **22** |
| 5 | **Advanced Wastewater Treatment and Tertiary Processes**: Nutrient Removal: Phosphorus and nitrogen removal processes, Membrane Filtration: Ultrafiltration, nanofiltration, and reverse osmosis, Disinfection Methods: Chlorination, UV treatment, and ozonation, Multi Effect Evaporator (MEP), Sludge Management: Dewatering, stabilization, and disposal methods. | **8** | **18** |
| 6 | **Wastewater Treatment for Industrial Applications:** Specialized Treatment Systems: Treatment of effluents from industries like textiles, pharmaceuticals, and chemicals, Emerging Contaminants: Removal of microplastics, heavy metals, and endocrine disruptors. | **3** | **6** |
| 7 | **Design and Case Studies:** Factors affecting plant layout and operation, Economic Analysis: Cost estimation and comparison of treatment options, Case Studies: Success stories in wastewater treatment plant implementation. | **4** | **9** |
| | **Total** | **45** | **100** |

**Suggested Specification Table with Marks (Theory):**

| Distribution of Theory Marks | | | | | |
|---|---|---|---|---|---|
| **R Level** | **U Level** | **A Level** | **N Level** | **E Level** | **C Level** |
| 10 | 15 | 15 | 15 | 10 | 5 |

*Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy*

**References/Suggested Learning Resources:**

**(a) Books:**

1. Water and Wastewater Engineering by M. L. Davis. 2017. 7th Ed. McGraw-Hill, ISBN: 978-1259064838
2. Waste water Treatment Concept and Design Approach by G L Karia, R A Christian, 2 nd edition, PHI Learning Pvt. Ltd.
3. Wastewater Engineering: Treatment and Resource Recovery by Metcalf & Eddy, 2013., 5th Ed, McGraw-Hill. ISBN13: 978-0073401188
4. Principles of Water and Waste Water Treatment Processes by Stuetz R and T Stephenson. 2009.. IWA Publishing, Alliance House, UK. 214p.
5. Wastewater Treatment for Pollution Control and Reuse by Arceivala S.J. and Asolekar S.R., 3rd Ed., Tata McGraw Hill, 2007.
6. Biological Wastewater Treatment: Principles, Modelling and Design by Henze M., van-Loosdrecht M.C.M., Ekama G.A. and Brdjanovic D., , IWA publishing, 2008.
7. Advanced Biological Processes for Wastewater Treatment: Emerging, Consolidated Technologies and Introduction to Molecular Techniques by Márcia Dezotti, Geraldo Lippel, João Paulo Bassin, , Springer Nature, 2018.
8. Biological wastewater treatment processes: mass and heat balances by Davide Dionisi.. CRC Press, 2017.
9. Basic Principles of Wastewater Treatment by Marcos von Sperling,. IWA Publishing, 2007.
10. Biological Wastewater Treatment by C. P. Leslie Grady, Glen T. Daigger, Nancy G. Love, Carlos D. M. Filipe.. Co-published by IWA Publishing & CRC Press, 2011.

**(b) Open source software and website:**

1. Students can refer to video lectures available on the websites including NPTEL lecture series.
2. Students can refer to the CDs available with some reference books for the solution of problems using software's /spreadsheets. Students can develop their own programs/spreadsheets for the solution of

problems.

**Suggested Course Practical List:**

1. Determination of physical (e.g., turbidity, color), chemical (e.g., BOD, COD), and biological (e.g., MPN) parameters of wastewater.
2. Jar test experiments to determine the optimal coagulant dose and pH for wastewater treatment.
3. Study the sedimentation process in a model tank and calculate settling velocities for different particle sizes.
4. Practical demonstration of grit removal and estimation of efficiency in a laboratory-scale grit chamber.
5. Experiment on oil and grease trap systems to determine efficiency and factors affecting separation.
6. Simulation of the activated sludge process in a lab setup to measure microbial activity and efficiency in organic matter removal.
7. Study the production of biogas in a laboratory anaerobic digester and analyze its composition.
8. Demonstration of ultrafiltration or reverse osmosis for wastewater treatment, including efficiency evaluation.
9. Practical study of phosphorus and nitrogen removal using chemical or biological methods.
10. Study of sludge dewatering and stabilization processes (e.g., centrifuge or drying beds) and measurement of moisture content reduction.

**Major Equipments** Turbidity Meter, pH Meter, Spectrophotometer, BOD Incubator, Jar Test Apparatus, Sedimentation Tank Setup, Oil and Grease Trap Setup, Activated Sludge Process (ASP) Unit, Anaerobic Digester, Membrane Filtration Unit, Nutrient Removal System, Sludge Dewatering Equipment

**Laboratory Facilities**

1. Waste water Sample Collection kit
2. Chemical Storage Cabinets
3. Fume Hoods and Waste Disposal Unit
4. Personal Protective Equipment (PPE)

**Suggested Project List:**

- Optimizing Activated Sludge Process
- Anaerobic Digestion plant design for Biogas Production
- Development of Adsorbent Materials for Waste Treatment
- Development of Low-cost Membrane Filtration Systems

- Electrocoagulation for Industrial Wastewater Treatment
- Magnetic Nanoparticles for Pollutant Removal
- Wastewater Reuse for Agriculture
- Nutrient Recovery from Wastewater
- Recovery of Energy from Wastewater
- Zero-Liquid Discharge (ZLD) Systems
- Production of Bio-plastics from Sludge
- Development of Eco-friendly Coagulants

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