[ENG73]

UNIVERSITY OF BOLTON

SCHOOL OF ENGINEERING

BENG (HONS) CIVIL ENGINEERING

SEMESTER TWO EXAMINATION 2024/2025

HYDROLOGY AND ENVIRONMENTAL ENGINEERING

MODULE NO: CIE5017

Date: Thursday 15 MAY 2025 **Time: 14:00 – 16:00**

INSTRUCTIONS TO CANDIDATES:

This exam paper contains TWO Sections: Section 'A' and Section 'B'

Section A contains TWO QUESTIONS: YOU MUST ANSWER BOTH QUESTIONS. This section questions are worth 70 marks.

Section B contains TWO QUESTIONS. YOU SHOULD ANSWER EITHER OF THEM. Each of these questions is worth 30 marks.

Answer each section in a separate answer booklet'

Marks for parts of questions are shown in brackets.

This assessment carries 100 marks.

All working steps must be shown.

This is an Open book exam.

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Section A – (Answer Both Questions in this Section)

Question 1

(a) List the standard relations, which must be satisfied for the correct analysis of fluid flow in a ring-main pipe network**.**

(8 marks)

(b) Computer software was used for the analysis of the ring main network, which is shown in **Figure Q1**. The software produced the following solution in Table Q1 for the pipe network:

Table Q1: Solutions for network flows and head losses

Pipe no.	Node	Q (m^3/s)	Head Loss (m)
1	(A,B)	0.1228	31.9000
2	(B,C)	0.0428	3.9665
3	(C,D)	-0.0272	-1.6353
4	(D,A)	-0.1272	-34.2312

(Clockwise discharges and head losses are considered positive)

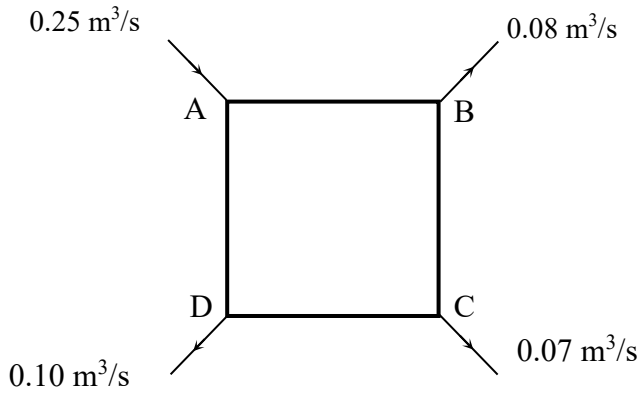
Check the validity of the above solution using the standard relations referred to in part (a). (Neglect local head losses).

(24 marks)

(c) Find the pressure head at point B, C, and D, if the pressure at A is 70 m and A, B, C and D have the same elevation.

(8 marks)

Figure Q1



Question 1 continues over the page…

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Question 1 continued

Data for the pipe network shown in **Figure Q1**

Pipe No	Node	Diameter (mm)	Length (m)	Roughness (mm)
1	**(A,B)**	**250**	**1000**	**0.6**
2	**(B,C)**	**250**	**1000**	**0.6**
3	**(C,D)**	**250**	**1000**	**0.6**
4	**(D,A)**	**250**	**1000**	**0.6**
The kinematic viscosity of water at 15° C is $\nu = 1.14 \times 10^{-6}$ **m²/s**				

Total 40 marks

Please turn the page

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Question 2

Two storms occur successively each of 2-hr duration with a rainfall excess of 2.5 cm and 3.0 cm, respectively. The 2-hr unit hydrograph (2-hr UH) is given in **Table Q2** below.

(a) Calculate the resulting Direct Runoff Hydrograph (DRH).

(10 marks)

(b) Plot the unit hydrograph and the Derived Direct Runoff hydrograph (DRH) on the same chart.

(10 marks)

(c) Use the given 2-hr UH as given in **Table Q2** below, Drive the 6-hr UH using the method of superposition.

(10 marks)

Table Q2: Ordinates of the 2-hr Unit Hydrograph

Time (hr)	0	2	4	6	8	10	12	14	16	18	20	22	24	26
2-hr UH (m3/sec.cm)	0	50	150	300	600	750	650	550	450	350	250	150	50	0

Total 30 marks

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End of Section A

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Section B – (Answer Either of the two Questions in this Section)

Question 3

A series of peak floods at a gauging site on the River Thames are assumed to be EV1 distributed with mean = 100 m^3/sec and standard deviation = 15 m^3/sec. Calculate the peak flow which has:

(a) Non-exceedance probability of 0.75

(7 marks)

(b) Exceedance probability of 0.15

(7 marks)

(c) What value of exceedance probability and return period does Q = 125 m^3/sec have?

(10 marks)

(d) If the Q = 125 m^3/sec is to be adopted as the design flood for a bridge, what is the probability that the design flood will be exceeded at least once in a 5-year period construction.

(6 marks)

Total 30 marks
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Question 4

(a) With the aid of simple sketches explain the mode of operation of the Activated Sludge unit in sewage treatment processes:

(5 marks)

(b) Briefly outline the general design and construction criteria which is used for separate foul and storm drainage systems.

(5 marks)

(c) A 55ha drainage basin containing 30 ha net residential area with average 8 dwelling units per ha with 4 residents, and 20 ha zoned commercial area and the rest is a green field. Determine the design flow for a sewer servicing this area and an appropriate sewer size for an existing slope of 5%. Ensure that the minimum cleansing velocity of 0.75 m/s and a maximum partial flow ratio of d/D = 0.75 prevail in the sewer. Take k_s = 1.5mm for the sewer.

Take wastewater generation for
Residential = 250 l/capita/d
Commercial = 17500 l/ha/d
Peak Industrial & Infiltration allowance = 10000 l/ha/d

Use a flow peak factor (PF) of 4.5 for both the commercial and residential flows and none for the Industrial & Infiltration flows.

(20 marks)

Total 30 marks

End Of Section B

END OF PAPER