

**HYDROGEOLOGY**

Time Allowed : Three Hours

Maximum Marks : 200

**Question Paper Specific Instructions**

*Please read each of the following instructions carefully before attempting questions :*

*There are **NINE** questions divided under **FIVE** sections.*

*Candidate has to attempt **FIVE** questions in all.*

*The **ONLY** question in Section A is **compulsory**.*

*Out of the remaining **EIGHT** questions, the candidate has to attempt **FOUR**, choosing **ONE** from each of the other Sections B, C, D and E.*

*The number of marks carried by a question / part is indicated against it.*

*Symbols, abbreviations and notations have their usual standard meanings.*

*Neat sketches are to be drawn to illustrate answers, wherever required.*

*Wherever required, graphs/tables are to be drawn on the Question-cum-Answer Booklet itself.*

*Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly.*

*Any page or portion of the page left blank in the Question-cum-Answer Booklet must be clearly struck off.*

*Answers must be written in **ENGLISH** only.*

**SECTION A**  
**(Compulsory Section)**

- Q1. Write short notes on the following in not more than 5 sentences each :** **5×8=40**
- (a) Geologic Materials as Aquifers 5
  - (b) Isohyets 5
  - (c) Relationship between Porosity, Specific retention and Specific yield 5
  - (d) Residence Time of Groundwater 5
  - (e) Reynolds Number 5
  - (f) Groundwater Drawdown 5
  - (g) Direct Rotary Drilling 5
  - (h) Wenner Array in Resistivity Survey 5

## SECTION B

Attempt any **one** question.

- Q2.** (a) Derive Darcy's equation for anisotropic materials. 15
- (b) Groundwater flows through an aquifer of cross-section area  $10,000 \text{ m}^2$  and with a length of 1000 m. Hydraulic heads at the groundwater entry and exit points in an aquifer are 250 m and 200 m respectively. Groundwater from the aquifer discharges into a stream at a rate of  $100 \text{ m}^3/\text{day}$ . Calculate the hydraulic conductivity of the aquifer. If the effective porosity of the aquifer is 0.2, what is the linear groundwater velocity? 15
- (c) Differentiate between Dispersion and Diffusion. 10
- Q3.** (a) Differentiate between Hydraulic conductivity and Permeability. 15
- (b) An aquifer consisting of 400 m interbedded sandstone and shale has 60% sandstone. The sandstone and shale have hydraulic conductivity of 0.1 m/s each and vertical hydraulic conductivity of 0.01 m/s each. Calculate the ratio of equivalent horizontal hydraulic conductivity and vertical hydraulic conductivity of the aquifer. 15
- (c) If hydraulic conductivity and thickness of an aquifer are 0.5 cm/sec and 25 m respectively, what is the transmissivity of the aquifer? 10

## SECTION C

Attempt any **one** question.

- Q4.** (a) Derive Thiem's method for steady-state flow in a confined aquifer. 15
- (b) Discuss on well completion and development methods. 15
- (c) What is base flow ? How is it estimated ? 10
- Q5.** (a) What is the difference between aquifer performance test and step drawdown test for sustainable yield of tube-wells ? 15
- (b) Explain the difference between the groundwater level fluctuation due to evaporation and evapotranspiration. 15
- (c) Define slug test. How is transmissivity of aquifer calculated by this test ? 10

## SECTION D

Attempt any **one** question.

- Q6.** (a) Explain the technique to infer suitable sites for groundwater exploration by using Resistivity meter. 15
- (b) Explain borehole logging with special reference to Gamma logging in groundwater exploration. 15
- (c) Discuss the drilling methods for groundwater exploration in different geological formations. 10
- Q7.** (a) What is DTH drilling for groundwater exploration ? 15
- (b) Using hyperspectral sensor, how is it possible to infer groundwater quality ? 15
- (c) What is Proton Precession Magnetometer ? Discuss the functioning of this instrument in groundwater exploration. 10

## SECTION E

Attempt any **one** question.

- Q8.** (a) What are the major chemical constituents of groundwater ? Discuss the factors that may affect the composition of groundwater. 15
- (b) What is Total Dissolved Solids (TDS) in groundwater ? Explain its significance in determining the suitability of groundwater for drinking purposes. 15
- (c) Express 23 mg/L sodium (Na) in mol/L (Atomic wt. of Na = 23). 10
- Q9.** (a) Discuss the use of Hydrogen and Oxygen isotopes in the study of groundwater. 15
- (b) What is Artificial groundwater recharge ? Discuss with suitable illustration, Roof-Top Rainwater Harvesting System for recharging the groundwater. 15
- (c) Calculate the total harvestable rainwater from a roof having an area of  $40 \text{ m}^2$ , with total annual rainfall of 60 inches and runoff coefficient 0.9. 10