



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Environmental Engineering

Subject Code: BE05013041

Subject Name: Groundwater Hydrology and Contamination

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	Professional Elective - I

Prerequisite:	Knowledge of subject Environmental Sciences and fundamentals of water quality.
Rationale:	The subject Groundwater Hydrology provides fundamental knowledge of groundwater occurrence, flow, recharge, contamination, monitoring, and sustainable management essential for environmental engineers. It helps students understand groundwater resource assessment, pollution control, contaminant transport, and remediation techniques required for protecting and managing groundwater systems effectively.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Explain occurrence, distribution and properties of groundwater systems.	20
CO-2	Apply Darcy's law and groundwater flow equations to solve hydraulic problems.	25
CO-3	Analyze pumping test data and estimate aquifer parameters.	20
CO-4	Evaluate groundwater quality and contamination sources.	25
CO-5	Apply contaminant transport principles for groundwater pollution assessment and recommend remediation techniques.	10

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
L	T	P	SL	Total no of hours per semester		Theory		Tutorial / Practical			
						ESE (E)	PA / CA (M)	PA/C A (I)	TW/ SL (I)	ESE (V)	
45	30	0	15	90	3	70	30	20	30	00	150



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Content:

Sr. No.	Content	Total Hrs
1	Introduction to Groundwater Hydrology: Hydrologic cycle and role of groundwater; Occurrence of groundwater in subsurface formations, Geological formations affecting groundwater; Types of aquifers: Confined aquifer, Unconfined aquifer, Leaky aquifer, Perched aquifer; Properties of Aquifer Materials: Porosity, Specific yield and specific retention, Permeability and intrinsic permeability, Transmissibility, Hydraulic conductivity, Coefficient of storage; Factors affecting hydraulic conductivity: Grain size distribution, Void ratio, Fluid properties, Groundwater table and piezometric surface; Groundwater basin concept; Recharge and discharge mechanisms of groundwater	10
2	Groundwater hydraulics: Darcy's Law and Its Applications: Statement and derivation of Darcy's Law, Assumptions and limitations, Hydraulic gradient and head loss, Numericals based on Darcy's law; Groundwater Flow Equations: General groundwater flow equation, Steady and unsteady groundwater flow; Flow nets: Construction, Applications	10
3	Well Hydraulics Types of wells: Dug wells, Tube wells, Artesian wells; Well construction methods; Components of tube wells; Well losses and efficiency; Pumping tests: Constant discharge test, Recuperation test; Estimation of aquifer parameters; Safe yield of aquifers; Steady Unidirectional Flow; Steady radial flow to a well; Unsteady Radial flow in confined and unconfined aquifer; Numericals on yield of wells, interference of wells.	10
4	Groundwater water quality, Monitoring and contamination: Groundwater quality characteristics; Groundwater monitoring; Objectives of groundwater monitoring, components of groundwater monitoring: sampling equipment, measuring equipment, Groundwater level monitoring, contaminated site monitoring, applications of GIS and remote sensing in groundwater monitoring. Groundwater contamination; Groundwater quality characteristics; Point and non-point source pollution; Sources and Types of Groundwater contamination: Geological formations, Industrial effluents, Agricultural runoff, Landfills and leachate migration, Septic tanks and sewage disposal, Mining activities; Classification of pollutants: Organic pollutants (BTEX, hydrocarbons), Inorganic pollutants (heavy metals, nutrients), Pathogens, Emerging contaminants (pharmaceuticals, microplastics); Salt Water intrusion	10
5	Contaminant Transport in Groundwater and Remediation: Mechanisms of contaminant transport; In-situ Remediation Techniques: Bioremediation, Air sparging, Permeable reactive barriers (PRBs), Natural attenuation; Ex-situ Remediation Techniques: Pump and treat, Soil vapor extraction; Emerging Technologies: Phytoremediation, Nanotechnology applications; Methods of Sustainable groundwater management: Artificial recharge, Rainwater harvesting	5
TOTAL		45



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Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	20	15	20	00	00

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.

The syllabus of Groundwater Hydrology and Contamination directly contributes to

SDG 3	Good health and well-being: This subject deals with groundwater which is the major source of drinking water for communities and availability of good quality and sufficient quantity of groundwater will lead to good health and well-being.
SDG 6	Clean Water and Sanitation: This subject deals with sustainable management of water for all.
SDG 12	Responsible Consumption and Production: The topics on groundwater recharge ensures the concept of sustainable consumption

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

List of Tutorials

1. Assignment on terms used in groundwater hydrology including numerical on Porosity and permeability calculations, Storage coefficient estimation, Hydraulic conductivity calculations
2. Assignment on derivation of Darcy's law and numericals based on it.
3. Assignment on well hydraulics including numericals on Well discharge estimation.
4. Assignment on groundwater quality, monitoring and contamination
5. Assignment on mechanisms of contaminant transport in groundwater.
6. Assignment on groundwater remediation techniques and artificial recharge of groundwater.



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List of Open Source Software/learning website:

NPTEL - SWAYAM

List of suggested activities for Term Work / Self Learning:

Sr No	PBL category	Name of activity	No of hours	Evaluation criteria
1	Seminar	Based on given technical topics beyond syllabus.	Duration=10 hrs	Based on content and presentation skills
2	Mini Project	Determination of Groundwater Quality Index based on groundwater samples collection and analysis of given area	Duration=10 hrs	Based on samples collection plan, location, analysis results and calculations.
3	Micro project	Determination of specific pollutant affected areas of given districts/states based on secondary data (from government websites like State Groundwater Boards/Central Groundwater Boards)	Duration=5 hrs	Based on data collection, interpretation and comparison with respect to IS.
4	Poster/ Chart/ Power point presentation	Preparation of a poster showing types of aquifers and properties of aquifers	Duration=5hrs	Based on poster/chart preparation and presentation skills
5	Video Based Learning	Technical Video (NPTEL)based learning related to the subject	Duration : 10 hrs	Multiple choice questions-based Assessment
6	Case study Analysis	Case study related to groundwater pollution and remediation	Duration : 5 hrs	Based on detail study of given case, interpretation of data and conclusion.
7	Estimation of groundwater recharge	Estimation of groundwater recharge of given site and	Duration : 10 hrs	Based on onsite , geological and rainfall data used.
