

**GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)****Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)**

Semester-V

**Course Title: Physico Chemical Treatment of water & waste water**

(Course Code: 4351302)

| Diploma programme in which this course is offered | Semester in which offered |
|---|---------------------------|
| Environmental Engineering                         | 5 <sup>th</sup> Semester  |

**1. RATIONALES**

Environmental challenges are increasingly impacting the life of community at large, particularly due to water quality & waste water related problems. The course aims to prepare students to develop understanding and maintain quality of water & waste water by testings, analysis, treatment & monitoring to keep the environment and community healthy & safe. This course on treatment of water and waste water is an essential course for diploma programme in Environmental Engineering. As environmental technicians/engineers they should develop certain abilities relating to testing, treatment of water & waste water. As Environmental Engineers they should also be conversant with the sedimentation, coagulation, filtration and disinfection of water and waste water. They should also be conversant with denaturing and disposal of sludge. This course attempts to develop all of these abilities in pass outs.

**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.

- **Estimate the quantity of water required for domestic and industrial uses and waste water generated by domestic and industrial use.**
- **Supervise operation and maintenance of the fresh water and waste water treatment plants.**

**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:

- Describe process for examination of water for removal of various impurities like suspended particles and oil & grease
- Design of sedimentation tank for treatment plant
- Identify various types of filters used in water treatment
- Identify methods of softening, desalination and disinfection for water
- Select appropriate method of sludge disposal

**4. TEACHING AND EXAMINATION SCHEME**

| Teaching Scheme<br>(In Hours) |   |   | Total Credits<br>(L+T/2+P/2) | Examination Scheme  |     |                       |     | Total<br>Marks |
|-------------------------------|---|---|------------------------------|---------------------|-----|-----------------------|-----|----------------|
| L                             | T | P | C                            | Theory Marks<br>CA* | ESE | Practical Marks<br>CA | ESE |                |
| 3                             | - | 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      | To determine the alkalinity of a given water sample  | I        | 02                    |
| 2      | To determine the acidity of a given water sample   | I        | 02                    |
| 3      | To determine the pH value of the given samples of Water  | I        | 02                    |
| 4      | To determine the chloride content of a given water sample  | I        | 02                    |
| 5      | To determine the Oil and grease content of a given water sample  | I        | 02                    |
| 6      | To determine the total solids of a given sample of water   | I        | 02                    |
| 7      | To determine the turbidity of the given water sample   | I        | 02                    |
| 8      | Demonstrate screening and skimming process by different types of screens and draw their sketches                             | I        | 02                    |
| 9      | Study of removal of suspended particulate matter by Sedimentation and Determination of optimum dose of coagulant by jar test | II       | 02                    |
| 10     | Demonstrate functioning of various types of filters for water and wastewater   | III      | 02                    |
| 11     | To determine the hardness of the given water samples   | IV       | 02                    |
| 12     | Demonstrate process of Disinfection and To determine the residual chlorine of given water sample                             | IV       | 02                    |
| 13     | Demonstrate process of Desalination  | IV       | 02                    |
| 14     | Determine Sludge volume Index  | V        | 02                    |
|        |  |          | <b>Total:28</b>       |

### Note

- 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.
- 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 % |
|------------------------|---|----------------|
| <b>For PrOs 1 to 7</b> |   |                |
| 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         |
| <b>Total</b> |   | <b>100</b> |

## 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      | <ul style="list-style-type: none"> <li>• Sampling containers</li> <li>• Refrigerator</li> <li>• Magnetic stirrer</li> <li>• UV Spectrophotometer</li> <li>• Flame photometer</li> <li>• pH meter</li> <li>• Distillation Assembly</li> <li>• Turbidity meter</li> <li>• TDS meter</li> <li>• Chemical testing glasswares</li> <li>• Jar test apparatus</li> <li>• Hot air oven</li> </ul> | 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.

