NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF CIVIL AND WATER ENGINEERING

GROUNDWATER HYDRAULICS AND MODELLING

TCW 5001

First Semester Examinations Paper

December 2016

This examination paper consists of 8 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: Semi Log paper

Examiner's Name: Mrs Sakhile Ndlovu

INSTRUCTIONS

1. Answer any four questions
2. Each question carries 25 marks

MARK ALLOCATION

QUESTION	MARKS
1	25
2	25
3	25
4	25
5	25
6	25
TOTAL	100

QUESTION 1

A river and a drainage channel are shown in Figure Q1a. The average elevation of the water surface in the river is 144.6 meters, and in the channel 142.20 meters. The hydraulic conductivity of the confined inter-granular aquifer developed in medium alluvial sand is 3.5×10^{-4} m/s. The distance between the river and the channel is 720 m. The average thickness of the aquifer is 3.5 m.

**Fig Q1a Plan view of the river and the drainage channel**
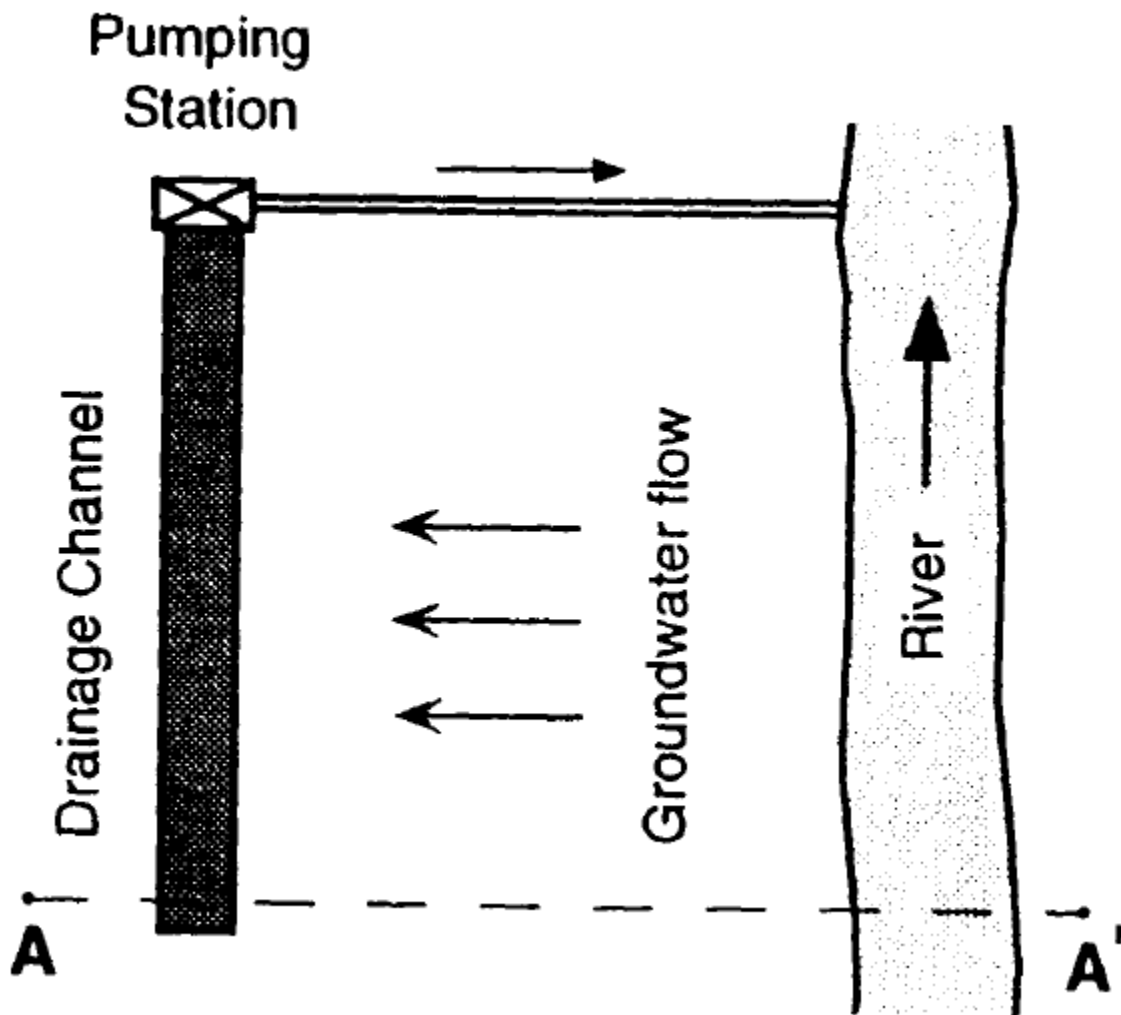
(a) Calculate the groundwater flow per unit width between the river and the drainage channel

(10 marks)

(b) What is the height z of the piezometric surface at a midpoint between the river and the channel? (4 marks)
(c) List 2 objectives of well development. (2 marks)
(d) Describe 2 methods used in well development. (4 marks)
(e) What factors contribute to well inefficiency (5 marks)

[25 marks]

