CVL 830 Groundwater Flow and Pollution Modelling

Course Coordinator: Prof. A. K. Keshari | **Major Test** | Marks: 40
Semester: 2nd, 2020-2021 | *Online through Videoconferencing* | Time: 2 hrs.

Answer all questions

[1.] **(a)** What is the difference between saturated and unsaturated flows through porous media? Write down Darcy's law for three-dimensional saturated flow through a heterogeneous anisotropic aquifer? Discuss its applicability and various parameters if we apply this to a planar flow through sedimentary rocks. (6)
(b) What do you mean by ponding time? Derive a mathematical expression for computing infiltration under a constant rainfall intensity of 'i' using Mein and Larson method. (6)

[2.] **(a)** The soil column in a particular area has uniform moisture content of 30%. The soil is having a void ratio of 0.8 and its effective grain size is 0.02 mm. The groundwater table in the area is at a depth of 10 m from the ground surface having an elevation of 200 m from the mean sea level. After some time, it is observed that the soil has got contaminated due to the leakage from a nearby petrol pump. The soil quality test reveals that the soil contains petrol content of 5%. Obtain contents of various fluid phases present in the soil. Draw initial and final profiles of various phases in the soil column. (6)
(b) What are commonly used finite difference schemes in groundwater modelling. Obtain a finite difference equation and write down expressions for the solution of following partial differential equation using explicit scheme at t = Δt. Take Δx = L/5, where L is the length of porous media. (6)

$$\frac{\partial h}{\partial t} = \frac{\partial^2 h}{\partial x^2}$$

[3.] **(a)** What are different mechanisms of groundwater contaminant transport? Explain how the ground pumping or recharge can affect the contaminant migration? (4)
(b) An injection well located 1 km away from a tube well into a confined aquifer is releasing a contaminant with a concentration of 2000 mg/L. The confined aquifer is homogeneous and is having a thickness of 50 m. A steady uniform flow with a velocity of 1 m/day exists in the aquifer. The aquifer is having an effective porosity of 0.25 and the longitudinal and transverse dispersivities of the aquifer are 20 m and 5 m, respectively. Assume molecular diffusion to be 10^{-9} m^2 /s. Determine followings:
(i) Mechanical dispersion tensor (ii) Darcy's flux vector
(iii) Contaminant concentration at the tube well after one year
Following values for complementary error function may be taken if required, and the linear interpolation may be considered to determine values of complementary error function for other values of x: (6)

erfc (x ≈ 0.90) = 0.203, erfc (x ≈ 1.0) = 0.157
erfc (x ≈ 2.0) = 0.005, erfc (x ≈ 3.0) = 0.000

[4.] Differentiate between followings: (6)
(i) Diffusivity and Tortuosity (ii) Calibration and Validation
(iii) Diffusion and Dispersion (iv) Block-centered and Mesh-centered

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