Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015

COURSE NAME	:	GROUNDWATER ENGINEERING
COURSE CODE	:	BFW 40403
PROGRAMME	:	BACHELOR OF CIVIL ENGINEERING WITH HONOURS
EXAMINATION DATE	:	JUNE 2015/ JULY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 (a) Define with aided of sketch the following.

i. Groundwater Table
ii. Heads
iii. Unconfined aquifer
iv. Confined aquifer

(4 marks)

(b) Briefly explain **THREE (3)** importances of groundwater studies in engineering perspective.

(9 marks)

(c) During one year, the water balance terms for a lake included rainfall P = 1040 mm/year, evaporation E = 720 mm/year, surface inflow I = 55 mm/year, surface outflow O = 135 mm/year, and change in storage ΔS = 60 mm/year. Compute the net groundwater flow for the lake.

(12 marks)

Q2 (a) Compute the flow rate (in m^3/day) through an aquiclude, with the following parameters obtained from a laboratory experiment:

Sample column size = 15 cm diameter and 30 cm long
Head difference between manometers Δh = 5 cm
Hydraulic conductivity $K = 2.85 \times 10^{-7}$ cm/s

(6 marks)

(b) A cylindrical field sample of an unconfined aquifer with length of 60 cm and diameter of 20 cm is tested for a period of 10 minutes under a constant head difference of 15 cm. The pore diameter and effective porosity is found to be, 0.037 cm and 0.1, respectively. If the hydraulic conductivity K computed is 1.736×10^{-3} cm/min,

i. Categorize the type of material of the aquifer by refer to **Table Q2**.

(5 marks)

ii. Determine the applicability of Darcy's law if dynamic viscosity and density of water are 1.005×10^{-3} kg/ms and 998.2 kg/m^3, respectively.

(10 marks)

iii. Compute the volume of collected water (in litre) at the outlet of the test apparatus.

(4 marks)

Q3 (a) Derive Theim equation for unconfined aquifers in steady radial flow conditions by using Darcy's law.

(3 marks)

(b) A well penetrates an unconfined aquifer. Prior to pumping, the initial head is 25 m. After a long period of pumping at a constant rate of 0.05 m^3/s, the drawdowns at distances of 50 m and 150 m from the pumping well were observed to be 3 m and 1.2 m, respectively. Determine;

i. Hydraulic conductivity (in m/s)
ii. Type of aquifer material (refer to **TABLE Q2**)

(10 marks)

(c) A 30-cm well completely penetrates an unconfined aquifer of saturated depth 40 m. After a long period of pumping at a steady rate of 0.025 m^3/s, the drawdown in two observation wells 25 and 75 m from the pumping well were found to be 3.5 and 2.0 m respectively. By using the Theim equation derived from **Q3(a)**, determine:

i. Transmissivity (in m^2/s)
ii. Drawdown at pumping well

(12 marks)

Q4 (a) Derive Theim equation for confined aquifers in steady radial flow conditions by using Darcy's law.

(3 marks)

(b) A 0.46 m diameter well was used to pump water from a confined aquifer at 0.38 m^3/min. The drawdown recorded at observation wells located at 15.24 and 60.96 m from the pumping well were 3.05 m and 2.44 m, respectively.

i. Determine the transmissivity value of the aquifer.
ii. Determine the drawdown at the pumping well.

(10marks)

(c) A well fully penetrates a 25-m thick confined aquifer. After a long period of pumping at a constant rate of 0.05 m^3/s, the drawdowns at distance of 50 and 150 m from the production well were observed to be 3 and 1.2 m, respectively. Determine;

(i) Transmissivity (in m^2/s)
(ii) Hydraulic conductivity (in m/s)
(ii) Type of unconsolidated deposit (refer to **TABLE Q2**)

(12 marks)

Q5 (a) Breifly explain the suitable methods for drilling of shallow and deep wells.
(4 marks)

(b) Discuss the electrical imaging resistivity method in groundwater investigations.
(8 marks)

(c) A 30-cm well penetrating a confined aquifer is pumped at a rate of a 0.02 m^2/s. Drawdown measured at an observation well located 30 m away is given in **TABLE Q5**. By using the Cooper-Jacob method, calculate:

(i) Transmissivity (in m^2/s)
(ii) Storativity

(13 marks)

- END OF QUESTION -

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TABLE Q2

Typical Values of Hydraulic Conductivity

Material	Hydraulic conductivity (m/day)
Gravel, coarse	150
Gravel, medium	270
Gravel, fine	450
Sand, coarse	45
Sand, medium	12
Sand, fine	2.5
Silt	0.08
Clay	0.0002
Sandstone, fine-grained	0.2
Sandstone, medium-grained	3.1
Limestone	0.94
Dolomite	0.001
Dune sand	20
Loess	0.08
Peat	5.7
Schist	0.2
Slate	0.00008
Till, predominantly sand	0.49
Till, predominantly gravel	30
Tuff	0.2
Basalt	0.01
Gabbro, weathered	0.2
Granite, weathered	1.4

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TABLE Q5

Elapsed Time (min)	Drawdown (m)
1	0.2
2.5	0.5
5	0.8
10	1.2
20	1.8
50	2.5
100	3.0
200	3.7
500	4.4
1000	5.0

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Supplementary Equations

$$\mathrm{Re} = \frac{\rho V D}{\mu}$$

$$K = \frac{Q}{\pi\left(h_2^2 - h_1^2\right)} \ln\left(\frac{r_2}{r_1}\right)$$

$$T = \frac{Q}{2\pi(h_2 - h_1)} \ln\left(\frac{r_2}{r_1}\right)$$

$$\mathrm{T} = \frac{2.3\mathrm{Q}}{4\pi\Delta s'}$$

$$S = \frac{2.25 T t_o}{r^2}$$