**GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)**

**Competency-focused Outcome-based Green Curriculum-2022 (COGC-2022)**
Semester-IV

**Course Title: Environmental Chemistry-II**
(Course Code: **4341305**)

| Diploma programme in which this course is offered | Semester in which offered |
|---|---|
| Environmental Engineering | Fourth |

## 1. RATIONALE

This course will help the diploma environmental engineering students to understand the proper methods of sampling which is an important step in chemical analysis of water and waste water. This course also introduces them to various kinds of analytical technics like classical, colorimetry, electrochemical, chromatography and spectrophotometry. By acquiring the basic knowledge of analytical techniques, they can choose appropriate methods to determine the quantity of various parameters and presence of heavy metals in water and waste water. Quantifying the pollutants will help in choosing appropriate treatment methods.

## 2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competencies:

- **Perform sampling for chemical analysis to assess the quality of fresh & waste water.**
- **To select proper process or equipment for different tests for chemical analysis.**

## 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) Carry out proper sampling for chemical analysis
b) Identify appropriate method of chemical analysis from classical or colorimetry methods
c) Identify appropriate method of instrumental analysis from Electrochemical, Chromatography and Mass spectrometry methods of chemical Analysis
d) Analyze data using statistical methods

## 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 | |
| 2 | - | 4 | 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 | Collection,Labelling and preservation of grab sample by proper sampling procedure | I | 04 |
| 2 | Collection,Labelling and preservation of composite sample by proper sampling procedure | I | 04 |
| 3 | Determination of Sulphate by gravimetric methods | II | 04 |
| 4 | Determination of Oil and Grease by gravimetric methods | II | 04 |
| 5 | Determination of Ammonical Nitrogen by spectrophotometer | II | 04 |
| 6 | Determination of Organic Nitrogen by spectrophotometer | II | 04 |
| 7 | Determination of Fluoride by spectrophotometer | II | 04 |
| 8 | Determination of Sodium using Flame photometer | III | 04 |
| 9 | Determination of Potassium using Flame photometer | III | 04 |
| 10 | Determination of Salinity | III | 04 |
| 11 | Determination of Conductivity | III | 04 |
| 12 | Determination of Residual free chlorine | III | 04 |
| 13 | Determination of Phosphorus | III | 04 |
| 14 | Examples on errors and treatment of statistical data | IV | 04 |
| | | | **Total:56** |

***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 | • Sampling containers<br>• Refrigerator<br>• Magnetic stirrer<br>• UV Spectrophotometer<br>• Flame photometer<br>• pH meter<br>• Distillation Assembly<br>• Turbidity meter<br>• TDS meter<br>• Chemical testing glasswares | 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**<br><br>**Sampling for Analysis** | 1a. Sampling<br>1b. Water sample preservation<br>1c. Transportation of samples.<br>1d. Data quality | 1.1 Sampling methods: Systematic, Random, nonstatistical, stratified, haphazard, continuous monitoring<br>1.2 Types of sample: Grab & composite samples, Solid Phase extractors<br>1.3 Water sample preservation by refrigeration, acidification, addition of preservatives and use of proper container |

| Unit | Unit Outcomes (UOs) | Topics and Sub-topics |
|---|---|---|
| | | 1.4 Precautions to be taken while transportation of samples.<br>1.5 Types of error, detection limits |
| **Unit – II**<br>**Classical and Colorimetry methods of chemical Analysis** | 2a. Classical methods of analysis<br>2b Colorimetry<br>2b. Spectrophotometric methods of analysis | 2.1 Volumetric analysis, gravimetric analysis, titration<br>2.2 Lambert's law, Beer's law, Color comparison tubes, Photo electric colorimeter<br>2.2 Absorption spectrophotometry, atomic absorption and emission analysis, atomic emission techniques |
| **Unit– III**<br>**Electrochemical, Chromatography and Mass spectrometry methods of chemical Analysis** | 3a. Electrochemical methods of analysis<br>3b. Chromatography<br>3c. Capillary Electrophoresis<br>3d. Mass spectrometry<br>3e. Other instrumental analysis | 3.1 Types of electrochemical method: potentiometric, voltametric, amperometric, Ion selective electrodes and various other electrodes.<br>3.2 Gas chromatography, high performance liquid chromatography, Ion chromatography<br>3.3 Capillary Electrophoresis<br>3.4 Identification of organic pollutants by mass spectrum<br>3.5 Other instrumental analysis like X-ray analysis and nuclear magnetic resonance spectroscopy |
| **Unit– IV**<br>**Errors and Treatment of statistical data** | 4a. Rounding numerical data<br>4b. Important definitions in statistics<br>4c. Error<br>4d. Detection limits | 4.1 Rounding numerical data Total solid<br>4.2. Definitions: Mean, median, standard deviation, accuracy and precision, normal distribution<br>4.3 Standard error of the mean, Confidence interval, confidence limits,<br>4.4 Instrument detection limit and method detection limit |

