Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	WATER SYSTEM DESIGN AND MANAGEMENT
COURSE CODE	:	BFC 35303
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER ALL QUESTIONS
		2. THIS FINAL EXAMINATION IS CONDUCTED VIA **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 **NINE (9)** PAGES

Q1 (a) Briefly explain the concept of control at source approach in urban stormwater management.

(2 marks)

(b) Discuss the advantages and disadvantages of **TWO (2)** external water distribution systems in Malaysia.

(4 marks)

(c) A residential area is proposed in Pengerang, Kota Tinggi, Johor to be developed by Jabatan Kerja Raya Kota Tinggi. You are assigned to design the project water reticulation system as shown in **FIGURE Q1(c)**. Total area of development is 3.17 acre with estimated water demand as in **TABLE Q1(c)(i)**. Water will be supplied through central reservoir. Details of service reservoir and internal storage are provided in **TABLE Q1(c)(ii)**. Design criteria for the water reticulation system is as follow:

- Analysis of average flow will be checked with factor 1.0.
- Analysis of peak flow will be checked with factor 2.5.
- Analysis of fire hydrant flow will be checked with average flow (1.0 factor) + 22.7 L/s (Node 5).
- Water demand for hose reel tank is 0.17 L/s (Node 6).

(i) Determine total water demand (in L/s) for domestic use based on **TABLE Q1(c)(iii)**.

(5 marks)

(ii) Design size of tank required for service reservoir, suction tank and hose reel tank (in m^3).

(14 marks)

Q2 (a) An area is to be developed to provide for 170-unit houses and 5,000 m^2 gross area of recreational centre. Assuming that average flowrate in sewerage system is 225 L/cap/day and **TABLE Q2(a)** applies, determine

(i) Population equivalent (PE).

(3 marks)

(ii) Peak flow rate of sewerage reticulation.

(5 marks)

(b) Select land area requirements for sewerage treatment plant (STP) based on a proposed development of 1,000 population. Provide comments on your selection.

(7 marks)

(c) Based on MSIG Volume 3, design a circular gravity sewer to run half-full on longitudinal slope of 0.005 and Manning coefficient of 0.01. Consider sewer diameter of 225 mm and sewer cleansing velocity in the design. Comment on the diameter of sewer used.

(10 marks)

Q3 A textile factory is to be constructed in Mukim Padang Meha, Kulim, Kedah. The proposed area has the following characteristics:

Rainfall station	=	Ibu Bekalan Sg Kulim
Total catchment area	=	40.4686 ha (or 404,686 m^2)
Sub-catchment area	=	7.85 ha
Impervious area (covered up)	=	7.07 ha
Pervious area (open space)	=	0.78 ha
Slope of overland surface S	=	0.005%
Proposed stormwater drainage	=	1.8 m × 1.8 m rectangular concrete drain (n = 0.013)
Proposed drainage length	=	957 m
Friction slope of drainage	=	0.001

(a) Considering minor stormwater drainage system, estimate peak flow for 2-year, 5-year and 10-year return period.

(10 marks)

(b) Evaluate capability of proposed stormwater drainage to receive the post-development peak flow.

(11 marks)

(c) Describe briefly **TWO (2)** mitigation measures to prevent any overflows in stormwater drainage system of a new development.

(4 marks)

Q4 (a) Discuss **FOUR (4)** importance of Best Management Practices in earthwork.

(8 marks)

(b) Based on a proposed development site as shown in **FIGURE Q4(b)**, propose Best Management Practices to mitigate erosion and sediment impact during the following phases.

(i) Pre-construction

(5 marks)

(ii) Construction in progress

(6 marks)

(iii) Post-construction

(6 marks)

- END OF QUESTIONS-

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TABLE Q1(c)(i): Domestic water demand

Type of building	Unit	Rate (L/day)
Quarters	16 unit	1300/unit
Surau	50 persons	50/person
Bin Centre	13.30 m^2	1000/100m^2
Guard House	9.67 m^2	1000/100m^2

TABLE Q1(c)(ii): Details of service reservoir and internal storage

Service reservoir					
Location	Capacity (MLD)	Type	PL (m)	BWL (m)	TWL (m)
Pengerang	2.272 mld	R.C. I	5.50	27.00	32.00
Internal storage					
Type	Capacity (L/day)	Type	PL (m)	BWL (m)	TWL (m)
Suction tank	24,000	FRP tank	5.40	6.350	8.350
Hose reel tank	14,547	FRP tank	5.40	6.350	8.750

