INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad -500 043

CIVIL ENGINEERING

COURSE DESCRIPTOR

Course Title	INDUSTRIAL WASTEWATER TREATMENT				
Course Code	ACE526				
Programme	B. Tech				
Semester	VI	CE			
Course Type	Elective				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mr. Balakrishna, Assistant Professor				
Course Faculty	Mr. Balakrishna, Assistant Professor Dr. J S R Prasad, Professor				

I. COURSE OVERVIEW:

This course provide an understanding of the mechanisms and processes used to treat Industrial waste water that have been contaminated in some way by anthropogenic industrial or commercial activities prior to its release into the environment or its re-use. To understand various terms used in industrial waste water treatment and to acquaint with different steps involved in treatment of industrial waste water. To understand Wastewater treatment technologies or advanced waste water treatment methods. The major goal of wastewater treatment plants is to eventually produce water that can be reused for various purposes or disposes of in a more ecological and healthy way. Waste water treatment is a major element of water pollution control.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS009	II	Environmental Studies	3

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Industrial Waste Water Treatment	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✘	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory		Total Marks
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):
Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

	Program Outcomes (POs)	Strength	Proficiency assessed by
PO6	**The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	2	Assignments/ Exams
PO7	**Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	2	Seminars/ NPTEL
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	1	Assignments
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	Assignments/ NPTEL

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

	Program Specific Outcomes (PSOs)	Strength	Proficiency assessed by
PSO1	**Engineering Knowledge**: Graduates shall demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good foundation in mathematics, basic sciences and technical communication.	-	-
PSO2	**Broadness and Diversity**: Graduates will have a broad understanding of economic, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage.	2	Lectures, Assignments
PSO3	**Self-Learning and Service**: Graduates will be motivated for continuous self-learning in engineering practice and/or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly.	-	-

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VIII. COURSE OBJECTIVES:

	The course should enable the students to:
I	Enrich the knowledge on sources and characteristics of industrial wastewater.
II	Discuss the different methods of waste water treatment such as de-nitrification, membrane separation, air stripping, etc.
III	Understand the characteristics and composition of wastewater generated from industrial processes.
IV	Design and operate effluent treatment plants for joint treatment of raw industrial wastewater and domestic sewerage.

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Distinguish between the quality of domestic and industrial water requirements and Wastewater quantity generation.	CLO 1	Know the Sources of pollution
		CLO 2	Understand the Physical, chemical, organic and biological properties of industrial wastes.
		CLO 3	Define the Characteristics and composition of waste water.
		CLO 4	Effects of industrial effluents on sewers and natural water bodies.
CO 2	Understand the industrial process, water utilization and waste water generation.	CLO 5	Understand the different stages of pre and primary treatment of Industrial wastewater
		CLO 6	Describe the process of Equalization and Proportioning
		CLO 7	Explain the Neutralization process.
		CLO 8	Understand oil separation by floatation process.
		CLO 9	Describe the waste Reduction, volume reduction processes.
		CLO 10	Understand the strength Reduction and the process involved in it
CO 3	Acquire the knowledge on operational problems of common effluent treatment plants.	CLO 11	Explain the importance of waste Treatment methods.
		CLO 12	Understand the process involved in Nitrification and De-nitrification stages of waste water treatment.
		CLO 13	Understand the process involved in phosphorous removal and Heavy Metal removal.
		CLO 14	Understand the process involved in Air stripping and Absorption techniques in treatment method.
		CLO 15	Analyse the special treatment methods and process of disposing treated waste water
CO 4	Impart knowledge on selection of treatment methods for industrial wastewater.	CLO 16	Understand the procedure and process of disposing treated waste water
		CLO 17	Analyse and understand the characteristics and Composition of waste water.
		CLO 18	Manufacturing processes of industries like sugar, steel, petroleum refineries.
		CLO 19	Understand the Characteristics of Industries like Petroleum Refineries.
CO 5	Specify design criteria for physical, chemical, and biological unit operations.	CLO 20	Characteristics and composition of industries like textiles, tanneries.
		CLO 21	Characteristics and composition of industries like atomic energy plants and other mineral processing industries

COs	Course Outcome	CLOs	Course Learning Outcome
		CLO 22	Joint treatment of raw industrial waste water and domestic sewage.
		CLO 23	Common effluent treatment plants location, design, and operation and maintenance problems.

X. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
ACE526.01	CLO 1	Know the different sources of wastewater pollution from industries.	PO 6, PO 10	2
ACE526.02	CLO 2	Understand the Physical, chemical, organic and biological properties of industrial wastes.	PO 6, PO 7	2
ACE526.03	CLO 3	Define the Characteristics and composition of waste water.	PO6, PO 8	2
ACE526.04	CLO 4	Effects of industrial effluents on sewers and natural water bodies	PO 7	2
ACE526.05	CLO 5	Understand the different stages of pre and primary treatment of Industrial wastewater	PO 6	2
ACE526.06	CLO 6	Describe the process of Equalization and Proportioning	PO 6	2
ACE526.07	CLO 7	Explain the Neutralization process.	PO 6, PO 7	2
ACE526.08	CLO 8	Understand oil separation by floatation process.	PO 8	2
ACE526.09	CLO 9	Describe the waste Reduction, volume reduction processes.	PO 7	2
ACE526.10	CLO 10	Understand the strength Reduction and the process involved in it	PO 6	2
ACE526.11	CLO 11	Explain the importance of waste Treatment methods.	PO 6	2
ACE526.12	CLO 12	Understand the process involved in Nitrification and De-nitrification stages of waste water treatment.	PO 6	2
ACE526.13	CLO 13	Understand the process involved in phosphorous removal and Heavy Metal removal.	PO 6, PO 8, PO 10	2
ACE526.14	CLO 14	Understand the process involved in Air stripping and Absorption techniques in treatment method.	PO 6	2
ACE526.15	CLO 15	Understand the process involved in Membrane Separation Process.	PO 6	1
ACE526.16	CLO 16	Analyse the special Treatment Methods.	PO 6, PO 10	2
ACE526.17	CLO 17	Understand the procedure and process of disposing treated waste water	PO 6	1
ACE526.18	CLO 18	Analyse and understand the characteristics and Composition of waste water.	PO 8	2
ACE526.19	CLO 19	Manufacturing processes of industries like sugar, steel, petroleum refineries.	PO 7, PO 8	2
ACE526.20	CLO 20	Understand the Characteristics of Industries like Petroleum Refineries.	PO 6, PO 7, PO 10	2
ACE526.21	CLO 21	Characteristics and composition of industries like textiles, tanneries, atomic energy plants and other mineral processing industries.	PO 6, PO 7, PO 10	2
ACE526.22	CLO 22	Joint treatment of raw industrial waste water and domestic sewage.	PO 6	3

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
ACE526.23	CLO 23	Common effluent treatment plants location, design, and operation and maintenance problems.	PO 6	3

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XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (POs)				
	PO 6	PO 7	PO 8	PO 10	PSO 2
CO 1	2	2			2
CO 2	2	3	1	1	
CO 3	3	2		1	2
CO 4	2	2		1	2
CO 5	2	2	1	2	3

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XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1						2				2				2	
CLO 2						2	2							2	
CLO 3						2		2							
CLO 4							2							2	
CLO 5						2								2	
CLO 6						2									
CLO 7						2	2								
CLO 8								2							
CLO 9							2								
CLO 10						2								1	
CLO 11						2								1	
CLO 12						2								1	
CLO 13						2		1		2					

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 14						2									
CLO 15						1									
CLO 16						2				2				2	
CLO 17						1									
CLO 18								2							
CLO 19							2	2						2	
CLO 20						2	1			1					
CLO 21						2	2			1				2	
CLO 22						3								1	
CLO 23						3								1	

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XIII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO6, PO7, PO8, PO10 PSO2	SEE Exams	PO6, PO7, PO8, PO10 PSO2	Assignments	PO6, PO7, PO8, PO10	Seminars	PO6,PO7, PO8, PO10
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XIV. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XV. SYLLABUS

Unit-I	CHARACTERISTICS OF INDUSTRIAL WASTE WATER
Sources of pollution, physical, chemical, organic and biological properties of industrial wastes, difference between industrial and municipal waste waters, effects of industrial effluents on sewers and natural water bodies	
Unit-II	COMMMON TYPES OF TREATMENT PROCESS
Pre and primary treatment, equalization, proportioning, neutralization, oil separation by floatation, waste reduction, volume reduction, strength reduction.	
Unit-III	DESCRIPTION OF MAIN TREATMENT METHODS
Waste treatment methods, nitrification and denitrification, phosphorous removal, heavy metal removal, Membrane separation process, air stripping and absorption processes, special treatment methods, disposal of treated waste water	

Unit-IV	**WASTE WATER FROM DIFFERENT INDUSTRIES**

Characteristics and composition of waste water and manufacturing processes of industries like sugar, characteristics of industries like food processing industries, steel, petroleum refineries

Unit-V	**COMPOSTION OF WASTE WATER AND COMMON EFFLUENT TREATMENT PLANTS**

Characteristics and composition of industries like textiles, tanneries, atomic energy plants and other mineral processing industries, joint treatment of raw industrial waste water and domestic sewage, common effluent treatment plants location, design, operation and maintenance problems.