QUESTION 2

Answer the following questions based on Figure Q2

Figure Q2
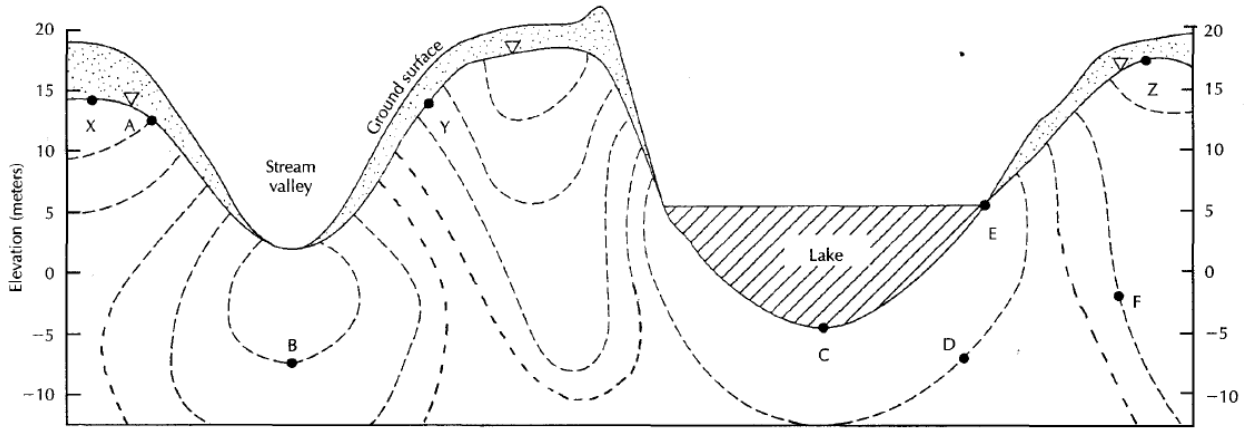
a) Fill in the heads at the locations labelled on the diagram

Location	Elevation Head	Pressure head	Total Head
A			
B			
C			
D			
E			
F			

(12 marks)

b) Label the recharge and discharge points   (3 marks)
c) Draw in flow lines on Figure Q2 (attached on the last page of the exam paper) starting at points X, Y and Z. Attach this Figure onto your answer booklet   (5 marks)
d) Hydraulic contact between groundwater and surface water bodies is an important phenomenon. What is your understanding of this phenomenon? Illustrate with examples
(5 marks)

[25 marks]

QUESTION 3

a) What are the main differences between the finite element and the finite difference methods of groundwater modeling? In your answer, include the strengths and weaknesses of each method

(10marks)

b) Describe 5 common mistakes that are made during groundwater modelling. How can the mistakes be avoided? (10 marks)

c) What is your understanding of the following terms:

i. Specific yield

ii. Artesian aquifer

iii. Effluent streams

iv. Vadose zone

v. Specific retention. (5 marks)

[25 marks]

QUESTION 4

(a) Discuss five methods for groundwater contaminant remediation. In your answer, include the advantages and disadvantage of each method, as well as its applicability. (20 marks)

(b) In low rainfall areas, artificial recharge may be used to increase groundwater recharge. Describe two methods of artificial recharge. What are the disadvantages and advantages of each method (5 marks)

[25 marks]

QUESTION 5

Table Q5 shows the data of a pumping test conducted in a confined aquifer having a large spatial extent. The well was pumped at a uniform rate of 2500 m3/day. Drawdowns during the pumping period were measured in an observation well 60m away, observations of s and t are listed in Table Q5.

Table Q5

t (min)	0	1	1.5	2	2.5	3	4	5	6	8	10	12	14
s (m)	0	0.2	0.27	0.3	0.34	0.37	0.41	0.45	0.48	0.53	0.57	0.6	0.63
t (min)	18	24	30	40	50	60	80	100	120	150	180	210	240
s (m)	0.67	0.72	0.76	0.81	0.85	0.9	0.93	0.96	1	1.04	1.07	1.1	1.12

(a) Describe briefly how a pumping test is performed in the field.

(5 marks)

(b) Estimate T and S using the Cooper-Jacob method.   (15 marks)

(c) Suppose the aquifer has a thickness of 8 m what is the hydraulic conductivity of the aquifer material?   (2 marks)

(d) Why does the cone of depression of a confined aquifer spread more quickly than the cone of depression of an unconfined aquifer?   (3 marks)

[25 marks]

QUESTION 6

The drawdown data from a step drawdown test ate tabulated in Table Q6. Using the given data and assuming n = 2:

Table Q6

Q (m^3/day)	500	1000	1500	2000	2500	3000	3500
s_w (m)	1.14	2.5	4.22	6.43	9.12	11.97	14.87

a) Calculate the formation and well loss coefficients   (15 marks)

b) Comment on the validity of the n = 2 assumption   (2marks)

c) Assess the well condition   (2 marks)

d) Calculate the specific capacity and efficiency of the well for a pumping rate of 1250 m3/day   (6 marks)

[25 marks]

END OF EXAMINATION

List of equations

$S = (2.3Q/4\pi T) / \log(2.25Tt/r^2 S_c)$ $\Delta s = (2.3Q/4\pi K) \log(t_2/t_1)$ $I = Q(6.87/A)$

$T = 2.3Q/4\pi\Delta s$ $S = 2.25Tt_0/r^2$ $s = 2.3Q/2\pi T$

$$s_w = \frac{Q}{2\pi T} \ln\left(\frac{r_0}{r_w}\right) + CQ^n$$