

MRT 452-3 Solute Transport Modelling Methods

Number of questions: Five (05) Essay Questions

Answer all questions

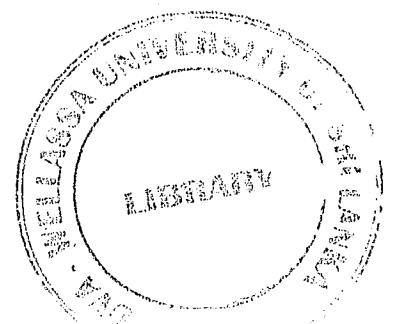
Time allocation: Three (03) hours

Mark allocation: 500

1. (a) State Darcy's Law of fluid flow through porous media. State the generalized Darcy Law for 3-dimensional flow. Clearly stating all assumptions simplify it for 1-dimensional conditions. (20 mark)
- (b) Prove that the hydraulic head expressed in length dimensions is actually a quantity that relates to the total mechanical energy of a unit weight of fluid. (40 mark)
- (c) Distinguish between steady-state and transient-state conditions used in groundwater flow modelling. Describe one example for each condition. (40 mark)
2. (a) Discuss the advantages of mathematical groundwater models over sand tank and analogue models. Critically evaluate the limitations of mathematical models. (30 mark)
- (b) Elaborate with examples, how groundwater models are used as predictive tools in groundwater resource management. (30 mark)
- (c) Generic models can be applied to study groundwater systems that occur in similar hydrogeologic settings. Comment and illustrate with an example. (40 mark)
3. (a) Describe a groundwater environment where you might need variable finite difference grid cell sizes in the numerical formulation of its mathematical model. (30 mark)
- (b) When sinks or sources are present, the 2-D steady-state groundwater flow equation takes the following form (Eqn. 3.1). Symbols have the standard meanings. Using central approximation, develop the finite difference scheme for the governing equation.

$$\frac{\partial^2 h}{\partial x^2} + \frac{\partial^2 h}{\partial y^2} = -\frac{R(x, y)}{T} \quad \text{Eqn. 3.1}$$

Page 1 of 2



4. (a) What are the advantages of Finite Element Method over Finite Difference Method when used in groundwater flow modeling?

(30 marks)

- (b) The 2-D steady-state groundwater flow equation takes the following form when there are no sinks or sources (Eqn. 4.1). Symbols have the standard meanings. Using a central approximation, develop the finite difference scheme for the governing equation.

$$\frac{\partial^2 h}{\partial x^2} + \frac{\partial^2 h}{\partial y^2} = 0 \quad \text{Eqn. 4.1}$$

Demonstrate its use with aid of an example.

(70 marks)

5. (a) Briefly describe solute transport mechanisms in groundwater environments. How can the movement of solutes be retarded?

(40 marks)

- (b) Distribution of solute mass in a groundwater environment is governed by various geochemical processes and movement of the fluid phase. Describe in detail the major processes that redistribute the solute mass in the aquifer system.

(60 marks)

-END-