Course Type	Course Code	Name of Course	L	T	P	Credit
DE4	NGLD408	Hydrogeology	3	0	0	3

Course Objective

In this course, the students will study the fundamental concepts and principles of occurrence, movement and quality of groundwater, focussing on qualitative as well as quantitative analyses.

Learning Outcomes

Upon completion of the course, students will be able to:

- Assess the role of water in Earth's climate
- Understand the hydrological cycle and its components in detail
- Apply Darcy's law to groundwater flow and geological material interpretation
- Use pump test data for groundwater flow applications
- Develop skills in approaching complex problems involving flow and storage of groundwater
- Gain knowledge on sustainable development of groundwater resources

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1.	**Introduction to Hydrogeology:** Water on Earth; Types of water; Distribution of water; Role of water in Earth's climate; Hydrological cycle and its components	6	Get introduced to key hydrologic processes
2.	**Occurrence of Groundwater:** Water-bearing properties of rocks – porosity, intrinsic permeability, specific yield and specific retention; Vertical distribution of water; Zone of aeration and zone of saturation; Classification of rocks according to their water-bearing properties; Aquifers; Classification of aquifers	6	Get to know how water is stored in the subsurface and its distribution with depth
3.	**Aquifer Characteristics:** Aquifer parameters: transmissivity, hydraulic conductivity and storage coefficient; Determination of permeability in laboratory; Concept of heterogeneity and anisotropy; Water table and piezometric surface; Hydrographs; Hydrostratigraphic units	8	Understand the fundamental properties of sub-surface storage and their key controls
4.	**Principles of Groundwater Movement:** Hydrostatic pressure; Fluid potential; Energy in groundwater; Hydraulic head; Theory of groundwater flow; Darcy's law and its applications; Specific discharge; Limitations of Darcy's Law; Reynolds Number; Governing equation for flow through porous medium; Steady and non-steady state flow - Initial and boundary Conditions; Solution of flow equations; Dupuit's Assumption	8	Understand the factors driving the movement of water
5.	**Well Hydraulics:** Flow through aquifers: 2-D groundwater flow equations; Flow in steady and non-steady state conditions; Evaluation of aquifer parameters of confined, semi-confined and unconfined aquifers - Thiem, Theis and Jacob methods; Numerical problems on pumping test; Water wells: types of wells, drilling methods, construction, design, development and maintenance of wells	8	Get to know how water flows in the saturated subsurface in different dimensions
6.	**Groundwater Quality:** Physical and chemical properties of water; chemical reactions; Quality criteria for different uses; Graphical presentation of groundwater quality data; Saline water intrusion (Ghyben-Herzberg relation)	4	Will know how to assess the quality and suitability of groundwater and the sources of contamination
7.	**Management of Groundwater:** Over-exploitation of groundwater; Groundwater problems in urban/rural settings;	2	Get to know the major issues related to groundwater availability,

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
	Climate change impact on ground water resources; Rainwater harvesting and managed aquifer recharge		utilization and management
Total Classes		42	

Textbooks:

1. Groundwater Hydrology by D. K. Todd and L. W. Mays, 3rd Edition, 2011, Wiley India
2. Applied Hydrogeology by C. W. Fetter, 4th Edition, 2014, Pearson New International

References Books:

1. Groundwater by H. M. Raghunath, 3rd Edition, 2007, New Age International Publishers
2. Groundwater by R.A. Freeze and J.A. Cherry, 1979, Prentice-Hall
3. Geochemistry, Groundwater and Pollution by C. Anthony J. Appelo and Dieke Postma, 2004, CRC Press
4. Physical and Chemical Hydrogeology by P. A. Domenico and F. W. Shcwartz, 2nd Edition, 1997, Wiley
5. Elements of Physical Hydrology by G. M. Hornberger, J. P. Raffensperger, P. L. Wiberg and K. N. Eshleman, 1st Edition, 1998, The Johns Hopkins University Press