NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF CIVIL AND WATER ENGINEERING

GROUNDWATER HYDRAULICS AND MODELLING

TCW 5001

Main Examination Paper

April 2015

This examination paper consists of 3 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: NONE

Examiner's Name: ELLEN MANGORE

INSTRUCTIONS

1. Answer any four (4) questions
2. Each question carries 25 marks
3. Use of calculators is permissible

MARK ALLOCATION

QUESTION	MARKS
1.	25
2.	25
3.	25
4.	25
5.	25
TOTAL	100

QUESTION 1

a.　Define the following terms as used in groundwater
　　i.　　conceptual model
　　ii.　　boundary condition
　　iii.　　contaminant transport model
　　iv.　　zone of saturation
　　v.　　vadose zone　　　　　　　　　　　　　　　　　　　　　(10 marks)
b.　Discuss the difference between the finite element and the finite difference methods of groundwater modelling　　　　　　　　　　　　　　　　　　(15 marks)
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QUESTION 2

a.　What do you understand by stream-aquifer phenomenon? What is its usefulness in augmenting streamflow?　　　　　　　　　　　　　　　　　　(7 marks)
b.　A long canal was constructed running parallel to a river 2.5km away. Both fully penetrate a sand aquifer with hydraulic conductivity of 3.1m*/d.* The area is subject to a rainfall of *2.6 m/year* and evaporation *of 0.9 m/year.* The elevation of water in the river is 45m and in the canal it is 40m.
Determine (i) the water divide (where specific discharge is zero), (ii) the maximum water table elevation, (iii) the steady discharge per km length of canal into the canal, and (iv) the steady discharge per km length of river into the river.　　　　　(18 marks)
　　　　　　　　　　　　　　　　　　　　　　　　　　　　[25 marks]

QUESTION 3

a.　Derive Dupuit-Thiem's equation for the yield of a well penetrating an unconfined aquifer. What are the basic assumptions of the theory?　　　　(15 marks)
b.　A 0.4 m diameter well fully penetrates an unconfined aquifer whose bottom is 80 m below the undisturbed groundwater table. When pumped at a steady rate of 1.5 m^3/min, the drawdowns observed in 2 observation wells at radial distances of 5 m and 15 m are 4 m and 2 m, respectively. Determine the drawdown in the well.　　(10 marks)
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QUESTION 4

a.　An aquifer pump test is conducted in a leaky aquifer in which the semiconfining layer is estimated to have a thickness of 2 m, and the aquifer has a thickness of 20 m. The pumping rate is 50l/s from a well of radius 0.5 m, and the steady-state drawdowns at 50 m and 100 m from the well are 0.3 m and 0.1 m, respectively. Estimate the hydraulic conductivity and transmissivity of the aquifer and the hydraulic conductivity of the semiconfining layer. Assume leakage factor of 63 m.　　　　　(15 marks)

b.　A fully penetrating well is abstracted at a constant rate of 400 m^3/hr over a considerable period of time from a homogeneneous, isotropic confined aquifer of constant thickness of 40 m. Two observation wells, one at a distance of 25 m shows a water level of 85.3 m and the other at 75 m shows a steady water level at 89.6 m. Determine the aquifer transmissivity and hydraulic conductivity.　　　　　　　　(10 marks)
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QUESTION 5

a.   Water flows through a sand aquifer with a piezometric head of 0.01.
- i.   If the hydraulic conductivity and effective porosity of the aquifer are 2 m/d and 0.3, respectively, estimate the specific discharge and seepage velocity in the aquifer
- ii.   Estimate the volumetric flow rate of the groundwater if the aquifer is 15 m deep and 1 km wide.
- iii.   How long does it take the groundwater to move 100 m.   (10 marks)

b.   Briefly describe the sequence of activities for groundwater quality monitoring in a urban setup located in a semi-arid region   (15 marks)

[25 marks]