UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	URBAN STORMWATER MANAGEMENT
COURSE CODE	:	BNA 40703
PROGRAMME	:	BNA
DATE	:	DECEMBER 2019/JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) The responsibility for urban stormwater management is shared between Malaysian Federal and State agencies/institution. List **FIVE (5)** roles and responsibilities for each of Federal and State agencies.

(5 marks)

(b) Average Recurrence Interval (ARI) is important in design especially for risk analysis. Explain **TWO (2)** factors that need to be considered in choosing the average recurrence interval (ARI).

(5 marks)

(c) An annual maximum series of 30 years for a 20 minutes rainfall depths is given in **Table Q1(b)(i)** and **Table Q1(b)(ii)** respectively, solves the following:
i) Average of annual maximum depth, P_{TM}
ii) Variance of annual maximum depth, s

(8 marks)

(d) Assuming extreme value type I distribution fits the 30 year annual maximum series, analyze the 20 minutes storm and its rainfall intensity where the average intensities are associated with a 40 year ARI that could cater for a road culvert design according to annual maximum series. Refer to **Table Q1(b)(ii)**.

(7 marks)

Q2 (a) Compare **TWO (2)** differences of the functions between detention and retention ponds from engineering purposes.

(6 marks)

(b) An urban catchment with 58 hectares of commercial area in Bandar Maharani, Muar Johor is shown in **Figure Q2(b)**. By using the method from MSMA 2nd edition,

(i) Calculate the rainfall intensity using empirical method

(5 marks)

(ii) Plot the temporal pattern of design rainfall for 15 minutes for this catchment with return period of 10-years ARI. Refer to **Table Q2(b)(i), (ii)** and **(iii)**.

(4 marks)

(iii) Using time-area method, predict the peak discharge of the hydrograph if the design rainfall event calculated from **Question Q2(b)** occurs in this catchment. Assume continuous loss is constant at 0.8 mm/5min. Plot the hydrograph. Refer to **Table Q2(c)**.

(10 marks)

Q3 (a) Explain with the aid of flow chart the procedures of estimating peak discharge for the sub-catchment using the Rational Method.

(5 marks)

(b) List down **FIVE (5)** benefits of retention facilities for stormwater management.

(5 marks)

(c) An industrial area located in Bukit Soga, Batu Pahat, has been adopted for the warehouse development with lot area of 1 ha (100 m × 100 m), floor area 60 m × 60 m and parking area 60 m × 20 m as shown in **Figure Q3(c)**. The stormwater runoff from the impervious area will be directed to the vegetated filter strip around the perimeter of the building and parking areas. The distributed stormwater runoff from vegetated filter strip will be collected in the grassed swale to be conveyed downstream of the lot area and treated by a bioretention facility of impermeable type. Given that velocity V and length L of flow in the swale, overland flow time t_o and average recurrence interval ARI, are 0.25 m/s, 175 m, 5 minutes, and 5-yr respectively. Compute the water quality volume for this onsite retention if rainfall depth P for this area is 45 mm for 3 months ARI.

(15 marks)

Q4 (a) Explain **TWO (2)** examples of facilities that are effectively involve in Best Management Practice (BMPs) to control stormwater quality.

(5 marks)

(b) An industry, commercial and business centre areas comprising urban sub-catchment 1 and 2 respectively as shown in **Figure Q4(b)** are to be developed in Kompleks Prai Pulau Pinang. Design the peak flow rate from minor system for the second segment at pipe cross section-y.

(5 marks)

(c) At the construction sites, where erosion and sedimentation occur, discuss the following problems and propose the solutions:

(i) Large flat exposed areas are prone to sheet erosion and should be protected.

(5 marks)

(ii) Unprotected steep slopes are prone to erosion as runoff velocity is high.

(5 marks)

(iii) Any construction works near or at streams or waterways are caused dislodged sediments to enter water directly.

(5 marks)

