Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	WATER SYSTEM DESIGN AND MANAGEMENT
COURSE CODE	:	BFC 35303
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 **TEN (10)** PAGES

Q1

(a) Explain key legislative frameworks governing sewerage system management in Malaysia to ensure effective wastewater treatment and environmental protection.

(4 marks)

(b) A new development area is planned, comprising 750 low-cost houses, a day school accommodating 800 students and staff, and a 2-storey commercial centre spanning 1000 m^2. The new sewage system is management plan aims to connect this new development area to an existing Sewage Treatment Plant (STP) with a design capacity of 10,000 PE. However, the existing STP is already receiving sewage from existing developed area, amounting to 7,500 PE. Refer to **APPENDIX A**.

(i) Calculate PE for new development area.

(6 marks)

(ii) Evaluate the capacity of the existing STP to receive the sewerage from the new development area.

(5 marks)

(iii) Suggest the recommended land area required for the new STP.

(4 marks)

(c) Evaluate critically the advantages and disadvantages use of septic tanks relative to Sewage Treatment Plants (STPs) in the context of wastewater management.

(6 marks)

Q2

(a) Discuss **TWO (2)** factors influencing water demand within a specific locality.

(4 marks)

(b) Determine the fundamental design requirements essential for developing a reticulation system.

(6 marks)

(c) You have been tasked with designing a water reticulation system for a development project. Total area development is 5.2 acres. Determine total water demand (in m^3/s) for domestic use based on **Table Q2(c)**. Refer **APPENDIX B**.

Table Q2(c)

Type of building	Unit
Quarters	180 unit
Surau	50 persons
Wet market	10 m^2
Dry market	15 m^2

(5 marks)

(d) A loop as shown in **Figure 2(d)** with K=50, calculate the flow rate in each pipe. Assume that minor losses are negligible. Limit to **TWO (2)** iterations.

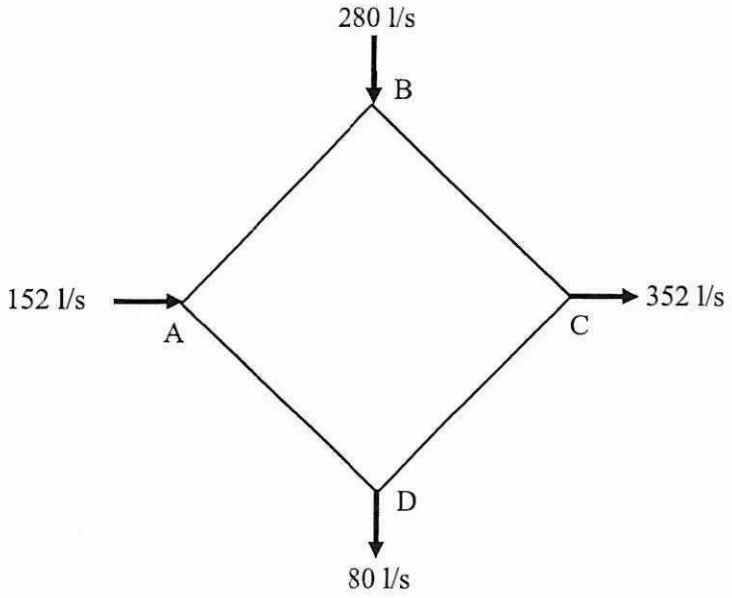

Figure Q2(d)

(10 marks)

Q3

(a) Based on **Figure Q3(a)**, discuss the impact of land used changes on hydrology characteristic when receiving the same rainfall intensity.

