UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2011/2012

COURSE NAME	:	GROUNDWATER ENGINEERING
COURSE CODE	:	BFW 4043 / BFW 40403
PROGRAMME	:	BFF
EXAMINATION DATE	:	JUNE 2012
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) Discuss **FIVE (5)** importance of groundwater studies.

(10 marks)

(b) State **FIVE (5)** typical characteristics of groundwater.

(10 marks)

(c) During one year, the water balance for a lake are rainfall $P = 1025$ mm/year, evaporation $E = 706$ mm/year, surface inflow $I = 50$ mm/year, surface outflow $O = 125$ mm/year, and change in storage $\Delta S = 60$ mm/year. Compute the net groundwater flow for the lake.

(5 marks)

Q2 (a) Discuss **FOUR (4)** reasons why groundwater is not fully utilized in Malaysia.

(8 marks)

(b) A cylindrical field sample of an unconfined aquifer with length 50 cm and diameter 10 cm is tested for a period of 6 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 5.556×10^{-3} cm/min,

(i) Categorize the type of material of the aquifer.

(9 marks)

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

(5 marks)

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

(3 marks)

Q3 (a) Prove that the discharge Q of the steady-state radial flow towards a well of radius r_w of an unconfined aquifer is given as

$$Q = \pi K \frac{h_0^2 - h_w^2}{\ln(r_0 / r_w)}$$

where, K = hydraulic conductivity, h_0 = initial uniform head, h_w = head in the well, r_0 = radial distance between the uniform head to the centre of the well, and r_w = radial distance of the well.

(10 marks)

(b) After a period of pumping at a rate 110 m^3/hour, the drawdowns in wells 15 m and 30 m from the pumped well were found to be 1.0 m and 0.75 m, respectively. If the diameter and depth of the pumped well are 0.5 m and 15 m below the static water table, respectively, find the transmissivity of the aquifer.

(8 marks)

(c) Determine the approximate drawdown in the pumped well described in **Q1(b)**.

(7 marks)

Q4 (a) An unconfined aquifer lying on an impervious base, and sandwiched between two fully penetrating ditches is subjected to rainfall recharge. Show that the maximum head within the aquifer is given as

$$h_{\max}^2 = h_1^2 - \frac{(h_1^2 - h_2^2)d}{L} + \frac{W}{K}(L - d)d$$

where, h_1 = depth of water in river 2, h_2 = depth of water in river 1, $h_1 > h_2$, d = horizontal distance of $h_{\max}$, $d = \frac{L}{2} - \frac{K}{W}\frac{(h_1^2 - h_2^2)}{2L}$, W = rainfall recharge, K = hydraulic conductivity, and L = length of the aquifer.

(10 marks)

(b) A 500 m long unconfined aquifer of clean sand and gravel is located between two fully penetrating rivers with hydraulic conductivity $K = 1.25 \times 10^{-2}$ cm/s. The aquifer is subjected to a uniform recharge of 1.5 m/year. If the depth of water in the rivers $h_1 = 5.0$ and $h_2 = 3.5$, estimate

(i) Maximum elevation of the water table and its location.

(5 marks)

(ii) Travel times from groundwater divide to both rivers, where effective porosity $n_e = 0.25$.

(5 marks)

(iii) Daily discharge per kilometre from the aquifer into both rivers.

(5 marks)

TERJEMAHAN:

S1 (a) Huraikan **LIMA (5)** kepentingan pengajian air bumi.

(10 markah)

(b) Nyatakan **LIMA (5)** ciri-ciri am air bumi.

(10 markah)

(c) Dalam satu tahun, imbangan air bagi sebuah tasik ialah hujan P = 1025 mm/tahun, sejatan E = 706 mm/tahun, aliran permukaan masuk I = 50 mm/tahun, aliran permukaan keluar O = 125 mm/tahun, dan perubahan takungan ΔS = 60 mm/tahun. Kira aliran air bumi bersih untuk tasik tersebut.