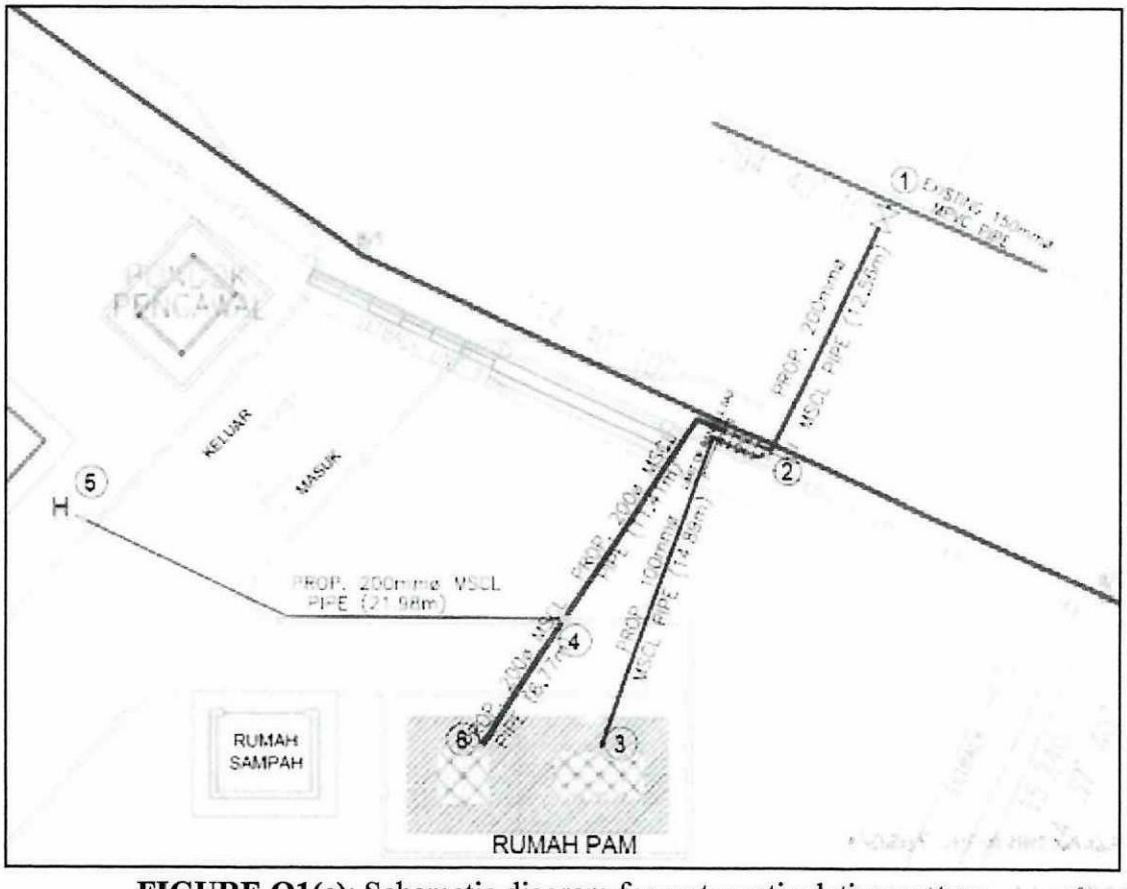

FIGURE Q1(c): Schematic diagram for water reticulation system

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TABLE Q1(c)(iii): Water demand based on type of premises

Type of premises	Water demand
Low-cost terrace house/ flat	1135 lpd (250 gpd)
Single-storey terrace/ low-medium & medium-cost flat	1360 lpd (300 gpd)
Double-storey terrace house/ high-cost flat	1590 lpd (350 gpd)
Semi-detached house	1820 lpd (400 gpd)
Bungalow/ condominium	2270 lpd (500 gpd)
Shophouse (single-storey)/ food stall	2270 lpd (500 gpd)
Shophouse (double-storey)	2730 lpd (600 gpd)
Shophouse (three-storey)	4090 lpd (900 gpd)
Light industrial workshop	1590 lpd (350 gpd)
Semi-detached/ bungalow workshop	2730 lpd (600 gpd)
Heavy-industry	65,000 l/ha/day
Medium-industry	50,000 l/ha/day
Light-industry	33,000 l/ha/day
Office/ complex/ commercial (domestic usage)	1,200 lpd/100m^2
Hotels (with dining and laundry facility – domestic usage) • Hotel (3 star) • Hotel (5 star)	 1360 lpd/room 2000 lpd/room
School/ education institution • Day school/ institution • Fully residential	 55 lpd/student 360 lpd/student
Hospitals (domestic usage)	1100 lpd/bed
Mosque (domestic usage)	135 lpd/person
Other place of worship	55 lpd/person
Wet market	820 lpd/store
Petrol kiosk	5000 lpd/service bay
Stadium	55 lpd/person
Golf course	5500 lpd/hole

