Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	DESIGN OF WATER SUPPLY
COURSE CODE	:	BFA 40203
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY 2024
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER ALL QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ Closed book 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK.

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

Q1 (a) Explain temporary and permanent hardness of water.

(4 marks)

(b) Illustrate the natural process by which water becomes hard.

(6 marks)

(c) Recommend the chemical dosage of lime and soda, both in mg/L as $CaCO_3$ to soften the water to meet the practical solubility limits. Use data in **Table Q1.1** and assume that CO_2 concentration is 21.9 mg/L as $CaCO_3$.

(10 marks)

Table Q1.1 Concentration and molecular weight for ion

Ion	Concentration (mg/L)	Molecular Weight (mg/mmol)
Ca^{2+}	70	40.1
Mg^{2+}	21	24.3
Na^{+}	15	23.0
HCO_3^{-}	190	61.0
SO_4^{2-}	130	96.1

Q2 (a) Explain **TWO (2)** assumptions for ideal sedimentation basin.

(4 marks)

(b) Illustrate a weir in a rectangular sediment basin and explain the significance of weir in sedimentation process.

(6 marks)

(c) Recommend a rectangular horizontal flow settling tank for Parit Raja water treatment plant for a flowrate of 1150 m^3/hr, with respect to the dimension of one (1) tank, Reynolds number, and the weir loading rate. Use the following data:

i. Surface loading rate = 1.5 m/hr
ii. Sedimentation tanks = 2 units
iii. Depth = 3 meters
iv. Kinematic viscosity, ν of water at 27°C = 8.54 x 10^{-7} m^2/s

The recommendation shall comply with the following criteria:
i. Length to width ratio = 3: 1 to 5:1
ii. Velocity, v_f = 0.005 – 0.018 m/s
iii. Reynolds number = <2000
iv. Weir loading rate = 6.25 – 12.5 m^3/h.m

(10 marks)

Q3 (a) Explain **TWO (2)** advantages of chlorination.

(4 marks)

(b) Chlorine solution strength is 0.9% NaOCl (w/v) is injected into water that flows at 50 gpm (gallon per minutes). The chlorine demand and chlorine residual are 2.0 mg/L as Cl_2 and 0.2 mg/L as Cl_2 respectively. Calculate

(i) Chemical feed rate in mL/min to achieve a chlorin residual as stated above

(2 marks)

(ii) Chlorine dosage in mg/L as Cl_2.

(2 marks)

(iii) Volume of 0.9 % NaOCl (w/v) that is injected to produce 50000 disinfected waters in litre.

(2 marks)

(c) Review **FIVE (5)** criterias that should be considered when selecting a disinfectant.

(10 marks)

Q4 (a) Explain **TWO (2)** functions of service reservoir.

(4 marks)

(b) Differentiate between gravity supply and pumped supply systems by an illustration.

(6 marks)

(c) A pump is installed in the distribution reservoir to supply the water in the reservoir uniformly. The estimated hourly consumption of water for a residential area for one day is tabulated in **Table Q4.1**. Recommend the storage capacity of the distribution reservoir. Assume a uniform flowrate in the range of 1.40 to 1.60 m^3/s.

(10 marks

Table Q4.1 Hourly consumption

Hour	Demand or consumption in million litres/hr	Hour	Demand or consumption in million litres/hr
1	2.5	13	8
2	2.4	14	7.6
3	2.3	15	7.2
4	2.2	16	6.8
5	2.4	17	7.2
6	3.0	18	7.0
7	3.4	19	6.8
8	5.6	20	6.2
9	6.4	21	6.0
10	7.0	22	4.4
11	7.6	23	3.4
12	7.8	24	3.0

Q5 (a) Explain the static pressure.

(4 marks)

(b) The water level in a water tower that supplies a factory is 1500 ft. The elevation of the supply line at the factory is 1135ft. Assume that the head lost is 3.5 ft, estimate the static head, static pressure, dynamic head, and actual pressure of the water as it enters the factory. Use I Psi equals 2.31 ft.

(6 marks)

(c) The fittings used in a pipeline are tabulated **in Table Q5.1**. **Table Q5.2** shows the details of fittings for different pipe sizes. Select the pipe size from **Table Q5.2** and recommend the actual pressure in pipeline at a discharge location. Given:

i. Difference between two elevation = 200 ft
ii. Length = 8202 ft
iii. Flowrate = 250 gpm
iv. Hazen William coefficient, *C* for a cement line pipe = 140
v. 1 Psi = 2.31 ft

(10 marks)

Table Q5.1 Fittings used in the pipeline

Fittings	Number
Elbow 90 degree	8
Tee branch flow	10
Return bends, regular 180 degree	4
Valves, globe	2

Table Q5.2 Equivalent length for fittings

Flanged Fittings		**Pipe size (inch)**		
		8	**10**	**12**
Elbows	Regular 90 Degree	12.0	14.0	17.0
	Long radius 90 degree	7.0	8.0	9,0
	Regular 45 degree	7.7	9.0	11.0
Tees	Line flow	4.7	5.2	6.0
	Branch flow	24.0	30.0	34.0
Return bends	Regular 180 degree	12.0	14.0	17.0
	Long radius 180 degree	7.0	8.0	9.0
Valves	Globe	260.0	310.0	390.0
	Gate	3.2	3.2	3.2
	Angle	90.0	120.0	140.0
	Swing Check	90.0	120.0	140.0

-END OF QUESTIONS-

APPENDIX A

EQUATIONS

$$\text{Eq. Wt (EW)} = \frac{\text{MW}}{\text{n}} \text{ (mg/meq)}$$

$$\text{meq/L} = \text{meq/mg} \times \text{mg/L}$$

$$\text{Mg/L as } CaCO_3 = \text{meq/L} \times 50 \text{ mg/meq}$$

$$V_f = \frac{Q}{A}$$

$$R_h = \frac{A_x}{P_w}$$

$$R = \frac{V_f R_h}{\upsilon}$$

$$\text{Chemical Feed Rate, mL/min} = \frac{(Cl_2 \text{ residual, mg/L}) \times (\text{Flow, gpm}) \times 0.3785}{\%\ \text{NaOCl solution (w/v)}}$$

$$Cl_2 \text{ Dosage, mg/L} = \frac{9525 \times (\text{gallons of NaOCl solution injected}) \times (\%\text{NaOCl w/v})}{\text{(gallons of water produced)}}$$

$$h_f = \frac{10.44\ L\ Q^{1.85}}{C^{1.85} d^{4.86}}$$