Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	GROUNDWATER ENGINEERING
COURSE CODE	:	BFW 40403
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS.

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

Q1 (a) The first and most important step in achieving a good well design is to complete a drilling log, during the actual drilling process. Soil samples will be taken at regular depths (e.g. every meter) and described during the drilling process. The soil description is then recorded in the form of a drilling log. Identify **FOUR (4)** elements of the results that could be derived from this process.

(8 marks)

(b) The groundwater monitoring must include the measuring static level elevations in each well prior to purging the well for sampling.

(i) Briefly explain the importance and requirements of this monitoring.

(3 marks)

(ii) Point out the field measurements that may include during this process.

(5 marks)

(c) At a certain point in an unconfined aquifer of 3 km^2 area, the water table was at an elevation of $102.0\ m$. Due to natural recharge in a wet season, its level rise to $103.2\ m$. A volume of $1.5 \times 10^6\ m^3$ of water was then pumped out of the aquifer causing the water table to reach a level of $101.2\ m$. Assuming the water table in the entire aquifer to respond in a similar way, calculate:

(i) the specific yield S_y of the aquifer.

(5 marks)

(ii) the volume of recharge during the wet season.

(4 marks)

Q2 (a) Groundwater contamination is a serious threat to water supply. Risk assessment of groundwater contamination is an effective way to protect the safety of groundwater resource. Groundwater is a complex and fuzzy system with many uncertainties, which is impacted by different geological and hydrological factors. Determine **FIVE (5)** potential sources of groundwater contamination and explain each of the sources.

(15 marks)

(b) Groundwater quality monitoring can be understood to be a continuous, methodologically and technically standardized approach of field observation and laboratory measurements, procedures of selected physical, chemical and biological parameters of a hydrogeological system. Rely on this understanding, outline **TWO (2)** main objectives of groundwater quality monitoring.

(4 marks)

(c) Groundwater remediation relates to all instruments which are used to deal with groundwater that has already been contaminated. This includes measures that actively reduce pollution, as well as controlling pollution by limiting its spread within an aquifer. Recommend **THREE (3)** different categories of response activities.

(6 marks)

Q3 (a) The rainfall that percolates below the ground surface passes through the void of the rocks and joins the water table. These voids are generally interconnected permitting the movement of water between the interstices. The mode of occurrence of groundwater depends largely upon the type of formation and the geology of the area. The possibility of occurrence of groundwater mainly depends upon **TWO (2)** geological factors. Identify and explain each of the factors.

(4 marks)

(b) A field test for permeability consists in observing the time required for a tracer to travel between two observation wells. A tracer was found to take $10\ h$ to travel between two wells $50\ m$ apart when the difference in the water surface elevation in them was $0.5\ m$. The mean particle size of the aquifer was $2\ mm$ and the porosity of the medium 30%. If $v = 1 \times 10^{-6}\ m^2/s$,

(i) estimate the coefficient of permeability and intrinsic permeability of the aquifer.

(9 marks)

(ii) find the Reynolds number of the flow.

(3 marks)

(c) The artificial surface reservoirs are constucted by building dams in order to store the surplus surface waters. In the same manner, artificial underground resevoirs are developed by artificial recharge for storing water underground. Supporting this approach by justifying with **THREE (3)** methods of recharging.

(9 marks)

Q4 (a) The basic principle in well development is to course reversals of flow through the screen openings that will rearrange the aquifer particles. This is essential to break down bridging of the groups of particles. Review **TWO (2)** commonly adopted well development methods.

(5 marks)

(b) 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 to **Table Q4(b)** for estimating the value of u and $W(u)$.

(8 marks)

(c) If simultaneous measurements of the drawdown are made at a given time in three or more observation wells, the Cooper-Jacob straight-line method for time-drawdown data can be used. During a pumping test conducted in a confined aquifer, the aquifer was pumped at a constant rate of 280 m^3/h. After 180 minutes of pumping, drawdowns were simultaneously measured in nine observation wells located at different radial distances from the pumping well as shown in **Table Q4(c)**. By referring to the observed distance-drawdown data, produce graph of drawdown versus log(r) in validating the transmissivity (*T*) and storage coefficient (*S*) of the confined aquifer.

(12 marks)

- END OF QUESTIONS -

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Table Q4(b): 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		

Table Q4(c): Distance-drawdown pumping well data

Distance (m)	3	15	30	45	60	75	90	120	150
Drawdown (m)	10.73	7.42	6.00	5.17	4.58	4.13	3.76	3.18	2.73

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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

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

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

$$V_{discharge} = nV_a$$

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

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

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

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