- Work as a team member/ individual.
- Follow ethical practices.
- Follow safe practice on site and in laboratory.
- 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:

- 'Valuing Level' in 1<sup>st</sup> year
- 'Organization Level' in 2<sup>nd</sup> year.
- 'Characterization Level' in 3<sup>rd</sup> 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   |
|--|--|---|
| <b>Unit – I</b><br><b>Examination of water/waste water and process of screening and skimming</b> | 1a. Describe characteristics and examination of water and waste water and variation in flow<br>1b. List the standards of potablewater quality and type of impurities<br>1c. Describe purpose of screening,skimming, flotation and equalization.<br>1d. Explain types of screens and terms related to screening andskimming<br>1e. Describe removal of oil, grease etc & disposal of skimming | 1.1Characteristics and Examination of water and wastewater and variation in flow<br>1.2 Standards of quality of treated water and wastewater and types of impurity like suspended, dissolved and colloidal impurities<br>1.3 Purpose of screenings, skimming, flotation and flow equalization<br>1.4 Types of bar racks and screens<br>1.5 Working of skimming tank<br>1.6 Disposal of screenings<br>1.7 Types of flotation: Dissolved and dispersed<br>1.8 Types of equalization: In line and off line |
| <b>Unit – II</b><br><b>Sedimentation</b>   | 2a. Describe sedimentation and types of particle settling<br>2b. Classify sedimentation tanks<br>2c. List the factors influencing & deciding size sedimentation tank for water and wastewater<br>2d. Explain working of clarifiers and tube settlers<br>2e. Explain Flocculation and Coagulation<br>2f. List the types of coagulants andtheir suitability                                    | 2.1 Principles of Sedimentation and Stokes' law applied to fluids<br>2.2 Types of particle settling<br>2.3 Classification of sedimentation tanks on basis of shape and flow<br>2.4 Factors influencing sedimentation<br>2.5 Deciding size of sedimentation tank<br>2.6 Coagulation and flocculation – purpose, principle<br>2.7 Types of coagulation and Determination of optimum coagulation dose.   |
| <b>Unit– III</b><br><b>Filtration</b>  | 3a. Describe filtration<br>3b. List the types of filters<br>3c. Explain with the remedies Filter clogging , Filter washing and Break through<br>3d. State Advances in filtration   | 3.1 Theory of filtration, Uniformity coefficient and effective size<br>3.2 Type of filters -Slow sand filter, rapid sand filter, depth filters, pressure sand filter<br>3.3 Filter clogging, Turbidity breakthrough and Filter backwash<br>3.4 Advances in filtration   |

| Unit  | Unit Outcomes (UOs)  | Topics and Sub-topics   |
|---|--|---|
| <b>Unit– IV</b><br><br><b>Softening</b><br><b>Desalination</b><br><b>&amp;</b><br><b>Disinfection</b> | 4a. Describe softening and its various methods<br>4b. Describe Desalination and its various methods<br>4c. Describe disinfection and its various methods<br>4d. Describe removal of color<br>4e. Describe Advanced Oxidation Process and Sono hybrid waste water treatment | 4.1 Types of hardness and its effects.<br>4.2 Methods of softening - Zeolite, lye, lime-soda, Ion- exchange method etc.<br>4.3 Methods of removal of dissolved solids - solar distillation gadgets and plants, direct freezing, reverse osmosis, electrolysis<br>4.4 Methods of disinfection<br>-chlorination – chlorine dose, chlorine demand, residual chlorine, breakpoint chlorination<br>4.5 Color removal methods<br>4.6 Advanced Oxidation process like photo catalytic treatment, Fenton and ozone catalytic treatment, Introduction to Sono hybrid waste water treatment and its types |
| <b>Unit– V</b><br><br><b>Sludge</b><br><b>Dewatering</b><br><b>and Disposal</b>                       | 5a. Know sources of sludge<br>5b. Describe principles and methods of dewatering  | 5.1 Sources of sludge<br>5.2 Estimation of bulk density of sludge<br>5.3 Methods of dewatering and thickening of sludge<br>5.4 Elutriation of sludge  |

## 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            | Examination of water/wastewater and process of screening and skimming | 08             | 04                           | 06        | 02        | 12          |
| II           | Sedimentation   | 08             | 04                           | 06        | 02        | 12          |
| III          | Filtration  | 08             | 04                           | 06        | 02        | 12          |
| IV           | Softening Desalination & Disinfection                                 | 12             | 10                           | 10        | 04        | 24          |
| V            | Sludge Dewatering and Disposal  | 06             | 04                           | 04        | 02        | 10          |
| <b>Total</b> |   | <b>42</b>      | <b>26</b>                    | <b>32</b> | <b>12</b> | <b>70</b>   |

**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) Explore internet for different water treatment processes being used to treat fresh and waste water and prepare report based on these.
- b) Prepare Charts/Models for different water treatment processes.

