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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION (ONLINE) SEMESTER II SESSION 2019/2020

COURSE NAME	:	GROUNDWATER ENGINEERING
COURSE CODE	:	BFW 40403
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY 2020
DURATION	:	6 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS EXAMINATION PAPER CONSISTS OF **FIVE (5)** PAGES

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Q1 (a) List **FIVE (5)** indicators in measuring good productivity of groundwater characteristics.

(5 marks)

(b) Distinguish between unconfined and confined aquifer.

(4 marks)

(c) Water flows through a sand aquifer 15 m deep and 1 km wide with a piezometric head gradient of 0.01. If the hydraulic conductivity and effective porosity of the aquifer are 2 m/day and 0.3 respectively, estimate:

(i) the specific discharge and seepage velocity.

(3 marks)

(ii) the volumetric flowrate and time it takes for groundwater to travel till 100 m distance.

(3 marks)

(d) In a field test, a period of 6 hours was required for a tracer to travel through an aquifer from one well to another. The observation wells were 42 m apart and the difference of water levels was found to be 0.42 m.

(i) Calculate the discharge velocity.

(2 marks)

(ii) Calculate the coefficient of permeability (K). Given the porosity of the soil medium is 20 %.

(2 marks)

(iii) Justify the value of coefficient of instrinsic permeability for the aquifer in Darcy's by refering to **TABLE Q1(d)** for a suitable viscosity value.

(6 marks)

Q2 (a) Describe **TWO (2)** techniques that incorporate resistivity application and their purposes.

(2 marks)

(b) A step test was carried out at 4-hours steps. **TABLE Q2(b)** shows the data obtained for yield (Q) and corresponding drawdown (S_w) in the pumping well. Estimate:

(i) Value of losses.

(3 marks)

(ii) Percent (%) of well efficiency drops.

(3 marks)

(c) If the water table drops 40 m, the changes in intergranular pressure at the bottom of the sand layer occur. Consider a 60 m thick of sand layer and the water table is located at a depth of 10 m below the groundwater surface. Illustrate the groundwater profile for the new water table and justify this condition.

(8 marks)

(d) A well is being pumped at a constant rate of 0.004 m^3/s. Given that $T = 0.0025$ m^2/s $r = 100$ m and the storage coefficient $S = 0.00087$. Predict the drawdown in the observation well for a time period of 15 minutes and 20 hours. Refer **TABLE Q2(d)** for estimating the value of u and $W(u)$.

(9 marks)

Q3 As a groundwater engineer, it is your responsibility to keep the stakeholders aware of information and insights related to the containment of any factors that cause groundwater contamination. Extensive knowledge among the community on this matter will contribute to a sustainable conservation of groundwater resources at all level of ages. Develop a best method and approach to achieve this goal based on the following criterias:

(i) Knowledge, perception and understanding of groundwater contamination.

(10 marks)

(ii) Perceptions of groundwater quality in terms of impacts and consequences for each sector through comparisons in two different situations.

(15 marks)

Q4 (a) Discuss the relationship of monitoring work and site remediation which are needed for groundwater flow as a transport of contaminants.

(10 marks)

(b) For vadose zone soil water budget, present a conclusion of the **THREE (3)** distinct processes in groundwater recharge.

(15 marks)

- END OF QUESTIONS –

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TABLE Q1(d): Liquid viscosity values

Liquid Types	**Viscosity (cm^2/s)**
Air	1×10^{-3}
Petrol	3×10^{-2}
Water	1×10^{-2}
Oil	0.1
Glycerol	1
Corn-Syrup	1×10^{4}
Bitumen	1×10^{11}

TABLE Q2(b): Pumping test well data

Step	**Q (l/s)**	**S_w (m)**	**Q/S_w (m^2/day)**
Rest	0	0	0
1	14.7	1.43	888
2	31.5	3.46	787
3	44.4	5.41	709
4	57.6	8.90	559

TABLE Q2(d): Values of $W(u)$ for various value of u

u	$W(u)$	u	$W(u)$	u	$W(u)$	u	$W(u)$
1×10^{-10}	22.45	7×10^{-8}	15.90	4×10^{-5}	9.55	1×10^{-2}	4.04
2	21.76	8	15.76	5	9.33	2	3.35
3	21.35	9	15.65	6	9.14	3	2.96
4	21.06	1×10^{-7}	15.54	7	8.99	4	2.68
5	20.84	2	14.85	8	8.86	5	2.47
6	20.66	3	14.44	9	8.74	6	2.30
7	20.50	4	14.15	1×10^{-4}	8.63	7	2.15
8	20.37	5	13.93	2	7.94	8	2.03
9	20.25	6	13.75	3	7.53	9	1.92
1×10^{-9}	20.15	7	13.60	4	7.25	1×10^{-1}	1.823
2	19.45	8	13.46	5	7.02	2	1.223
3	19.05	9	13.34	6	6.84	3	0.906
4	18.76	1×10^{-6}	13.24	7	6.69	4	0.702
5	18.54	2	12.55	8	6.55	5	0.560
6	18.35	3	12.14	9	6.44	6	0.454
7	18.20	4	11.85	1×10^{-3}	6.33	7	0.374
8	18.07	5	11.63	2	5.64	8	0.311
9	17.95	6	11.45	3	5.23	9	0.260
1×10^{-8}	17.84	7	11.29	4	4.95	1×10^{0}	0.219
2	17.15	8	11.16	5	4.73	2	0.049
3	16.74	9	11.04	6	4.54	3	0.013
4	16.46	1×10^{-5}	10.94	7	4.39	4	0.004
5	16.23	2	10.24	8	4.26	5	0.001
6	16.05	3	9.84	9	4.14		

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Equations

$$Q = Area \times \Delta H_{water\ table} \times S_y$$

$$V = S_y \times \Delta H \times Area$$

Reynolds Number

$$Re = \frac{V \times d_{particle\ size}}{v}$$

Coefficient of permeability

$$K = \frac{V_{discharge}}{i}$$

$$V_{actual} = \frac{S}{t}$$

$$V_{discharge} = nV_a$$

$$i = \frac{H_L}{S}$$

$$Intrinsic\ permeability, K_o = \frac{Kv}{g}$$

$$u = \frac{r^2 S}{4tT}$$

$$s = \frac{QW(u)}{4\pi T}$$