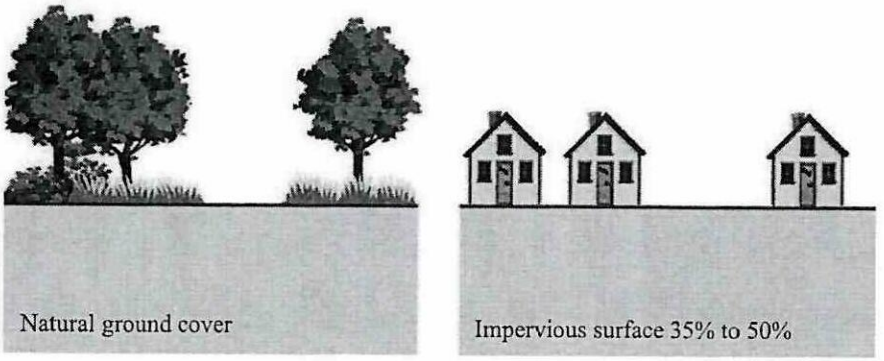

Figure Q3(a) Pervious and impervious surface

(5 marks)

(b) A solar farm will be built in an industrial area. At peak times, it is estimated to produce 100 megawatts (MW) of electricity per day. The proposed area has the following characteristics:

Rainfall station	=	Pusat Kem Pekan Nenas
Total catchment area	=	50 ha
Sub-catchment area	=	7 ha
Impervious area (covered up)	=	3.75 ha
Pervious area (open space)	=	3.25 ha
Slope of overland surface S	=	0.005%
Proposed stormwater drainage	=	1m x 1m rectangular concrete drain (n = 0.013)
Overland flow path	=	50 m
Proposed drainage length	=	750 m
Friction slope of drainage	=	0.001

(i) Considering minor stormwater drainage system, estimate peak flow for 2-year, 5-year and 10-year return period. Refer **APPENDIX C**.

(10 marks)

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

(10 marks)

Q4

(a) Suggest best management practices to comprehensively mitigate erosion and sediment impact during the construction and post-construction phases of a proposed new development project. Refer **APPENDIX D** and attach together with your answer script.

(12 marks)

(b) A comprehensive sediment design plan must be developed to prevent uncontrolled erosion on the recently cleared 7-hectare area designated for development. Recommend setting zone of wet sediment basin by considering design criteria of sediment basin for sediment control (**Table Q4.1 (b)(i)** and **Table Q4.1 (b)(ii)**). Assume time of concentration of basin catchment is 45 minutes.

Table Q4.1 (b)(i)

Parameter	Requirement
Storage volume	Settling zone volume = half of total storage Sediment zone volume = half of total storage
Basin dimension	Minimum length to width ratio= 2:1 Minimum length to settling depth ratio= 200:1 Minimum settling zone depth =0.6 m Minimum sediment storage zone depth =0.3 m
Embankment	Side slope 2 (H): 1 (V) or flatter

Table Q4.2 (b)(ii)

Parameter	Time of Concentration of Basin Catchment (minutes)				
	10	20	30	45	60
Surface area (m^2/ha)	333	250	200	158	121
Total volume (m^3/ha)	400	300	240	190	145

(13 marks)

- END OF QUESTIONS -

APPENDIX A

Table Q1 (b)(i)

Type of establishment	Population equivalent
Residential	5 per house
Commercial: Includes offices, shopping complex, entertainment/ recreational centres, 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
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

APPENDIX A

Table Q1 (b)(ii)

Classification	PE
Class 1	≤1000
Class 2	1001 – 5000
Class 3	5001 – 20000
Class 4	> 20000

Table Q1 (b)(iii)

Population Equivalent	Land Area Requirement *	
	(m^2)	(acre)
1100	1115	0.276
1200	1160	0.287
1300	1200	0.297
1400	1240	0.306
1500	1275	0.315
1600	1310	0.324
1700	1340	0.331
1800	1370	0.339
1900	1395	0.345
2000	1420	0.351
3000	2226	0.55
4000	2671	0.66
5000	3076	0.76

APPENDIX B

Table Q2 (c)

