Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-V

Course Title: Environment Engineering and Pollution Control
(Course Code: 4350608)

Diploma program in which this course is offered	Semester in which offered
Civil Engineering	5th Semester

1. RATIONALE

After learning basic concepts of Environmental Engineering in second semester, this subject is introduced as an elective subject in 5th semester for all those students who are willing to study some advanced topic related to environment. This subject includes causes and preventive measures of different types of pollution, treatment processes for water and wastewater, solid waste separation and their disposal methods, environmental audits and environmental impact assessment. Environment is a global issue and environmental impact assessment is compulsory for all industries and major infrastructure projects. Therefore, this subject has been designed in such a way that students will have advanced knowledge of land survey, waste management, inspection and testing, environmental audit etc. and they can have career opportunities in this area.

2. COMPETENCY

The aim of this course is to help the students to attain the following industry identified competency through various teaching learning experiences:

- **Diagnose and manage environment related issues.**

3. COURSE OUTCOMES (COs)

The theory should be taught and the exercises should be done in a way that allows students to illustrate the course objectives by demonstrating various learning outcomes in the cognitive, psychomotor, and affective domains to demonstrate following courses outcomes.

[1] Suggest suitable methods for biodiversity conservation.
[2] Identify sources of pollution and use standards for measurement and prevention of Water, Air & Noise pollution.
[3] Suggest advanced wastewater treatment processes according to the quality of wastewater.
[4] Identify and segregate solid waste and suggest suitable method for proper disposal.
[5] Interpret findings of Environmental Impact Assessment (EIA)and suggest suitable steps for reducing the pollution in the given situation.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T/2+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate the integration of COs, and the remaining 20 marks is the average of 2 tests to be taken during the semester for assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *-Practical;* ***C*** *– Credit,* ***CA*** *- Continuous Assessment;* ***ESE*** *-End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the Sub-components of the COs. *Some of the* ***PrOs*** *marked* ***'*'*** *are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.*

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Determine pH value of water sample	II	2*
2	Determine Turbidity of water sample	II	2*
3	Determine B.O.D. of domestic wastewater sample	II	2*
4	Determine concentration of Fine Particulate matter PM(2.5) in ambient air	II	2*
5	Determine concentration of Respirable Suspended Particulate Matter PM(10) in ambient air	II	2*
6	Measurement of noise at different sources using Sound meter	II	2*
	Draw labelled sketch of:	II	4*
7	• Wastewater treatment plant	III	
8	• Membrane filtration	III	
9	• Advanced Oxidation Processes (AOPs)	III	
10	• Biological Nutrient Removal (BNR)	III	
11	• Membrane Bioreactors (MBRs)	III	
12	• Advanced Sludge Treatment	III	
13	• Constructed Wetlands	III	
14	• Mechanical Processing for materials recycling : Magnetic Separation , Optical Sorting, Screening	IV	
15	• Waste Heat recovery from flue gases, Waste heat Recovery boilers.	IV	
	Visits		
16	GPCB Laboratory	II/III	2*
17	Industry where stake-sampling can be carried out.	II	2*
18	Solid waste Management Plant	IV	2*
19	Sewage Treatment Plant	III	2*
20	Seminar		4*
Total			28

Note

i. *More* ***Practical Exercises*** *can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

ii. *The following are some* ***sample*** *'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed* ***Practical Exercises*** *of this course required which are embedded in the COs and ultimately the competency.*

S. No.	Sample Performance Indicators for the PrOs	Weight age in %
	For PrOs 1 to 6	
1	Identify components	10
2	Prepare experimental setup	20
3	Operate the equipment setup	20
4	Follow safe practices	10
5	Record observations correctly	20
6	Interpret the result and conclude	20
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment's with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practical in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No
1.	Combo PM_{10} and $PM_{2.5}$ sampler with size selective inlet for PM_{10} and automatic volume inflow control, filter jacket, flow measuring device to control the air flow.	**4,5**
2	BOD Incubator: Double walled construction with PUF thermal insulation, 5 degree Centigrade to 60 degree Centigrade Temperature range, Chamber Volume above 200 Liters, Glasswares, Chemicals and D.O.Meter.	**3**
3	Digital pH meter: pH range 0 to 14.00 pH, Resolution 0.01pH,1 mV, LED display with pH electrode (0 to 14pH),buffer tablets , stand and clamp and Glasswares.	**1**
4	Digital Nephelometric Turbidity Meter:90 degree scattered light measurement nephelometer, highest value for turbidity in NTU range 1000, Resolution 0.01 and with glass cells.	**2**
5	Digital Sound Level Meter.	**6**