## 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 | Sampling for Analysis | 03 | 02 | 02 | 02 | 06 |
| II | Classical and Spectrophotometric methods of chemical Analysis | 08 | 05 | 07 | 08 | 20 |

| Unit No. | Unit Title | Teaching Hours | Distribution of Theory Marks | | | |
|---|---|---|---|---|---|---|
| | | | R Level | U Level | A | Total Marks |
| III | Electrochemical, Chromatography and Mass spectrometry methods of chemical Analysis | 11 | 05 | 10 | 15 | 30 |
| IV | Errors and Treatment of statistical data | 06 | 04 | 04 | 06 | 14 |
| **Total** | | **42** | **16** | **23** | **31** | **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) Preparation of chart of various methods to analyze different forms of Nitrogen
b) Preparation of chart of various methods to analyze Fluoride
c) Study and List the effects of Nitrogen and Phosphorus in water and waste water
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) Study various industries and select the sampling methods best suited for Dairy Industry, Pesticide Industry, Textile industry, Paper Industry, Oil refining industry etc. and prepare report based on observation.
b) Study and prepare report on preservation of samples for various parameter analysis
c) Compare various methods of analysis used for various parameters and list their merits and demerits and suitability for Indian conditions
d) Study and prepare report on best practices and waste minimization in laboratories

## 13. SUGGESTED LEARNING RESOURCES

| S. No. | Title of Book | Author | Publication with place, year and ISBN |
|---|---|---|---|
| 1 | Environmental Chemistry | B.K.Sharma and S.H.Kaur | Goel Publication House,Meerut |
| 2 | Environmental Chemistry | A.K.De. | New Age international . Pub. New Delhi |
| 3 | Chemistry for Environmental Engineering | C.N.Sawyer and P.L.Mc Carty | Mc Graw Hill ltd. |
| 4 | Standard Methods | _ | APHA |
| 5 | Environmental Chemistry | P.S. Sindhu | New Age international . Pub. New Delhi |
| 6 | Handbook of Water and Wastewater Analysis | Kanwaljit Kaur | Atlantic Publishers and Distributors |
| 7 | Relevant BIS Codes | _ | Bureau of IndianStandards |

## 14. SOFTWARE/LEARNING WEBSITES

a) www.gpcb.gov.in
b) www.gwssb.org
c) www.cpcb.nic.in
d) www.neeri.res.in
e) www.Nptel.ac.in

## 15. PO-COMPETENCY-CO MAPPING

| Semester II | Environmental Chemistry-II (Course Code:4341305) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 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 sampling for chemical analysis to assess the quality of fresh & waste water.<br>ii. To select proper process or equipment for different tests for chemical analysis. | | | | | | | | | |
| Course Outcomes<br>a) Carry out proper sampling for chemical analysis | 3 | - | - | 3 | 3 | - | 2 | 3 | 3 | - |
| b)Identify appropriate method of chemical analysis from classical or colorimetry methods | 3 | 3 | 3 | 3 | 3 | - | 2 | 3 | 3 | - |
| c) Identify appropriate method of instrumental analysis from Electrochemical, Chromatography and Mass spectrometry methods of chemical Analysis | 3 | 3 | 3 | 3 | 3 | - | 2 | 3 | 3 | - |
| d)Analyze data using statistical methods | 3 | 3 | 3 | 3 | 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

| S. No. | Name and Designation | Institute | Contact No. | Email |
|---|---|---|---|---|
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