UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	URBAN STORMWATER MANAGEMENT
COURSE CODE	:	BNA 40703
PROGRAMME CODE	:	BNA
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 Urban stormwater management responsibility is shared between Malaysian Federal and State agencies/institutions.

(a) Explain, with the aid of a flow chart, the roles and responsibilities of each of the Federal and State agencies in managing the urban stormwater in Malaysia.

(7 marks)

(b) Recently, flash floods have often occurred in large cities and greatly destroyed people's property. As a design engineer for stormwater, describe the steps that the government can take to reduce flash floods.

(6 marks)

(c) Assuming extreme value type I distribution fits the 30-year annual maximum series, analyze the 20-minute storm and its rainfall intensity where the average intensities are associated with a 50-year ARI that could cater for a road culvert design according to annual maximum series. Refer to **Tables Q1.1** and **Q1.2.**

Table Q1.1 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 Q1.2 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

(12 marks)

Q2 Design of an urban stormwater structure is crucial for the design engineers, who is needed to literally understand the concept of urban in the study area.

(a) A wet extended detention pond sized for the required water quality volume will be used to illustrate the sizing procedure for an extended-detention orifice. Given the following information, calculate the required orifice size for water quality design. Given: water quality volume (WQv) = 937.46 m3, Maximum hydraulic head (Hmax) = 1.524 m (from stage vs. storage data), $C = 0.6$ and $Q = CA(2gH)0.5$.

(10 marks)

(b) Briefly explain the purpose of detention and retention facilities.

(5 marks)

(c) List down **FIVE (5)** benefits of detention facilities for stormwater management.

(10 marks)

Q3 **Figure Q3.1** show an urban catchment with 58 hectares of commercial area in Bandar Maharani, Muar, Johor. By using the method from MSMA 2nd edition,

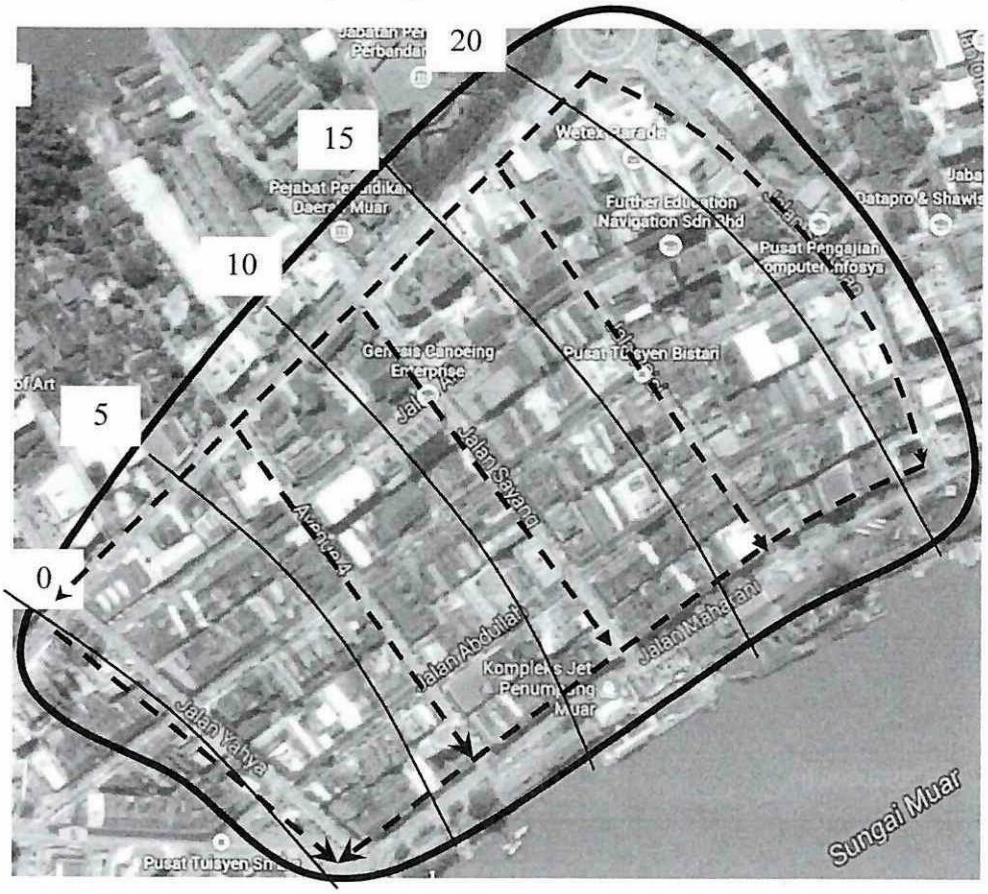

Figure Q3.1 Urban catchment with 58 hectares of commercial area in Bandar Maharani, Muar, Johor

(a) Calculate the rainfall intensity using the empirical method.

(8 marks)

(b) Plot the temporal pattern of design rainfall for 15 minutes for this catchment with a return period of 10 years ARI. Refer to **Table APPENDIX A.1, A.2** and **A.3**.

(7 marks)

(c) Using the time-area method, predict the peak discharge of the hydrograph if the design rainfall event calculated from **Question Q3(b)** occurs in this catchment. Assume continuous loss is constant at 0.8 mm/5min. Plot the hydrograph. Refer to **Table APPENDIX A.4.**

(10 marks)

Q4 Best Management Practices (BMP) are techniques or processes that are widely recognized and recognised as effective and efficient ways of achieving specific management objectives.

(a) Explain **FIVES (5)** examples of facilities or structures that are effectively involved in Best Management Practices (BMPs) to control stormwater quality and quantity.

(10 marks)

(b) Discuss the following problems where erosion and sedimentation occur at the construction sites and propose solutions.

(i) Unprotected steep slopes are prone to erosion when runoff velocity is high.

(5 marks)

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

(5 marks)

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

(5 marks)

- END OF QUESTIONS -

APPENDIX A

Table APPENDIX A.1 Fitting constants for the IDF empirical equation for the different locations in Malaysia for high ARIs between 2 and 100 years 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

Table APPENDIX A.2 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 APPENDIX A.3 Region 2: Johor, Negeri Sembilan, Melaka, Selangor and 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 APPENDIX A.4 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