[ENG29]

UNIVERSITY OF BOLTON

SCHOOL OF ENGINEERING

BEng (Hons) CIVIL ENGINEERING

SEMESTER ONE EXAMINATION 2023/24

WATER ENGINEERING AND THE ENVIRONMENT

MODULE NO: CIE6012

Date: Friday 12th January 2024 **Time: 10:00 – 13:00**

INSTRUCTIONS TO CANDIDATES:

1. **There are FIVE Questions**
2. **Answer FOUR Questions**

Important Note: Show all solution steps in detail along with the units.

If only final answers are given, no mark will be given.

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Question 1

A concrete lined trapezoidal channel **(Figure 1 Q1)** has a water depth (d) of 2.0 m. The base width (B) of the channel is 4.0 m and the side slope (H: V= 1.5:1). Manning's roughness coefficient (n) is 0.013 and the channel bed slope (S)=002. Calculate the

(a) Discharge passing through the cross section of the channel using the Manning's equation. **(20 marks)**

(b) Mean flow velocity. **(5 marks)**

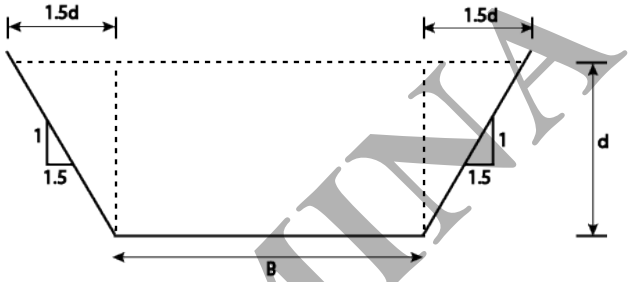


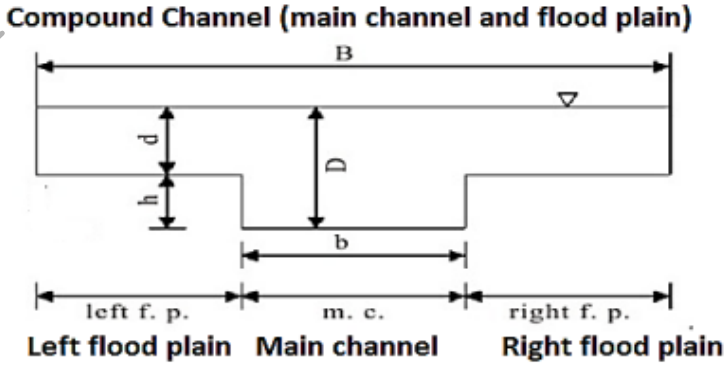
Figure 1 (Q1)

Total 25 Marks

Question 2

The compound channel shown in the **Figure 1 (Q2)** has roughness coefficient (n) equal to 0.015, slope = 0.002. Given: b = 2.0m h = 1.0m, D = 2.2m, B = 8.0m. The Left flood plain=Right flood plain. Find the discharge. **Assume that the velocity is uniform across the whole compound section**.

Figure 1 (Q2)



Total 25 Marks

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Question 3

Given the ordinates of a 2-hr unit hydrograph (2-hr UH) for a basin (**Table 1 of Q3).**

(a) Derive an 8-hr unit hydrograph for the same basin. **(15 marks)**

(b) Plot the 2-hr UH and the derived 8-hr UH on the same graph. **(10 marks)**

Table 1 of Q3

Time (hr)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
2-hr UH	0	24	36	60	80	120	100	70	60	42	30	18	14	10	6	0

Total 25 Marks

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Question 4

The ordinates of a 2-hr unit hydrograph (2-hr UH) are given in **Table 1 of Q4**

Table 1 of Q4

Duration (hr)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
2-hr (UH)	0	30	60	75	68	60	50	42	38	24	20	16	12	8	4	0

The hyetograph of the gross rainfall of three successive pulses each of 2 hours duration is given in **Table 2 of Q4**.

Table 2 of Q4

Duration (hr)	0-2	2-4	4-6
Gross Hyetograph (cm)	3.0	5.0	4.0

Assume the losses are 0.20 cm/hr. Baseflow is constant = 10 m^3/s**.** Determine

1. The hyetograph of the effective rainfall (excess rainfall) **(7 Marks)**
2. The direct runoff hydrograph (DRH) **(6 Marks)**
3. The total runoff hydrograph (TRH) **(6 Marks)**
4. Plot the UH and the TRH on the same graph **(6 Marks)**

Total 25 Marks

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Question 5

If the land use of an urban area of 70 ha and the corresponding runoff coefficients are as given in **Table 1 (Q5)**, the rainfall intensity (i) is 30 mm/hr, calculate the

(a) Weighted average runoff coefficient (C) (**15 marks)**

(b) Peak runoff (Qp) using the **Rational method**. **(10 marks)**

Table 1 (Q5)

Land use	**Are (ha)**	**Runoff coefficient**
Roads	6	0.70
Lawn	14	0.10
Residential area	42	0.30
Industrial area	8	0.80

Total 25 Marks

END OF QUESTIONS