SDFG-F-HDY

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 (QCA) 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 (QCA) 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) Connate water *5*

(b) Isotropic and Anisotropic aquifers *5*

(c) Drainage density and Stream density *5*

(d) Composite aquifer *5*

(e) Non-Darcian flow *5*

(f) Sodium Adsorption Ratio (SAR) *5*

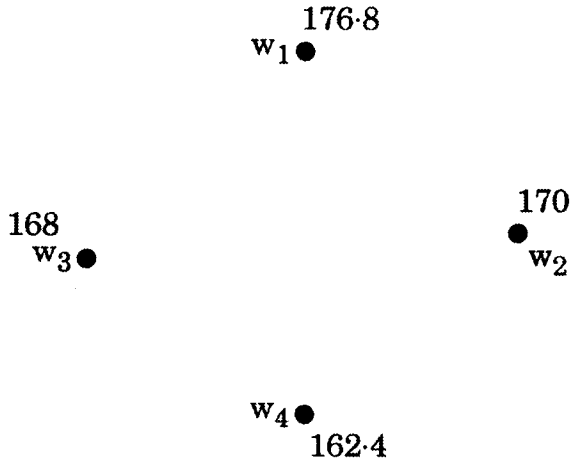
(g) Gamma-Gamma logging *5*

(h) Residual drawdown *5*

SECTION B

*Attempt any **one** question.*

Q2. (a) Draw the groundwater level contours (with 2 m interval) and flow direction using the water table elevations (m, bgl) of four observation wells (w_1, w_2, w_3 & w_4) given below. (m bgl – meters below ground level) *10*



(b) A 30 m thick confined aquifer with a hydraulic conductivity of 25 m/day is pumped from fully penetrating 80 cm diameter well with a constant rate of 20 litre/s. The piezometric drop in 1 km apart two observational wells aligned with the groundwater flow direction, is 4 m with respect to beginning of pumping. Determine the distance limits for which contaminant sources do not impact the well in the direction of hydraulic gradient (longitudinal) and direction perpendicular to that (transverse). *15*

(c) Define specific yield and specific retention. Explain the different field and laboratory methods used to determine specific yield. *15*

Q3. (a) Discuss about porosity, its types and factors affecting porosity. *10*

(b) The storage in a river is 90 million litres and rate of inflow and outflow are 12 m^3/s and 14 m^3/s, respectively, at a particular time. If the rate of inflow and outflow becomes 18 m^3/s and 22 m^3/s, respectively, after two hours, then calculate the change in storage during this time period. Estimate the storage volume of water in the river after two hours. *15*

(c) Water pressure in an aquifer is 0·16 N/cm^2 at a place 100 cm above the reference elevation. The water is moving at a velocity of 4×10^{-4} cm/s. Calculate the total energy per unit mass.

(Given, density of water = 1 g/cm^3, and gravitational acceleration = 980 cm/s^2) *15*

SECTION C

*Attempt any **one** question.*

Q4. (a) Differentiate between the formula used in Theis method and Cooper-Jacob method for determining Storage coefficient (S) and Transmissivity (T) for an unsteady radial flow in a confined aquifer. *10*

(b) Derive expression for saturated flow passing across a hydraulic conductivity boundary and show that ratio of hydraulic conductivity is equal to the ratio of tangent of the angles the flow lines make with the normal to the boundary. *15*

(c) A confined aquifer having transmissivity 400 m^2/day and storage coefficient 10^{-4} is pumped with a constant rate of 1000 litre/min. Compute the time to reach steady state conditions at 100 m from the pumping well. If it is assumed that near-steady-state conditions are achieved when drawdown rate falls below 1 cm/hr, then what is the time required to reach near-steady-state conditions ? (Cooper-Jacob approximations are assumed to compute the rate of piezometric drawdown around the pumping well with respect to time, i.e. $u < 0{\cdot}01$) *15*

Q5. (a) Describe common drilling methods employed in groundwater exploration. *15*

(b) A tracer test is conducted in an unconfined aquifer. The tracer took 9 hours to travel from one well to another well 60 m apart, when the water level in the wells is 18·3 m and 17·9 m, respectively. The porosity of the medium is 0·25 and mean particle size of the aquifer is 2 mm. If the kinetic viscosity of the water is 0·01 cm^2/s, then calculate (a) hydraulic conductivity and intrinsic permeability of the aquifer, and (b) Reynolds number of the flow. (Given $g = 980$ cm/s^2) *15*

(c) Discuss various types of groundwater level fluctuations. Add a note on impact of global climate changes on groundwater. *10*

SECTION D

*Attempt any **one** question.*

Q6. (a) Sketch the electrode arrangements of Wenner and Schlumberger methods for resistivity determination. Explain the formula of apparent resistivity for both methods. *10*

(b) Using a falling head permeameter, a 25 cm long field sample with a diameter 80 mm is tested. The falling head tube has the diameter of 3·0 cm. The head of the tube falls from initial level of 100 mm to 1 cm over a period of 10 hours. Calculate the hydraulic conductivity of the sample. *15*

(c) Discuss satellite-based groundwater monitoring and add a note on GRACE satellite data and InSAR. *15*

Q7. (a) Discuss in detail about groundwater basin concept with a focus on management issues. *10*

(b) Describe the basic principles of magnetic methods. Discuss its instrumentation and field procedures in groundwater survey. *15*

(c) Discuss the Ghyben-Herzberg relation and explain the status of saline water intrusion problem in the coastal aquifers of India. *15*

SECTION E

*Attempt any **one** question.*

Q8. (a) Discuss Rainwater Harvesting and various methods to manage the groundwater depletion in India. *15*

(b) Discuss Arsenic and Fluoride contamination in groundwater in India and its treatment protocols. *15*

(c) Elaborate on the use of environmental isotopes in groundwater studies. *10*

Q9. (a) Discuss the various diagrammatic representations of the groundwater quality variables for determining quality suitability and convenience of groundwater for different objectives. *15*

(b) Describe the chemical composition of groundwater and list five each of major ions, minor ions, trace constituents and dissolved gases in groundwater. *15*

(c) Define hardness along with its mathematical expression and classify water class based on hardness. *10*