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 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 m^3/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 m^2, with total annual rainfall of 60 inches and runoff coefficient 0·9. *10*