GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)
Semester-VI

Course Title: Environmental Monitoring
(Course Code: **4361302**)

Diploma programme in which this course is offered	Semester in which offered
Environmental Engineering	Sixth

1. RATIONALE

The course in Environmental Monitoring provides an in-depth understanding of environmental monitoring techniques and methodologies. Students will learn to measure, analyze, and interpret environmental parameters crucial for assessing environmental quality. The course will cover air, water, soil, and noise monitoring, emphasizing practical applications and fieldwork.

2. COMPETENCY

The course content should be taught and with the aim to develop required skills in students so that they are able to acquire following competencies.

- **Perform various tests to measure the concentration of pollutants in environment (air, water, soil etc.) and analyse the gathered data with reference to permissible levels and if required suggest corrective actions.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) Understand the importance of environmental monitoring in environmental engineering.
b) Analyze monitoring data to identify potential environmental issues related to water, air, soil and noise.
c) Conduct environmental monitoring programs compliant with industry.

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 integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the 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'*.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Solve given problems based on objectives and functions of monitoring, selection of monitoring sites, types of monitoring programme.	I	04
2	Collect water samples from a local river, lake, or pond. Perform on-site measurements for parameters such as pH, dissolved oxygen, turbidity, and temperature. Determine metallic constituents, Chromium, Fe, Copper by spectrophotometer.	II	04
3	Conduct laboratory analysis for nutrients (nitrate, phosphate) and heavy metals for ground water sample.	II	04
4	Use handheld air quality meters to measure concentrations of particulate matter (PM2.5, PM10), nitrogen dioxide (NO2), sulfur dioxide (SO2), and carbon monoxide (CO) at different locations on campus or in the city. Analyze and interpret the collected data, comparing it with air quality standards.	III	04
5	Assess indoor air quality in different buildings on campus. Measure parameters such as CO2 levels, VOCs, and humidity. Discuss the potential sources of indoor air pollution and suggest improvements.	III	04
6	Solve given problems based on ambient air quality and stack monitoring. Solve given problems based on frequency and time of sampling. Solve given problems based on sampling locations. Determine NOx , SOx, CO and SPM using appropriate test methods	III	04
7	Collect soil samples from different locations on campus or nearby areas. Measure soil pH, organic matter content, and nutrient levels using basic field test kits. Discuss the significance of the results for soil quality.	IV	04
			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	Weightage in %
	For PrOs 1 to 7	
1	Identification of Glassware and Equipment to perform various test	10
2	Prepare experimental setup accurately	10
3	Observe and record readings accurately	40
4	Calculate results accurately	20
5	Interpret results and their conclusions	10
6	Submission for progressive assessment on time	10
7	Viva Voce	10
	Total	**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	• **Analytical Balance** • **High volume air sampler** • **Filter media** • **UV Spectrophotometer** • **Flame photometer** • **Distillation Assembly** • **Chemical testing glasswares** • **Hot air oven**	1 to 14

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 fulfill the development of this competency.

a) Work as a team member/ individual.
b) Follow ethical practices.
c) Follow safe practice on site and in laboratory.
d) Practice of environmental friendly methods and processes.

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 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 to Environmental Monitoring and Fundamentals of Monitoring Techniques**	1a. Describe the objectives and functions of monitoring. 1b. Select monitoring site according to type of monitoring program. 1c. Operate monitoring devices 1d. Collect and record data	1.1 Objectives and functions of monitoring. 1.2 Selection of monitoring sites. 1.3 Types of monitoring programme. 1.4 Environmental Variability. 1.5 Place and time and location of monitoring. 1.6 Different types of monitoring: continuous, intermittent, passive, and active 1.7 Sampling techniques and protocols 1.8 Measurement instruments and equipment, Calibration, maintenance, and operation of monitoring devices 1.9 Data collection and recording, qualitative and quantitative
Unit – II **Water Quality Monitoring**	2a. Describe Parameters and pollutants affecting water quality 2b. Perform laboratory tests for analyzing various contaminants	2.1 Parameters and pollutants affecting water quality 2.2 Sampling methods for various water sources 2.3 Laboratory analysis, 2.4 Common laboratory tests for water quality assessment: titration, colorimetry, spectrophotometry, Interpreting laboratory results and assessing compliance with water quality standards 2.5 Biological monitoring methods and their significance, Bioindicators and their use in determining water quality 2.6 Introduction to emerging contaminants (e.g., pharmaceuticals, microplastics) and their impact on water quality, advanced monitoring techniques (e.g., mass spectrometry, high-performance liquid chromatography) for detecting and analyzing emerging contaminants