## 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) Prepare list of Environmental rules and Acts prevalent in India
- b) Prepare a chart depicting general standards for discharge of effluents into various sinks like Inland surface water, Public sewer, Land for irrigation and marine disposal

- c) Prepare a chart depicting water quality criteria and designated best uses prescribed by CPCB
- d) Prepare a chart depicting potable water quality standards prevalent in India
- e) Prepare a chart depicting various treatment units for removal of suspended solids of large size
- f) Prepare a chart depicting various treatment units for removal of oil and grease
- g) Prepare a working model of tube settler for removal of suspended solids
- h) Prepare a working model of rapid sand filter
- i) Prepare a working model for removal of color from waste water
- j) Prepare a working model for any one Advance Oxidation process

### 13. SUGGESTED LEARNING RESOURCES

| S. No. | Title of Book                                       | Author                                  | Publication with place, year and ISBN |
|--------|---|---|---------------------------------------|
| 1      | Wastewater Engineering, Treatment, Disposal, Reuse  | Metcalf and Eddy                        | McGraw Hill International Edition.    |
| 2      | Water supply and Sewerage.                          | E W Steel and Terence J McGhee          | McGraw Hill Book Company              |
| 3      | Physical–chemical treatment of water and wastewater | Arcadio P. Sincero, Gregoria A. Sincero | CRC Press                             |
| 4      | Water Supply and Sanitary Engg                      | G S Birdi                               | Dhanpatraj and Sons                   |
| 5      | Standard Methods                                    | –                                       | APHA                                  |
| 6      | Handbook of Water and Wastewater Analysis           | Kanwaljit Kaur                          | Atlantic Publishers and Distributors  |
| 7      | Relevant BIS Codes                                  | –                                       | Bureau of Indian Standards            |

### 14. SOFTWARE/LEARNING WEBSITES

- a) [www.gpcb.gov.in](http://www.gpcb.gov.in)
- b) [www.gwssb.org](http://www.gwssb.org)
- c) [www.cpcb.nic.in](http://www.cpcb.nic.in)
- d) [www.neeri.res.in](http://www.neeri.res.in)
- e) [www.Nptel.ac.in](http://www.Nptel.ac.in)

### 15. PO-COMPETENCY-CO MAPPING

| Semester V   | Physico chemical treatment of water & waste water (Course Code:4351302)   |                          |   |  |   |                            |                            |  |  |                      |
|--|---|--------------------------|---|--|---|----------------------------|----------------------------|--|--|----------------------|
|  | POs and PSOs  |                          |   |  |   |                            |                            |  |  |                      |
| Competency & Course Outcomes   | PO 1<br>Basic & Discipline specific knowledge   | PO 2<br>Problem Analysis | PO 3<br>Design/development of solutions | PO 4<br>Engineering Tools, Experimentation & Testing | PO 5<br>Engineering practices for society, sustainability & environment | PO 6<br>Project Management | PO 7<br>Life-long learning | PSO 1<br>Environmental planning & design | PSO 2<br>Environmental Impact Assessment | PSO 3<br>(If needed) |
| <b>Competency</b>  | i. Estimate the quantity of water required for domestic and industrial uses and waste water generated by domestic and industrial use.<br>ii. Supervise operation and maintenance of the fresh water and waste water treatment plants. |                          |   |  |   |                            |                            |  |  |                      |
| <b>Course Outcomes</b>   |   |                          |   |  |   |                            |                            |  |  |                      |
| a) Describe process for examination of water for removal of various impurities like suspended particles and oil & grease | 3   | 3                        | 2                                       | 3  | 3   | -                          | 2                          | 3  | 3  | -                    |
| b) Design of sedimentation tank for treatment plant  | 3   | 3                        | 2                                       | 3  | 3   | -                          | 2                          | 3  | 3  | -                    |
| c) Identify various types of filters used in water treatment   | 3   | 3                        | 2                                       | 3  | 3   | -                          | 2                          | 3  | 3  | -                    |
| d) Identify methods of softening, desalination and disinfection for water  | 3   | 3                        | 2                                       | 3  | 3   | -                          | 2                          | 3  | 3  | -                    |
| e) Select appropriate method of sludge disposal  | 3   | 3                        | 2                                       | 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                         |
|--------|----------------------|--------------------------------|--------------|-------------------------------|
| 1      | Mrs. Jini Sunil      | Shri K.J. Polytechnic, Bharuch | 0264-2246402 | jinivt@rediffmail.com         |
| 2      | Ms. Nairuti Shah     | Vairagya Consultants, Bharuch  | 9428 443695  | vairagyaconsultants@gmail.com |