GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Minor/Hons. Program

Level: UG

Branch: Minor/Hons. Waste Technology

Subject Code: BE050AB021

Subject Name : Design and Operation of Industrial Wastewater Treatment Process

w. e. f. Academic Year:	2026-2027
Semester:	5
Category of the Course:	Core Courses

Prerequisite:	A good understanding is required regarding the environmental science. Mathematical knowledge is also required.
Rationale:	The main objective of this subject is to design and understand the operation of industrial wastewater treatment process. This subject provides knowledge regarding the different processes involved in the treatment of industrial waste water as well as the design aspects.

Course Outcome:

After Completion of the Course, Student will able to:

Sr. No	Course Outcomes	Marks % Weightage
CO-01	To be able to design various components of Physico-Chemical treatment units.	21
CO-02	To be able to utilize various principles for design of biological treatment aerobic and anaerobic process.	27
CO-03	To select appropriate methods for industrial wastewater treatment processes through study of magnitude, characteristics and impacts of waste water.	27
CO-04	To analyze practical application in industries through case studies of various industries including CETPs and correlate them with ETP operation.	25

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	PBL*	TH	C	ESE (E)	PA (M)	PA(I)	PBL (I)	ESE (V)	
45	30	00	45	120	04	70	00	00	30	50	150

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Design Principles of Physico-Chemical Treatment Units:** Coagulation and flocculation, design of clari-flocculator, Sedimentation; concept and design of high-rate sedimentation techniques. Filtration- Design of filter media for slow and rapid sand filter, Design of sewage treatment plant units-screen chamber, Grit chamber, Trickling filters.	12	25
2.	**Design Principles of Biological Treatment Aerobic and Anaerobic Process:** Kinetics of biological growth; Design of activated sludge process and its modifications. Anaerobic treatment-High-rate anaerobic treatment processes; sludge stabilization and design of anaerobic digesters, Activated sludge process.	10	27
3.	**Industrial Wastewater Treatment Processes:** Introduction-magnitude of industrial pollution, their characteristics and impacts; selection procedure for physical, chemical and biological methods of industrial wastewater treatment.	12	21
4.	**Practical Applications in Industries:** Important aspects of Treatment Plant Operation, Trouble shooting, planning, Case Studies-Manufacturing process description; pollution sources, waste reduction and treatment methods for industries, small scale industries and pollution issues, concept of CETPs, concept of zero discharge.	11	27
	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	20	20	10	10	0

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. Design of Municipal Wastewater Treatment Plants: WEF Manual of Practice No. 8 ASCE Manuals and Reports on Engineering Practice No. 76, 5th Edition, 2010.
2. E. D. Schroeder, Water and Waste Water Treatment, McGraw Hill., 1979.
3. S. J. Arceivala, Waste Water Treatment and Disposal, Marcel Dekker Inc., 1981.
4. G. Tchobanoglous, Frank Burton QC, Waste water Engineering: Treatment, Disposal and Reuse, Metcalf and Eddy Inc., McGraw-Hill, 1991.
5. G. L. Karia & R. A. Christian, Waste Water Treatment, PHI Publication.

(b) Open-source software and website:

1) SWAYAM (Study Webs of Active-Learning for Young Aspiring Minds) does offer relevant open online courses you can use to learn the design principles and treatment processes you asked about. SWAYAM is the Indian government MOOC platform supported by the Ministry of Education.
2) SIMPO – Wastewater Process Modelling Platform, pollutant transport, treatment system analysis, Website: https://www.epa.gov/water-research/storm-water-management-model-swmm

(C) Suggested Course Practical List: (Minimum 6 experiments need to be performed)

List of Laboratory/Learning Resources Required:

1) Overall design of sewage treatment plant units.
2) To design treatment unit like clari-flocculator.
3) To design treatment unit like filtration systems.
4) To design treatment unit like conventional activated sludge process.
5) To design different treatment aeration devices.
6) To design treatment unit like trickling filter.
7) To determine chloride content of waste water sample.
8) To determine nitrogen and phosphorus of waste water.

Suggested Project List:

Sr. No	Name of the Project	Description / Objective
1	Design of Coagulation–Flocculation and Clari-Flocculator Unit	To design physico-chemical treatment units for removal of suspended and colloidal impurities.
2	Design and Performance Analysis of High-Rate Sedimentation System	To study concept, design, and efficiency of tube or plate settlers in sedimentation tanks.
3	Design of Slow Sand and Rapid Sand Filtration Systems	To design filter media and compare operational aspects of slow and rapid sand filters.
4	Design of Sewage Treatment Plant Units (Screen, Grit Chamber and Trickling Filter)	To design preliminary and secondary treatment units of a sewage treatment plant.
5	Design of Activated Sludge Process and Its Modifications	To design ASP based on biological kinetics and evaluate different process modifications.
6	Design of High-Rate Anaerobic Treatment System (UASB Reactor)	To design anaerobic reactor for wastewater treatment and estimate biogas generation.
7	Industrial Wastewater Characterization and Selection of Treatment Methods	To analyse industrial effluent characteristics and select suitable physical, chemical and biological treatment processes.

8	Case Study on CETP and Zero Liquid Discharge (ZLD) Concept	To study common effluent treatment plant operation and zero liquid discharge approach for industries.

Suggested Activities for Students:

Sr. No	Name of the Activity	No. of Hours	Evaluation Criteria
1	Technical Video-Based Learning on Physico-Chemical Treatment Units (Coagulation, Flocculation, Sedimentation)	10 (Video: 5 h + Report: 5 h)	Concept clarity, quality of report, linkage with design principles
2	Design Exercise on Clari-Flocculator and High-Rate Sedimentation Units	8 (Design: 4 h + Submission: 4 h)	Correctness of design, assumptions, presentation
3	Case Study Analysis of Rapid and Slow Sand Filtration Systems	6 (Study: 3 h + Report: 3 h)	Understanding of filtration media design, comparative analysis
4	Laboratory Demonstration & Report on Jar Test for Coagulation	6 (Lab: 3 h + Report: 3 h)	Data interpretation, procedural accuracy
5	Design Assignment on Preliminary Treatment Units (Screen & Grit Chamber)	8 (Design: 4 h + Viva/Submission: 4 h)	Design accuracy, application of standards
6	Study of Trickling Filter Design and Performance Evaluation	6 (Study: 3 h + Report: 3 h)	Technical understanding, use of design parameters
7	Technical Seminar on Aerobic & Anaerobic Biological Treatment Processes	6 (Preparation: 3 h + Presentation: 3 h)	Technical depth, communication skills
8	Numerical Problems on Kinetics of Biological Growth and ASP Design	8 (Problems: 4 h + Evaluation: 4 h)	Accuracy of calculations, conceptual clarity

9	Case Study on Activated Sludge Process Modifications (SBR, Extended Aeration, Oxidation Ditch)	6 (Study: 3 h + Report: 3 h)	Understanding of process selection, analysis
10	Design Exercise on Anaerobic Digesters and Sludge Stabilization	8 (Design: 4 h + Submission: 4 h)	Design methodology, use of kinetic concepts
11	Industrial Wastewater Characterization and Treatment Method Selection	8 (Study: 4 h + Report: 4 h)	Justification of treatment methods, relevance to industry
12	Group Case Study on CETPs and Zero Liquid Discharge (ZLD) Systems	10 (Study: 5 h + Presentation: 5 h)	Teamwork, practical understanding, solution approach

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