M.E. WATER RESOURCES AND HYDRAULIC ENGG. (EVENING) SECOND YEAR SECOND SEMESTER - 2024

Groundwater Dynamics
(Paper - II)

Time: Three hours | Full Marks: 100

Answers any five questions.
Each question carries 20 marks.

1 (a) Deduce the governing 1D equation for steady radial flow into a well for a confined, isotropic, and homogeneous aquifer.

(b) A 610 mm diameter well penetrates vertically through a confined aquifer of 15 m thick. When the well is pumped 2800 m^3/d, the drawdown in a well 15 m away is 3 m and another well is 30 m away is 900 mm. What is approximate head in a pumped well for steady state conditions and what is the approximate drawdown in the well? Take the initial piezometric level as 30 m above the datum.

[14+6=20]

2 (a) Deduce the governing 2D equation for unsteady flow of a homogeneous fluid in a, anisotropic, homogeneous media for unconfined aquifer.

(b) A well fully penetrates a 25 m thick confined aquifer. After a long period of pumping at a constant rate of 0.06 m m^3/s, the drawdowns at distances of 50 m and 150 m from the well were observed to be 3 m and 1.2 m respectively. What type of u consolidated deposit would you expect this to be?

[14+6=20]

3 (a) Deduce the general flow equation for confined aquifer of an incompressible fluid considering isotropic, homogeneous and porous media.

(b) During a constant permeability test on a soil sample of 100 mm diameter and 200 mm length, 0.004 m^3 of water was collected in 2.5 minutes under a constant of 0.5 m. Determine the permeability of the sample.

(c) A soil has a co efficient of permeability 0.00082 m/s. If the kinematic viscosity is 0.009×10^{-4}, then calculate the intrinsic permeability of the sample.

[10+5+5=20]

[Turn over

4 (a) **Prove that equation which describes the transient drawdown in the piezometric head caused by a fully penetrating pumping** well in a confined aquifer in unsteady state **solution**

$$s' = \frac{Q}{4\pi T} W(u)$$

Where, $W(u) = \int_u^\infty \frac{e^{-x}}{x} dx$ = well function; s' =drawdown (m); Q = well discharge **(m^3/day); T = transmissivity (m^2/day).**

(b) **A sand aquifer has a 10 percentile size** of 0.50 mm and effective porosity of 0.35. If **the temperature of the water in aquifer is 22°C,** Estimate the range of linear velocity **in case of Darcy's law is valid. Assume** Kinematic viscosity at 22°C.

[15+5=20]

5. (a) **"It is good practice to measure** residual drawdowns" – justify the statement?

(b) **A well penetrating at a uniform** rate of 2500 m^3/day was shut down after 240 min, **thereafter measurement of s and t** tabulated in table were made in an observation **well. Determine the tranmissivity** of the aquifer.

Table :Recovery test data (Pump shut down at t =240 min.)

t (min)	s (m)
1	0.89
2	0.81
3	0.76
5	0.68
7	0.64
10	0.56
15	0.49
20	0.45
30	0.38
40	0.34
60	0.28
80	0.24
100	0.21
140	0.17
180	0.14

[4+16=20]

6. (a) **Why Cooper Jacob straight line method** is advantageous over the Theis method? **State tits limitation.**

(b) **In a test of a confined aquifer,** the pumping rate was 500 m^3/day. Drawdown and **time data were collected at an** observation well 300m away (table given below) **Determine the transmissivity and** storativity of the aquifer using the Copper -Jacob **Straight Line Method.**

Table : Pumping test data

Time (min)	Drawdons (m)	Time (min)	Drawdons (m)
1.00	0.03	35.62	1.79
1.27	0.05	45.20	1.97
1.61	0.09	57.36	2.15
2.04	0.15	72.79	2.33
2.59	0.22	92.37	2.52
3.29	0.31	117.21	2.70
4.18	0.41	148.74	2.89
5.30	0.53	188.74	3.07
6.72	0.66	239.50	3.26
8.53	0.80	303.92	3.45
10.83	0.95	385.66	3.64
13.74	1.11	489.39	3.83
17.43	1.27	621.02	4.02
22.12	1.44	788.05	4.21
28.07	1.61	1000.00	4.39

[5+15=20]

7. (a) **Briefly describe the approach and** objective of groundwater modelling

(b) **An R.C network analog has to** be constructed to simulate a confined aquifer of 40 **km × 60 km with an average** thickness of 30 m, permeability of 25 m/day, and **storage coefficient 4 × 10-4** . The maximum head is 40 m. The model can be **represented by 40 × 60 nodes.** Resistor of 3000 Ω and capacitors of 0.01 μF are **available; model voltage =8 V.** Work out the scale factors. If a calibrating resistor **of 2500 Ω is used for simulating** pumping rate, determine the current pulse and **excitation voltage to simulate a** pumping rate 1000 m3/day at a particular node.

[5+15=20]

8. (a) **A test was conducted with** unconfined aquifer near river Damodar, Well was **pumped at constant rate of 80** m3/hr. The drawdown measured in an observation **well 10 m away are listed in** below table. The aquifer thickness is 20 m. Calculated **the hydraulic parameter for aquifer** using Numan's straight-line method

TIME SCIENCE PUMPING BEGAN (min)	S DRAWDOWN (m)
1	0.01
4	0.01
5	0.01
6	0.01
7	0.02
8	0.02
9	0.02
10	0.03
11	0.03
12	0.03
13	0.04
14	0.05
53	0.06
55	0.06
63	0.07
69	0.08
88	0.09
91	0.10
94	0.10
97	0.10
102	0.11
107	0.11
112	0.12
237	0.23
357	0.29
417	0.30
537	0.31
657	0.31
777	0.32
897	0.32
1282	0.33
1497	0.33

[20]