Type of Premises/Buildings	Average Daily Water Demand (Litres)
Low cost terrace house/ low cost flat	1100 /unit
Single storey terrace house/low cost house (less than RM 25,000)/ low medium & medium cost flats	1300/unit
Double storey terrace house/high cost flat/apartment/town house	1500/unit
Semi detached house/cluster	2000/unit
Bungalow/condominium	2000/unit
Wet market	1500/stall
Dry market	450/stall
Shop house (single storey) /low cost shop	2000 /unit
Shop house (double storey)	3000/unit
Shop house (three storey)	4100/unit
Shop house (four storey)	4550/unit
Light industrial workshop	1500 /unit
Semi detached/ bungalow workshops	1500/unit
Building for heavy industry	65000/hectare
Building for medium industry	50000/hectare
Building for light industry	30000/hectare
Office/complex/commercial (domestic usage)	1000/100 square meter
Community centres or halls	1000/100 square meter
Hotel	1500/room
Education institution (other than school and kindergarden)	100/person
Day school/kindergarden	50/person
Fully residential school/ institution with higher learning with hostel facilities	250/person
Hospital	1500/bed
Mosque or other place of worship	50/person
Prison/ Army camp	250/person
Bus terminal	900/service bay
Petrol kiosk (with car washing bay)	50000/unit
Petrol kiosk (without car washing bay)	10000/unit
Stadium	55/persom

APPENDIX C

Table Q3 (b)

State	No.	Station ID	Station Name	Constants			
				λ	κ	θ	η
Johor	1	1437116	Stor JPS Johor Bahru	59.972	0.163	0.121	0.793
	2	1534002	Pusat Kem. Pekan Nenas	54.265	0.179	0.100	0.756
	3	1541139	Johor Silica	59.060	0.202	0.128	0.660
	4	1636001	Balai Polis Kg Seelong	50.115	0.191	0.099	0.763
	5	1737001	SM Bukit Besar	50.554	0.193	0.117	0.722
	6	1829002	Setor JPS Batu Pahat	64.099	0.174	0.201	0.826
	7	1834124	Ladang Ulu Remis	55.864	0.166	0.174	0.810
	8	1839196	Simpang Masai K. Sedili	61.562	0.191	0.103	0.701
	9	1931003	Emp. Semberong	60.568	0.163	0.159	0.821
	10	2025001	Pintu Kaw. Tg. Agas	80.936	0.187	0.258	0.890
	11	2033001	JPS Kluang	54.428	0.192	0.108	0.740
	12	2231001	Ladang Chan Wing	57.188	0.186	0.093	0.777
	13	2232001	Ladang Kekayaan	53.457	0.180	0.094	0.735
	14	2235163	Ibu Bekalan Kahang	52.177	0.186	0.055	0.652
	15	2237164	Jalan Kluang-Mersing	56.966	0.190	0.144	0.637
	16	2330009	Ladang Labis	45.808	0.222	0.012	0.713
	17	2528012	Rmh. Tapis Segamat	45.212	0.224	0.039	0.711
	18	2534160	Kg Peta Hulu Sg Endau	59.500	0.185	0.129	0.623
	19	2636170	Setor JPS Endau	62.040	0.215	0.103	0.592

EQUATIONS

$$i = \frac{\lambda T^{\kappa}}{(d+\theta)^{\eta}} \qquad t_o = \frac{107 n^* L^{\frac{1}{3}}}{S^{\frac{1}{2}}} \qquad t_d = \frac{nL}{60 R^{\frac{2}{3}} S^{\frac{1}{2}}} \qquad Q = \frac{CiA}{360} \qquad Q = \frac{1}{n} A R^{\frac{2}{3}} S_o^{\frac{1}{2}}$$

$$L_1 = \frac{V_1}{W_1 y_1} \qquad W_2 = W_1 - 2 \times \frac{d_1}{2} \times z \qquad L_2 = L_1 - 2 \times \frac{d_1}{2} \times z$$

$$V_2 = Z^2 y^{\frac{3}{2}} - Z y^{\frac{2}{2}} (W_2 + L_2) + y_2 (W_2 L_2) \qquad W_B = W_1 - 2 \times z \times (\frac{y_1}{2} + y_2)$$

$$L_B = L_1 - 2 \times z \times (\frac{y_1}{2} + y_2) \qquad h_f = kQ^{1.85} \qquad \Delta = \frac{-\Sigma h_f}{1.85 \Sigma \frac{h_f}{Q}}$$

APPENDIX D