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned Cos and PrOs. More could be added to fulfil the development of this competency.

a) Demonstrate working as a leader/a team member.
b) Follow safety practices on site.
c) Follow ethical practices.
d) Practice environmental friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. **UNDERPINNING THEORY** Only the major Underpinning Theory is formulated as higher level UOs of *Revised Bloom's taxonomy* in order for the development of the COs and competency is not missed out by the students and teachers. If required, more such higher-level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit – I Introduction & Environment problems, Emerging Technologies for Environment Engineering	1.a State importance of Environmental Engineering 1.b State components of Environment. 1.c Elaborate Ecology and Ecosystem 1.d Use Ecological "pyramid " concept of numbers , Biomass , Energy 1.e Use Emerging technologies for Environment management	1.1 Importance of Environmental engineering 1.2 Component of Environment i Atmosphere ii Hydrosphere iii Lithosphere iv Biosphere 1.3 Need for public awareness 1.4 Concept of Ecology 1.5 Ecosystem 1.6 Components of Ecosystem i Abiotic ii Biotic 1.7 Balanced Ecosystem 1.8 Ecological Pyramid i Pyramid of Numbers ii Pyramid of Biomass iii Pyramid of Energy 1.9 Biochemical Cycle i Hydrological cycle ii Nitrogen Cycle iii Phosphorus cycle iv Sulphur cycle 1.11 Biodiversity 1.12 Emerging technologies for environment management i Hydrogen fuel cell usage ii Plant your roof 1.13 Ocean thermal energy conversion

Unit -II Environmental Pollution & its remedial measures	2.a Identify sources of land pollution and take preventive measures for reduction 2.b Identify sources of Water pollution and take preventive measures for reduction 2.c Identify sources of Air pollution and take preventive measures for reduction. 2.d Identify sources of Noise pollution and take preventive measures to reduce noise in buildings. 2.e Use standards to measure Water, Air & Noise pollution. 2.f Identify Characteristics of Solid waste, Bio-medical waste & E-waste and segregate them for proper disposal.	2.1 Definition of Pollution, types – Natural and Artificial. 2.2 Land Pollution 2.2.1 Causes 2.2.2 Effects and preventive measures. 2.3 Water Pollution 2.3.1 Sources of water 2.3.2 Water pollutants from different sources, effects on environment. 2.3.3 Preventive measures. 2.3.4 IS Standards for water quality. 2.3.5 Flow diagram of water treatment plant, water conservation. 2.3.6 Determination of pH value & Turbidity of water sample. 2.4 Wastewater 2.4.1 Generation (Domestic and Industrial) 2.4.2 Hazardous effects 2.4.3 Flow diagram of sewage treatment plant. 2.4.4 CPCB and GPCB norms for sewage disposal. 2.4.5 Determination of BOD & COD of domestic wastewater sample. 2.5 Air Pollution 2.5.1 Causes 2.5.2 Effects 2.5.3 Prevention 2.5.4 Air Pollutants: Particulate pollutants, Ambient Air quality standards, Stack and Ambient air sampling 2.5.5 CPCB and GPCB norms for Air Pollution. 2.5.6 Determination of concentration of Fine Particulate matter PM(2.5) & Respirable Suspended Particulate Matter PM(10) in ambient air. 2.6 Noise Pollution 2.6.1 Sources 2.6.2 Effects 2.6.3 Measurement of Noise and Control of Noise Pollution & CPCB and GPCB norms for Noise Pollution. 2.6.4 Measurement of noise at different sources using Sound meter. 2.7 Municipal Solid Waste, Bio-Medical waste and E-waste - sources, generation, characteristics, effects and methods to manage.