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit– III **Air Quality Monitoring**	3a. Describe Parameters and pollutants affecting air quality 3b. Perform laboratory tests for analyzing various contaminants	3.1 Parameters and pollutants related to air quality 3.2 Sampling methods for gases and particulate matter 3.3 Data analysis and interpretation for air quality assessment, Interpretation of air quality data in relation to air quality standards and guidelines, Use of air quality indices to communicate air pollution levels 3.4 Analyzing temporal and spatial variations in air quality data 3.5 Indoor Air Quality Monitoring, Parameters affecting IAQ: volatile organic compounds (VOCs), radon, mold, and allergens 3.6 Monitoring techniques and strategies for assessing IAQ
Unit– IV **Soil Quality Monitoring**	4a. Describe Parameters and pollutants affecting soil quality 4b. Perform laboratory tests for analyzing various contaminants	4.1 Understanding key parameters affecting soil quality: soil pH, organic matter, nutrients (nitrogen, phosphorus, potassium), heavy metals, salinity, and texture 4.2 Sample collection, handling, preservation, and preparation for analysis 4.3 Techniques for determining heavy metal concentrations in soil 4.4 Soil Erosion and Conservation Monitoring 4.5 Soil Microbial and Biological Assessment 4.6 Soil Remediation and Restoration Techniques 4.7 Soil Quality Monitoring for Sustainable Agriculture

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A	Total Marks
I	Introduction to Environmental Monitoring and Fundamentals of Monitoring Techniques	12	08	10	03	21
II	Water Quality Monitoring	10	05	09	03	17
III	Air Quality Monitoring	10	06	09	03	18
IV	Soil Quality Monitoring	10	04	07	03	14
Total		**42**	23	**35**	**12**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions 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 above table.*

10. SUGGESTED STUDENT ACTIVITIES

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

a) Prepare a report after gathering information the values of water and air pollution in your town or city and compare the values with that of other cities.
b) Collect sample of water and air from the specific field location.
c) Prepare sketches for different types of Plume behavior.
d) Undertake micro-project.
e) Give seminar on any relevant topic.

11. 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 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.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environment and sustainability

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become 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 Six.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of 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) Design a small-scale air quality monitoring project in a local urban area. Measure and analyze pollutants such as PM2.5, PM10, NO2, and SO2 using portable air quality sensors.
b) Conduct water quality assessments on a nearby river or lake. Collect water samples, analyze parameters like pH, dissolved oxygen, and assess the overall water quality.
c) Assess soil health of college campus. Measure soil parameters such as pH, organic matter, and nutrient levels to provide recommendations for sustainable gardening practices.
d) Measure noise levels in and around your educational institution during different times of the day. Analyze the data to understand potential noise pollution and propose mitigation strategies.
e) Assess indoor air quality in residential buildings by measuring parameters like CO2 levels, VOCs, and humidity. Provide recommendations for improving indoor air quality.
f) Measure and analyze greenhouse gas emissions in a local park. Use portable gas analyzers to assess CO2, methane, and other relevant gases.
g) Assess groundwater quality of your college/city. Conduct sampling and analyze parameters like pH, nitrate, and heavy metals to understand the suitability for drinking water.
h) Conduct a biodiversity assessment in local urban green spaces. Identify and document plant and animal species, and assess the impact of human activities on biodiversity.
i) Measure light pollution levels in residential areas during different times of the night. Evaluate the impact on the environment and suggest strategies for reducing light pollution.
j) Conduct a waste audit in a local community or college. Assess the types and amounts of waste generated, and raise awareness about proper recycling practices.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Environmental Monitoring Handbook	Frank R. Burden Ulrich Foerstner Ian D. McKelvie Alex Guenther	The McGraw-Hill Companies, Inc 2002; ISBN: 9780071351768
2	Environmental Monitoring	Shyam Kishor Agarwal	APH Publishing, 2005, ISBN:9788176488242
3	Environmental Monitoring: Approaches and Perspectives	Dr. Vimala Singh, Dr. Deepika Saini	Immortal Publications, ISBN-13 : 978-93-5493-662-3
4	Environmental Monitoring and Analysis (2 Vols.)	P.K. Behera and S.K. Sahu	Dominant Publishers And Distributors (1 January 1993), ISBN-13 : 978−8178885285
5	Indian standard methods for analysis of water, air and soil parameters	BIS	BIS

14. SOFTWARE/LEARNING WEBSITES

a) www.gpcb.gov.in

b) https://cpcb.nic.in/about-namp/www.neeri.res.in

c) www.Nptel.ac.in

d) https://www.indiacode.nic.in/

15. PO-COMPETENCY-CO MAPPING

Semester II	Environmental Monitoring (Course Code:4361300)									
	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 Environmental planning & deisgn	PSO 2 Environmental Impact Assessment	PSO 3 (If needed)
Competency	i. Perform various tests to measure the concentration of pollutants in environment (air, water, soil etc.) and analyse the gathered data with reference to permissible levels and if required suggest corrective actions.									
Course Outcomes a) Understand the importance of environmental monitoring in environmental engineering.	3	3	-	-	3	-	2	3	3	-
b) Analyze monitoring data to identify potential environmental issues related to water, air, soil and noise.	3	3	3	3	3	-	2	3	3	-
c) Conduct environmental monitoring programs compliant with industry.	3	3	3	2	3	-	2	3	3	-

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

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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