Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

COURSE NAME	:	GROUNDWATER ENGINEERING
COURSE CODE	:	BFW40403
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JUNE 2017
DURATION	:	3 HOURS
INSTRUCTIONS	:	ANSWER **ALL** QUESTIONS IN **SECTION A** AND **FOUR (4)** QUESTIONS IN **SECTION B**

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

SECTION A

Q1 (a) Describe in your own words according to groundwater occurrence in terms of hydrology perspective.

(4 marks)

(b) Rewrite **FOUR (4)** characteristics of groundwater according to water movement, water quality and quantity effects.

(8 marks)

(c) Compare **TWO (2)** situations with aided sketch of groundwater table interacts for hydraulically connected system with the stream bed.

(i) gaining stream

(ii) losing stream

(8 marks)

SECTION B

Q2 (a) Define the following terms:
(i) Aquitard
(ii) Aquiclude

(4 marks)

(b) Formulate groundwater flow based on Darcy's Law equations of unconfined aquifer:
(i) Homogeneous Anisotropic
(ii) Homogeneous Isotropic

(8 marks)

(c) A leaky confined aquifer is overlain by an aquitard that is also overlain by an unconfined aquifer. The estimated recharge rate from the unconfined aquifer into the confined aquifer is 0.085 m/year. Piezometric head measurements in the confined aquifer show that the average piezometric head in the confined aquifer is 6.8 m below the water table of the unconfined aquifer. If the average thickness of the aquitard is 4.30 m:
(i) estimate the hydraulic conductivity of the aquitard
(ii) identify the type of material could this possibly be as shown in **Table Q2(c)**

(8 marks)

Q3 (a) Relate the following terms according to groundwater movement in fluid characteristics:
(i) Steady flow
(ii) Unsteady flow

(4 marks)

(b) A field sample of an unconfined aquifer is packed in a test cylinder. The length and the diameter of the cylinder are 50 cm and 6 cm, respectively. The field sample is tested for a period of 3 min under a constant head difference of 16.3 cm. As a result, 45.2 cm^3 of water is collected at the outlet. Determine the hydraulic conductivity of the aquifer sample and categorize the type of soil classification as shown in **Table Q2 (c).**

(8 marks)

(c) The distance and the observed piezometric surface drop between two adjacent wells are 100 m and 3 m, respectively. Assume steady unidirectional flow in a homogeneous silty sand confined aquifer with a hydraulic conductivity K = 5.5 m/day and an effective porosity of 0.35. Predict of the time it takes for a molecule of water to move from one well to the other.

(8 marks)

Q4 (a) List down **THREE (3)** objectives of well test.

(3 marks)

(b) After a period of pumping at a rate of 120 m^3/hour, the drawdowns in observation wells of 15 m and 30 m distance from the pumped well are found to 1.0 m and 0.75 m, respectively. Calculate the transmissivity of the aquifer.

(8 marks)

(c) The steady state pumping rate is 300 m^3/hr. The drawdown at an observation well 50 m away is 40 m whilst in a second observation well 100 m away is 43 m:

(i) compute the permeability of an artesian unconfined aquifer being pumped by a fully penetrating well

(ii) iIllustrate the section view profile of groundwater wells completely

(9 marks)

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

(3 marks)

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

(5 marks)

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

(6 marks)

(d) 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.

(i) evaluate hydraulic conductivity (in m/s)

(ii) interpret type of aquifer material (refer to **Table Q2(c)**)

(6 marks)

Q6 (a) List **TWO (2)** objectives of the groundwater investigations.

(2 marks)

(b) Explain **TWO (2)** reasons the environmental impacts must be avoided to either fellow groundwater users or to the aqueous environment.

(8 marks)

(c) Design with aided sketch of flow chart of groundwater investigation process before drilling of well system.

(10 marks)

- END OF QUESTIONS –

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TABLE

Table Q2(c): Hydraulic conductivity values

Material	K (cm/sec)
Gravel	10^{-1} to 100
Clean sand	10^{-4} to 1
Silty sand	10^{-5} to 10^{-1}
Silt	10^{-7} to 10^{-3}
Glacial till	10^{-10} to 10^{-4}
Clay	10^{-10} to 10^{-6}

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EQUATIONS

$$T = \frac{Q}{2\pi(h_2 - h_1)} \ln\left(\frac{r_2}{r_1}\right) \qquad Q = K(2\pi rb)\frac{dh}{dr} \qquad Q = K(2\pi rh)\frac{dh}{dr} \qquad K = -\frac{v}{dh/dl}$$

$$T = \frac{Q}{2\pi\left(S_2 - h_0 - (S_1 - h_0)\right)} ln\left(\frac{r_2}{r_1}\right)$$

$$T = \frac{Q}{2\pi(S_2 - S_1)} ln\left(\frac{r_2}{r_1}\right) \qquad Q_s = -K_s \frac{dh}{ds} A \qquad A = \frac{\pi D^2}{4}$$

$$\frac{dh}{dl} = hydraulic\ gradient \qquad h = -\frac{vx}{K} \qquad v_e = \frac{v}{n_e}$$

$$S_w = \frac{Q}{2\pi T} \ln\left(\frac{r_1}{r_w}\right) + S_1$$

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

$$t = \frac{L_A}{V_A}$$