GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Civil (Water Resource Engineering)

Subject Code: ME02033011

Subject Name: Ground Water Management

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	PCC

Prerequisite:	Fundamental knowledge of surface and subsurface water hydrology, movement of fluid through porous media, Basics of fluid mechanics.
Rationale:	Students will be able to understand flow of ground water through porous media, recharge of aquifers and sea water intrusion in coastal aquifers. Students will be able to do groundwater assessment and analysis of ground water flow.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Comprehend the geohydrology and its significant, ground water storage and flow, well hydraulics, artificial recharge wells.	R, U
02	Investigate the groundwater level and movement of ground water through porous media and sea water intrusion.	A, N
03	Apply the differential equation governing the steady and unsteady flow for different types of aquifers.	A, N, E
04	Assessment of groundwater fluctuations, quality parameters.	A, N, E
05	Apply and evaluate the groundwater flow using different techniques.	U, E, C

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Introduction to Groundwater: Definition of groundwater, role of groundwater in hydrological cycle, Balance equation, Basic terminologies of Ground water characteristics, Types of aquifers, flow and storage characteristics of aquifers, Groundwater investigation methods, Aquifer parameters and their determination, Development of groundwater.	9	20
2.	Groundwater Flow: Law of groundwater movement-Darcy's law and its application, Dupuit assumptions, General differential equations governing steady and unsteady flow for confined and unconfined aquifers and analytical solutions, Initial and boundary conditions.	10	25
3.	Well Hydraulics: Type of Wells, Multiple well System, Well Design criteria, Construction and maintenance, Steady and unsteady radial flow in a well, Well flow near aquifer boundaries-Image wells, Method of images.	9	15
4.	Ground Water Quality: Introduction to ground water flow and contaminant transport process, Impact of climate change Sea Water intrusion in coastal aquifers, methods of its prevention and control, Groundwater pollution remediation and legislation	8	20
5.	GroundWater Flow Modelling and Management: Role of groundwater flow models, Introduction to ground water modeling through porous media/analog/digital computer models like MODFLOW, GSFLOW, FEFLOW, MT3DMS Groundwater basin management and conjunctive use, groundwater basin investigation, data collection and field work, artificial recharge of aquifers, methods of artificial recharge	9	20
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	**20**	**20**	**25**	**10**	**10**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. "Groundwater" - H. M. Raghunath
2. "Groundwater Resources Evaluation" - W. C. Walton
3. "Groundwater Hydrology" - D. K. Todd
4. "Numerical groundwater hydrology" - A.K. Rastogi
5. "Ground water assessment development and management" - K R Karanth
6. "Numerical analysis by Analog and Digital models for seepage and groundwater flows" - D R Ruston & S C Redshow
7. "Hydrogeology" - K R Karanth

(b) Open-source software and website:

1. https://nptel.ac.in/courses/105105219
2. https://nptel.ac.in/courses/105103026
3. https://www.usgs.gov/software/gsflow-coupled-groundwater-and-surface-water-flow-model
4. https://www.usgs.gov/mission-areas/water-resources/science/modflow-and-related-programs
5. http://hydro.geo.ua.edu/mt3d/

Suggested Course Practical List:

1. Find out the Flow through Porous Media
2. Find out the permeability of soil.
3. Ground water flow equation
4. Analytical solution for steady and unsteady flow for different types of aquifers
5. Well Hydraulics and analysis of flow into a well
6. Groundwater pollution and sea water intrusion
7. Groundwater management

List of Laboratory/Learning Resources Required:

Darcy's Law Apparatus,

Constant head and falling head permeameters,
GIS related high end computing system,
Image Processing Software,
Software like, MODFLOW, GSFLOW, FEFLOW, MT3DMS etc.

Suggested Project List:-NIL-

Suggested Activities for Students:

The work may include real-site visits, high-end computing systems, and deal with the real field works for different water level measurements and flow analysis. The students may work in a group for the practice such as:

1. Visit to the sites to collect the data of the water levels of groundwater,
2. Prepare the models/simulators for different types of aquifers,
3. Investigate the ground water quality parameters in to the laboratory,
4. Computation of the ground water fluctuation,
5. Analysis and assessment of groundwater flow (1D/2D) using different modeling methods.

* * * * * * *