

# GUJARAT TECHNOLOGICAL UNIVERSITY

## ENVIRONMENTAL ENGINEERING (13)

### GROUND WATER CONTAMINATION

**SUBJECT CODE: 2161307**

B.E. 6<sup>th</sup> SEMESTER

**Type of course:** Applied Science

**Prerequisite:** --

**Rationale:** To learn the principles and theories regarding ground water contamination

**Teaching and Examination Scheme:**

| Teaching Scheme |   |   | Credits<br>C | Examination Marks |        |     |                 |   |           | Total<br>Marks |
|-----------------|---|---|--------------|-------------------|--------|-----|-----------------|---|-----------|----------------|
| L               | T | P |              | Theory Marks      |        |     | Practical Marks |   |           |                |
|                 |   |   |              | ESE<br>(E)        | PA (M) |     | ESE (V)         |   | PA<br>(I) |                |
|                 |   |   |              | PA                | ALA    | ESE | OEP             |   |           |                |
| 3               | 2 | 0 | 5            | 70                | 20     | 10  | 30              | 0 | 20        | 150            |

**Content:**

| Sr. No.  | Content  | Total<br>Hrs | % Weightage |
|----------|--|--------------|-------------|
| <b>1</b> | <b>Introduction:</b><br>Definition of ground water, aquifers, vertical distribution of sub surface water, hydrological properties of water bearing strata, ground water in hydrologic cycle.   | <b>04</b>    | 10          |
| <b>2</b> | <b>Ground water hydraulics:</b><br>Darcy's law, its range of validity, Dupuit's assumptions, Applications of Darcy's law for simple flow systems, Governing differential equations for confined and unconfined aquifers, steady and unsteady flow solutions for fully penetrating wells, partially penetrating wells, interference of wells, test pumping analysis with steady and unsteady flows, delayed yield, method of images | <b>14</b>    | 33          |
| <b>3</b> | <b>Ground water quality :</b><br>Indian and international standards  | <b>02</b>    | 04          |
| 4        | <b>Ground water pollution :</b><br>Sources, remedial and preventive measures   | <b>04</b>    | 10          |
| 5        | <b>Ground water conservation:</b><br>Ground water budget, seepage from surface water, artificial recharge  | <b>04</b>    | 10          |
| 6        | <b>Models for ground water flow:</b><br>Sampling and monitoring methods , transport mechanisms, modelling Advective-Dispersive transport, Adsorption and chemical reaction, biodegradation kinetics, numerical flow and transport modelling, waste site characterization/investigation, ground water remediation, legal issues in ground water contamination.  | <b>14</b>    | 33          |

### Suggested Specification table with Marks (Theory):

| Distribution of Theory Marks |         |         |         |         |         |
|------------------------------|---------|---------|---------|---------|---------|
| R Level                      | U Level | A Level | N Level | E Level | C Level |
| 15                           | 15      | 15      | 15      | 10      | 0       |

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

### Reference Books:

1. Ground Water : by Raghunath
2. Ground Water Hydrology: By D K Todd
3. Groundwater Resources Education by W C Walton
4. Numerical Ground Water Hydrology by Roger Diewest.
5. Ground water hydrology and contamination by Nicholas Cheremisenoff

### Course Outcome:

After learning the course the students should be able to:

1. Apply the laws of ground water hydraulics and solve the differential equations for different types of aquifers.
2. Identify the sources of ground water contamination and suggest the remedial and preventive measures to overcome ground water contamination.
3. Decide the mechanisms for ground water conservation.
4. Use the models for ground water flow and apply them for minimization/prevention of ground water contamination and its transport.

**List of Exercises:** Term work will comprise of assignments on the questions related to definition of terms used in ground water hydrology, ground water contamination, methods of treatment of contaminated ground water

**Design based Problems (DP)/Open Ended Problem:** Numericals based on Darcy's law, Dupuit law for yield.

**List of Open Source Software/learning website:** <http://nptel.ac.in/>

**ACTIVE LEARNING ASSIGNMENTS:** Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.