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TABLE Q2(a): Population equivalent

Type of establishment	Population equivalent
Residential	5 per house
Commercial: Includes offices, shopping complex, entertainment/ recreational centers, restaurants, cafeteria and theatres	3 per 100 m^2 gross area
School/ Educational institutions: - Day schools/ institutions - Fully residential - Partial residential	 0.2 per student 1 per student 0.2 per non-residential student 1 per residential student
Hospitals	4 per bed
Hotel with dining and laundry facilities	4 per room
Factories, excluding process water	0.3 per staff
Market (wet type)	3 per stall
Market (dry type)	1 per stall
Petrol kiosks/ service stations	15 per toilet
Bus terminal	4 per bus bay
Taxi terminal	4 per taxi bay
Mosque/ church/ temple	0.2 per person
Stadium	0.2 per person
Swimming pool or sports complex	0.5 per person
Public toilet	15 per toilet
Airport	0.2 per passenger/day 0.3 per employee
Laundry	10 per machine
Prison	1 per person
Golf course	20 per hole

The PE may be converted to a flow rate using a simple formula such as set out in Malaysian Standards 1228 (MS 1228).

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Table Q3(i): Fitting constants for IDF empirical equation at selected rainfall stations in Penang

Station ID	Station Name	Constants			
		λ	κ	θ	η
5204048	Sg Simpang Ampat	62.089	0.220	0.402	0.785
5302001	Tangki Air Besar Sg Pinang	67.949	0.181	0.299	0.736
5302003	Kolam Tkgn Air Hitam	52.459	0.191	0.106	0.729
5303001	Rmh Kebajikan P Pinang	57.326	0.203	0.325	0.791
5303053	Komplek Prai	52.771	0.203	0.095	0.717
5402001	Klinik Bkt Bendera P Pinang	64.504	0.196	0.149	0.723
5402002	Kolam Bersih P Pinang	53.785	0.181	0.125	0.706
5404043	Ibu Bekalan Sg Kulim	57.832	0.188	0.245	0.751
5504035	Lahar Ikan Mati Kepala Batas	48.415	0.221	0.068	0.692

Table Q3(ii): Recommended runoff coefficients for various land use (MSMA 2012)

Land use	Runoff coefficient C	
	For minor system (≤ 10 year ARI)	For major system (> 10 year ARI)
Residential		
Bungalow	0.65	0.70
Semi-detached bungalow	0.70	0.75
Link and terrace house	0.80	0.90
Flat and apartment	0.80	0.85
Condominium	0.75	0.80
Commercial and business centres	0.90	0.95
Industrial	0.90	0.95
Sport fields, park and agriculture	0.30	0.40
Open spaces		
Bare soil (no cover)	0.50	0.60
Grass cover	0.40	0.50
Bush cover	0.35	0.45
Forest cover	0.30	0.40
Roads and highways	0.95	0.95
Water body (pond)		
Detention pond (with outlet)	0.95	0.95
Retention pond (no outlet)	0.00	0.00

Note: Runoff coefficients in this table are given as a guide for designers. Near-field runoff coefficient for any single or mixed land use should be determined based on imperviousness of the area.

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Table Q3(iii): Value of Horton's roughness n^*

Land surface	n^*
Paved	0.0150
Bare soil	0.0275
Poorly grassed	0.0350
Average grassed	0.0450
Densely grassed	0.0600

Table Q3(iv): Manning's n roughness coefficient

Surface type	Manning n
Short grass (< 150 mm)	0.0350
Tall grass (≥ 150 mm)	0.0500
Concrete smooth finish	0.0150
Concrete rough finish	0.0180
Stone pitching dressed stone in mortar	0.0170
Stone pitching random stone in mortar or rubble masonry	0.0350
Rock riprap	0.0300
Brickwork	0.0200
Pipe – vitrified clay	0.0120
Pipe – spun precast concrete	0.0130
Pipe – fibre reinforced cement	0.0130
Pipe – UPVC	0.0110

FIGUREQ4(b): Proposed development area is within the circle

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USEFUL EQUATIONS

$$i = \frac{\lambda T^{\kappa}}{(d+\theta)^{\eta}} \qquad t_o = \frac{107 n^* L^{\frac{1}{3}}}{S^{\frac{1}{3}}} \qquad t_d = \frac{nL}{60\, R^{\frac{2}{3}} S^{\frac{1}{2}}}$$

$$Q = CiA/360 \qquad Q = \frac{1}{n} A R^{\frac{2}{3}} S_o^{\frac{1}{2}}$$