Unit– III Advanced Waste Water Treatment Technology	3.a State advanced wastewater treatment. 3.b Identify components of wastewater treatment Process. 3.c Suggest suitable method of wastewater treatment process according to Emerging Technologies and future trends.	3.1 Introduction to Wastewater Management 3.1.1 Definition of wastewater 3.1.2 Importance of wastewater management 3.1.3 Overview of wastewater treatment processes 3.2 Wastewater Treatment Processes 3.2.1 Basic Concept of i Preliminary treatment: ii Secondary treatment: iii Tertiary treatment: nutrient removal 3.3 Methods of Advanced treatment processes: i Membrane filtration, ii Advanced Oxidation Processes (AOPs) iii Biological Nutrient Removal (BNR) iv Constructed Wetlands v Membrane Bioreactors (MBRs) vi Electrochemical Processes vii Advanced Sludge Treatment viii Advanced Monitoring and Control Systems 3.4 Emerging Technologies and Future Trends 3.4.1 Innovative wastewater treatment technologies. 3.4.2 Resource recovery and sustainability in wastewater management. 3.4.3 Challenges and opportunities in the field.
Unit – IV Solid Waste-Separation and Disposal	4.a Differentiate Recycling & Reuse. 4.b State the Heat Recovery from flue gases, Waste heat Recovery boilers. 4.c Identify and segregate different solid wastes considering relevant standards/policies. 4.d Suggest suitable method for proper disposal of solid waste.	4.1 Introduction of Recycling & Reuse of solid waste: 4.1.1 Concept 4.1.2 Application 4.2 Mechanical Processing for materials recycling : 4.2.1 Size Reduction: shredding, grinding, or crushing 4.2.2 Sorting and Separation: i Magnetic Separation ii Eddy Current Separation: iii Air Classification iv Optical Sorting v Screening vi Agglomeration vii Densification viii Washing and Cleaning ix Deinking x Refining and Purification

		4.3 Waste Heat recovery from flue gases, Waste heat Recovery boilers. 4.4 Methods for proper disposal of solid waste - Land fill, Incineration & Vermicomposting
Unit– V Environmental Audit and Environment Impact Assessment (EIA)	5.1 Justify necessity of Environmental audit for the given purposes 5.2 Carry out Environmental audit of the given building. 5.3 Carry out process of EIA for given building. 5.4 Interpret findings of EIA and suggest suitable steps for reducing the pollution in the given situation.	5.1 Environmental Audit 5.1.1 Necessity 5.1.2 Norms. 5.2 Types of Audit 5.2.1 Objective based types i Liabilities audit, ii Management audit, iii Activities audit 5.2.2 Client-driven types i Regulatory external audit ii Independent external audit iii Internal audit and third-party audit 5.3 EIA 5.3.1 Purpose of EIA 5.3.2 Regulations, steps in EIA process 5.3.3 Benefits of EIA 5.3.4 Limitations of EIA 5.3.5 Environmental clearance for the civil engineering projects.

***Note**: The UOs need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.*

8. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A	Total Marks
I	Introduction & Environment problems, Emerging Technologies for Environment Engineering.	8	3	3	6	12
II	Environmental Pollution & its remedial measures.	12	3	6	9	18
III	Advanced Waste Water Treatment Technology.	8	3	5	6	14
IV	Solid Waste - Separation and Disposal	8	3	5	8	16
V	Environmental Audit and Environment Impact Assessment (EIA)	6	2	3	5	10
Total		**42**	**14**	**22**	**34**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
***Note**: This specification table provides general guidelines to assist students in their learning and to teachers to teach and question paper designers/setters to formulate test*

items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U, and A) in the question paper may vary slightly from the above table.

9. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, the following are the suggested student-related ***co-curricular*** activities that can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct the following activities in groups and prepare reports of about 5 pages for each activity, also collect/record physical evidence for their (student's) portfolio which will be useful for their placement interviews:

a) Comparative study of RO systems available in nearby shops/dealers with photos.
b) Find the New Emerging technology for Environmental Management.
c) Visit Environment Consultant and carry out environmental audit with him and prepare report.
d) Collect photos and prepare report on segregation of solid/hazardous waste generated in nearby Hospital and their disposal site
e) Prepare report on Case study on Methods of Advanced treatment processes: Membrane filtration, Advanced Oxidation Processes (AOPs) etc.
f) Visit dumping site of solid waste treatment plant and prepare report on material recovery facility of dry waste, Biomethanation plant and organic waste compost machine.
g) Collect photos and prepare report on SCADA (Supervisory Control and Data Acquisition) operated treatment plant.
h) Collect list of NGOs working for environmental protection and prepare a report on their contribution.

10. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub M topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.11***, teachers need to ensure the creation of opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environmental and sustainability
g) Expert lecture by water resource engineer about the emerging scenario of this field or industry experts

11. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her at the beginning of the semester. In the first four semesters, the micro-project is

group-based. However, in the fifth and sixth semesters, it should preferably be ***individually*** undertaken to build up the skill and confidence in every student to become a problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-bawd, or field-based. Each macro-project should encompass two or more Cos which are in fact, integrations of PrOs, UOs and ADOs. Each student will have to maintain a date work diary consisting of individual contributions to the project work and given seminar presentation of it before submission. The total Duration of the micro-project work should not be less than 16 [sixteen] student engagement hours during the course. The student ought to submit a micro-project by the end the semester to develop the industry-oriented Cos.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Collect sample of raw sewage and treated sewage from sewage treatment plant and find the quality of treated wastewater by performing different tests.
b) Visit any nearby industry and carry out Air sampling and measure particulate pollutants and different gases and make the report for same.
c) Visit nearby PUC Centre and collect data of vehicular pollution.
d) Measure noise pollution using android application at various locations of institute building and city.
e) Collect sample of raw water and treated water from filter plant and find the quality of treated water by performing different tests.
f) Prepare a technical summary of Municipal Solid Waste types, Generation, Collection System, Dumping Methods, Bio degradable waste.
g) Case study of Recycle and Reuses of Mechanical Processes for materials
h) Prepare presentations on emerging topics or from the theory related to environmental engineering.

12. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year, and ISBN
1	New Technologies and Environmental Innovation	Joseph Huber	Edward Elgar ISBN- 9781843767992
2	Environmental Noise pollution, Causes, Evils	Vijendra Mahandiyan	Deep & Deep Publications Pvt. Ltd, Ned Delhi, ISBN: 81-7629-830-1
3	Air Pollution	M N Rao H V N Rao	TATA McGraw Hill Publication ISBN: -10. 9780074518717
4	Water pollution	B.K.Sharma	GOEL Publishing house, Meerut ISBN-10 : 8182831768
5	Text Book of Environmental Engineering	P.Venugopala Rao	PHI Learning Pvt.Ltd. ISBN : 9789390669240
6	Waste water treatment : advanced processes and technologies	D.G Rao R. Senthilkumar J. Anthony Byrne S.Feroz	CRC Press ,Taylor & Francis Group ISBN 13:978-178040-034-1

S. No.	Title of Book	Author	Publication with place, year, and ISBN
7	Environment Engineering: A Design Approach	Acrdio P. Sincero & Gregoria A. Sincero	TATA McGraw Hill Publication ISBN-
8	An Introduction to Global Environmental Issues	Kevin T. Pickering & Lewis A. Owen	Routledge , ISBN: 0 -415-16664-0
9	Solid Waste Management	Surendra Kumar	Northen Book Center New Delhi ISBN:81-7211-278-5
10	Recycling and Resource Recovery Engineering : Principle of waste processing	Richard Ian Stessel	Springer Publication ISBN 13 :978 – 3-642-80221-8
11	Environmental impact assessment	R.R Bathwal	New Age International Publishers ISBN:81-224-1357-9

13. SOFTWARE/LEARNING WEBSITES

1. https://archive.nptel.ac.in/courses/
2. Virtual Lab by Ministry of Education, Government of India https://www.vlab.co.in/
3. https://www.youtube.com/watch?v=2s2b5-EsmV0
4. https://gpcb.gujarat.gov.in/
5. https://www.cpcb.nic.in/
6. https://moef.gov.in/en/

5. PO-COMPETENCY-CO MAPPING

Semester IV	ENVIRONMENT ENGINEERING AND POLLUTION CONTROL (Course Code: 4350608)									
	POs and PSOs									
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning	PSO 1	PSO 2	PSO 3 (If needed)
Competency	• **Diagnose and manage environment related issues.**									
CO a) Suggest suitable methods for biodiversity conservation.	3	--	--	--	3	--	3			
CO b) Identify sources of pollution and use standards for measurement and prevention of Water, Air & Noise pollution.	3	3	--	3	3	---	3			
CO c) Suggest advanced wastewater treatment processes according to the	3	2	2	--	3	--	3			

quality of wastewater.										
CO d) Identify and segregate solid waste and suggest suitable method for proper disposal.	2	3	2	--	3	2	3			
CO e) Interpret findings of Environmental Impact Assessment (EIA) and suggest suitable steps for reducing the pollution in the given situation.	3	---	2	--	3	3	3			

Legend: '**3'** for high, '**2**' for medium, **'1'** for low or **'-'** for the relevant correlation of each competency, CO, with PO/ PSO

17. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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