-END OF QUESTION-

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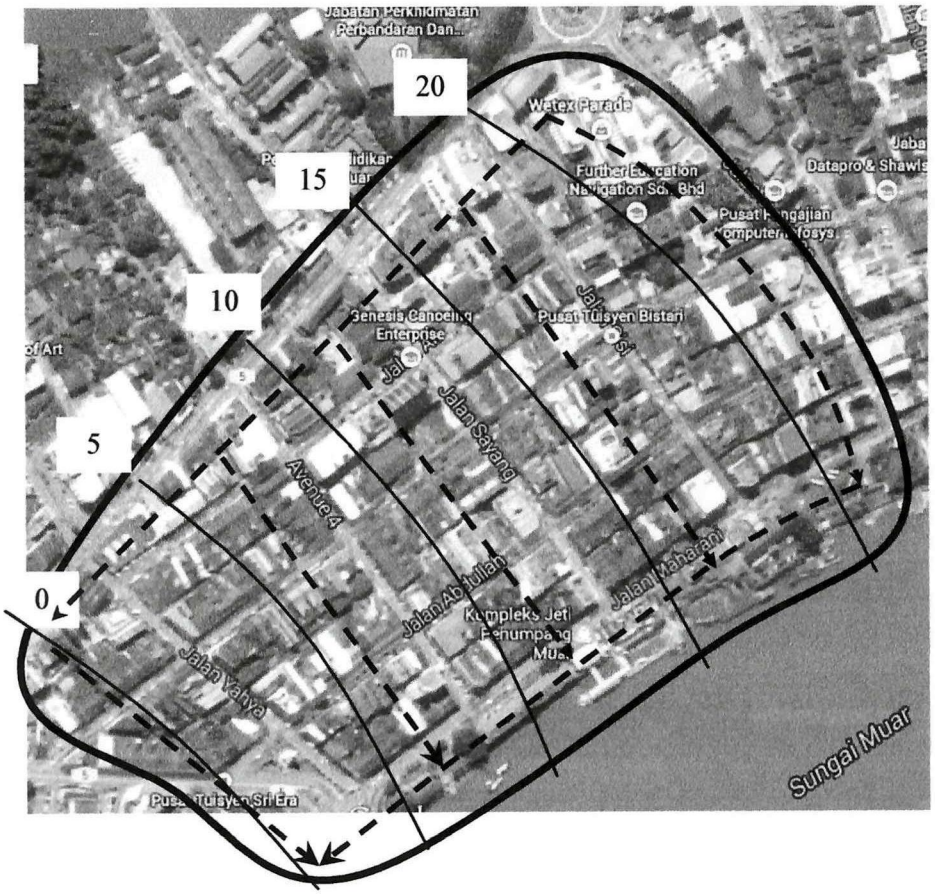

Figure Q2 (b): Urban catchment with 58 hectares of commercial area in Bandar Maharani, Muar Johor

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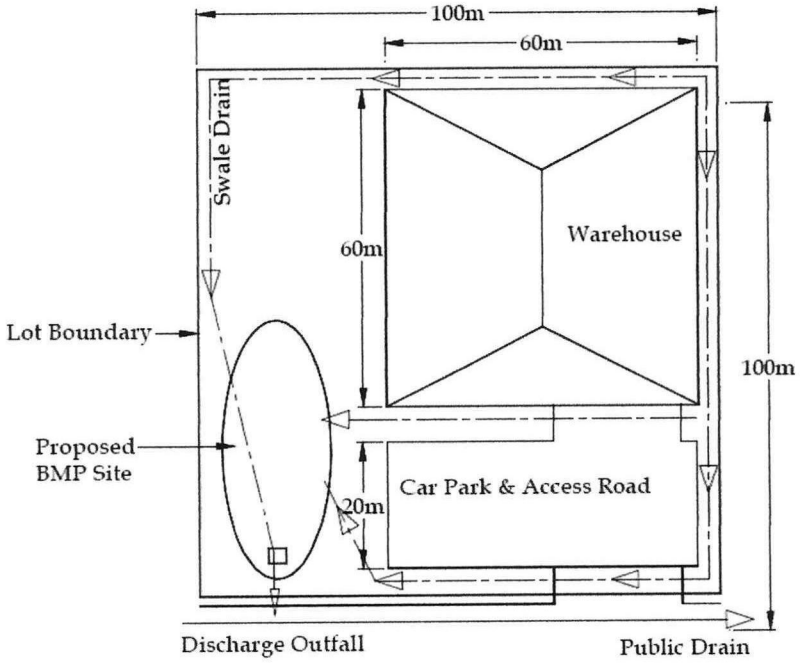

Figure Q3(c): Industrial Area located Bukit Soga, Batu Pahat

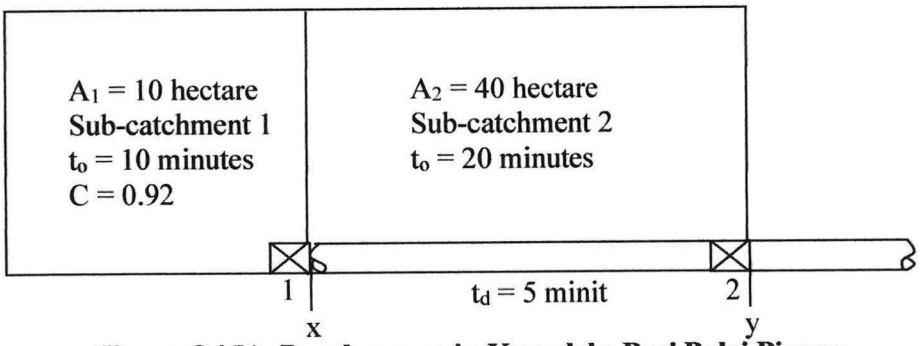

Figure Q4(b): Develop area in Kompleks Prai Pulai Pinang.