Text Books:

1. Metcalf and Eddy, "Wastewater engineering Treatment disposal reuse", Tata McGraw-Hill, 4th Edition, 2002.
2. Eckenfelder, W.W., "Industrial Water Pollution Control", McGraw-Hills, 3rd Edition, 1999.

Reference Books:

1. M.N. Rao and Dutta, "Waste Water treatment", Oxford and IBH publishing, 2009.
2. Mark J. Hammer, Mark J. Hammer, Jr., "Water & Wastewater Technology", Prentice Hall of India, 2013.
3. N.L. Nemerrow, "Theories and practices of Industrial Waste Engineering", B H Elsevier, 2007.
4. C.G. Gurnham, "Principles of Industrial Waste Engineering", Wiley, 1955.

XVI. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-2	Sources of pollution	CLO 1	T1: 2.1 - 2.2 R2: 7.2-7.3
3-4	Physical, chemical, organic and biological properties of industrial wastes	CLO 2	T1: 2.3 - 2.6
5-6	Physical, chemical, organic and biological properties of industrial wastes	CLO 2	T1: 2.7 - 2.9 R2:7.5
7-8	Difference between industrial and municipal waste waters	CLO 3	T1: 3.1 - 3.6 R2:7.8
9-10	Difference between industrial and municipal waste waters	CLO 4	T1: 3.8 - 3.10 R2:7.9
11-12	Effects of industrial effluents on sewers and natural water bodies	CLO 5	T1: 4.1 - 4.6
13-14	Pre and primary treatment, equalization, Proportioning	CLO 6	T1: 6.1 - 6.3 R2:7.7, 7.10
15-16	Neutralization, oil separation by floatation.	CLO 7	T1: 6.1 - 6.3 R1: 7.3, 7.4
17-19	Waste reduction, volume reduction, strength reduction.	CLO 8	T1: 6.1 - 6.3 R1: 12.6
20-22	Waste treatment methods, nitrification and denitrification.	CLO 9	T1: 6.1 - 6.3 R1: 12.7
23-25	Waste treatment methods, nitrification and denitrification.	CLO 10	T1: 6.1 - 6.3
26	Removal of phosphorous from waste water.	CLO 11	T1: 7.1 - 7.6
27-30	Heavy metal removal, Membrane separation process.	CLO 12	T1: 8.1 - 8.9 R1:12.3, 12.4
31-32	Air stripping and absorption processes, special treatment methods, disposal of treated waste water.	CLO 14	T4:9.6-11 R2:12.5.1
33-34	Air stripping and absorption processes, special treatment methods, disposal of treated waste water	CLO 14	

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
35-38	Characteristics and composition of waste water	CLO 15	T4: 10.1 - 10.7 R2:12.5.1
39-44	Manufacturing processes of industries like sugar, characteristics of industries like food processing industries, steel, petroleum refineries.	CLO 14	T1: 11.4 - 11.7 R2:12.5.1
45-49	Manufacturing processes of industries like sugar, characteristics of industries like food processing industries, steel, petroleum refineries.	CLO 16	T1: 16.1 - 16.9
50-55	Characteristics and composition of industries like textiles, tanneries, atomic energy plants and other mineral processing industries.	CLO 17	T1: 17.1 - 17.6
56	Joint treatment of raw industrial waste water and domestic sewage.	CLO 19	T1: 18.1 - 18.6
57-58	Common effluent treatment plants location, design.	CLO 21	T1: 7.1-3
59-60	Operation and maintenance problems.	CLO 23	T1: 12.1-3 R2:12.4

XVII. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Knowledge of characteristics and composition of Industrial wastewater.	Seminars/Lectures	PO 6, PO7	PSO 2
2	Understand different wastewater treatment methods.	Assignments /NPTEL	PO 8, PO10	PSO 2

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