(5 markah)

S2 (a) Huraikan **EMPAT (4)** sebab mengapa air bumi tidak digunakan sepenuhnya di Malaysia.

(8 markah)

(b) Satu sampel tanah akuifer tak terkurung dengan panjang 50 cm dan diameter 10 cm diuji selama 6 minit dengan perbezaan turus 15 cm secara malar. Diameter liang dan keliangan berkesan ialah 0.037 cm dan 0.1, masing-masing. Jika konduktiviti hidraulik K yang diperolehi ialah 5.556×10^{-3} cm/min,

(i) Kategorikan jenis bahan akuifer tersebut.

(9 markah)

(ii) Tentukan sama ada hukum Darcy boleh digunakan jika kelikatan dinamik dan ketumpatan air ialah 1.005×10^{-3} kg/ms dan 998.2 kg/m^3, masing-masing.

(5 markah)

(iii) Kira isipadu air (dalam liter) yang dikumpulkan di salur keluar peralatan ujikaji.

(3 markah)

S3 (a) Buktikan bahawa kadaralir Q aliran jejarian malar ke dalam sebuah telaga dengan jejari r_w bagi sebuah akuifer tak terkurung ialah

$$Q = \pi K \frac{h_0^2 - h_w^2}{\ln(r_0 / r_w)}$$

dimana, K = konduktiviti hidraulik, h_0 = turus awal, h_w = turus dalam telaga, r_0 = jarak jejarian di antara turus seragam awal ke titik tengah telaga, dan r_w = jejari telaga.

(10 markah)

(b) Selepas satu tempoh pengepaman pada kadar 110 m^3/jam, air yang surut dalam telaga-telaga yang berjarak 15 m dan 30 m daripada telaga yang dipam ialah 1.0 m dan 0.75 m, masing-masing. Jika diameter dan kedalaman telaga yang dipam ialah 0.5 m dan 15 m di bawah paras air statik, masing-masing, kira kebolehhantaran akuifer tersebut.

(8 markah)

(c) Kira kedalaman surut dalam telaga yang dipam yang dihuraikan di **Q1(b)**.

(7 markah)

S4 (a) Sebuah akuifer tak terkurung di atas dasar tak telap, dan berada di antara dua buah sungai menerima imbuhan daripada hujan. Tunjukkan bahawa turus maksimum dalam akuifer ialah

$$h_{max}^2 = h_1^2 - \frac{(h_1^2 - h_2^2)d}{L} + \frac{W}{K}(L - d)d$$

dimana, h_1 = kedalaman aliran sungai 2, h_2 = kedalaman aliran sungai 1, $h_1 > h_2$, d = jarak ufuk h_{max}, $d = \frac{L}{2} - \frac{K}{W}\frac{(h_1^2 - h_2^2)}{2L}$, W = imbuhan hujan, K = konduktiviti hidraulik, dan L = panjang akuifer.

(10 markah)

(b) Sebuah akuifer pasir bersih dan batu baur tak terkurung sepanjang 500 m long adalah terletak di antara dua buah sungai dengan konduktiviti hidraulik $K = 1.25 \times 10^{-2}$ cm/s. Akuifer tersebut menerima imbuhan seragam 1.5 m/tahun. Jika kedalaman aliran dalam sungai-sungai ialah $h_1 = 5.0$ dan $h_2 = 3.5$, kira

(i) Paras maksimum air bumi dan lokasinya.

(5 markah)

(ii) Masa aliran dari lokasi paras maksimum ke setiap sungai, dimana keliangan berkesan $n_e = 0.25$.

(5 markah)

(iii) Kadar alir harian setiap kilometer dari akuifer ke setiap sungai.

(5 markah)

FINAL EXAMINATION

SEMESTER/SESSION: II/2011/2012 PROGRAMME : 4BFF

COURSE NAME : GROUNDWATER ENGINEERING COURSE CODE : BFW40403/BFW4043

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