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Table Q1(b)(i): 15 minutes rainfall depth

P_j (mm)	3.55	3.81	4.32	4.44	4.73	5.11	5.82
	6.84	7.33	7.85	8.88	9.55	10.20	11.26

Table Q1(b)(ii): Frequency factor, K for extreme value type I

	T_r (years)				
n	**5**	**10**	**25**	**50**	**100**
15	0.967	1.703	2.632	3.321	4.005
20	0.919	1.625	2.517	3.179	3.836
25	0.888	1.575	2.444	3.088	3.729
30	0.866	1.541	2.393	3.026	3.653
35	0.851	1.516	2.354	2.979	3.598
40	0.838	1.495	2.326	2.943	3.554
45	0.829	1.478	2.303	2.913	3.520
50	0.820	1.466	2.283	2.889	3.491
75	0.792	1.423	2.220	2.812	3.400
100	0.779	1.401	2.187	2.770	3.349
∞	0.719	1.305	2.044	2.592	3.137

Table Q2(b)(i): Fitting constants for the IDF empirical equation for the different location in Malaysia for high ARIs between 2 and 100 year and storm duration from 5 minutes to 72 hours

State	No	Station ID	Station Name	Constant			
				λ	κ	θ	η
Johor	1	1437116	Stor JPS Johor Bahru	59.972	0.163	0.121	0.793
	2	1534002	Pintu Kawasan Tanjung Agas	80.936	0.187	0.258	0.890
	3	1541139	Ladang Labis	45.808	0.222	0.012	0.713
Kuala Lumpur	1	3015001	Puchong Drop, K Lumpur	69.650	0.151	0.223	0.880
	2	3116003	Ibu Pejabat JPS	61.976	0.145	0.122	0.818
	3	3116004	Ibu Pejabat JPS1	64.689	0.149	0.174	0.837

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Table Q2(b)(ii): Recommended Intervals for Design Rainfall Temporal Pattern

Storm Duration (minutes)	Time Interval (minutes)
Less than 60	5
60 – 120	10
121 – 360	15
Greater than 360	30

Table Q2 (b)(iii): Region 2: Johor, Negeri Sembilan, Melaka, Selangor dan Pahang

No. of Block	Storm Duration			
	15-min	30-min	60-min	180-min
1	0.255	0.124	0.053	0.053
2	0.376	0.130	0.059	0.061
3	0.370	0.365	0.063	0.063
4		0.152	0.087	0.080
5		0.126	0.103	0.128
6		0.103	0.153	0.151
7			0.110	0.129
8			0.088	0.097
9			0.069	0.079
10			0.060	0.062
11			0.057	0.054
12			0.046	0.042

Table Q2 (c): Areas between the isochrones

ID	Isochrones	Area (ha)
A_1	0 – 5	18
A_2	5 – 10	10
A_3	10 – 15	12
A_4	15 >	18

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APPENDIX

$$i = \frac{\lambda T^{\kappa}}{(d+\theta)^{\eta}}$$

$$Q = \frac{C.i.A}{360}$$

$$WQV = C.(P_d).A$$

$$Q = \frac{k_n T^{8/3} S_x^{5/3} S_L^{1/2}}{2.64n}$$

Table 1 : Recommended runoff coefficients for various landuses

Landuse	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
Commercial and bussines centres	0.90	0.95
Industrial	0.90	0.95
Sport fields 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
Road and highways	0.95	0.95

Table 2: Fitting constants for the IDF empirical equation for the different location in Malaysia for high ARIs between 2 and 100 year and storm duration from 5 minutes to 72 hours

State	No	Station ID	Station Name	Constant			
				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	1829002	Setor JPS Batu Pahat	64.099	0.174	0.201	0.826
Kuala Lumpur	1	3015001	Puchong Drop, K Lumpur	69.650	0.151	0.223	0.880
	2	3116003	Ibu Pejabat JPS	61.976	0.145	0.122	0.818
Penang	1	5303001	Rumah Kebajikan P Pinang	57.326	0.203	0.325	0.791
	2	5303053	Kompleks Prai	52.771	0.203	0.095	0.717
	3	5402002	Klinik Bkt Bendera	64.504	0.196	0.149	0.723