[ENG13]

UNIVERSITY OF BOLTON

SCHOOL OF ENGINEERING

BEng (Hons) CIVIL ENGINEERING

SEMESTER ONE OPEN BOOK EXAMINATION 2021/22

WATER ENGINEETING AND THE ENVIRONMENT

MODULE NO: CIE6012

Date: Friday 14th January 2022 **Time: 10:00 – 13:00**

INSTRUCTIONS TO CANDIDATES:

1. **There are FIVE questions**
2. **Answer ALL 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. A concrete lined trapezoidal channel **(Figure Q1 (a))** with uniform flow has a water depth of 1.5m. The base width is 4m and the side slopes are equal at 1.5:1. Manning's roughness coefficient (n) is 0.015 and the channel bed slope S=0001. Calculate the discharge and the mean flow velocity.

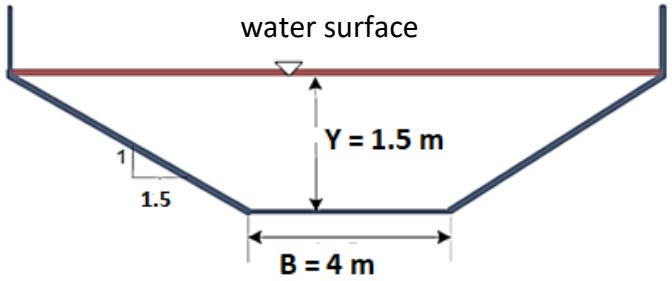

Figure Q1 (a)

(10 Marks)

b. A discharge of 15.0 m^3/s is to be carried in an open channel **(Figure Q1 (b))** at a velocity of 1.5m/s. If the channel cross-section is trapezoidal with water depth equal to the width of the channel bottom and side slope is 1.5:1. Manning's roughness coefficient (n) is 0.025. Determine the bottom width of the channel (B) and the water depth (y).

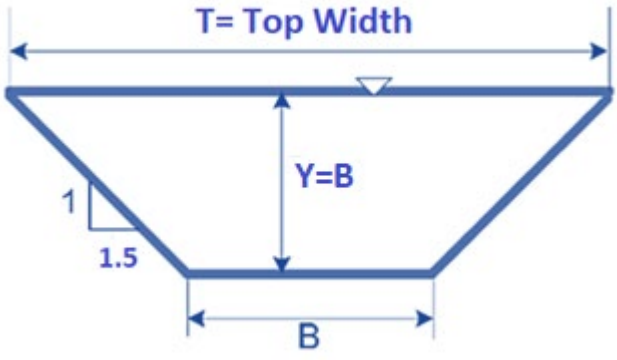

Figure Q1 (b)

(10 Marks)

Total 20 Marks

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Question 2

(a) The ordinates of a 6-hr unit hydrograph (6-hr UH) are given in **Table 1 of Q2**.

Table 1 of Q2

Duration (hr)	0	6	12	18	24	30	36	42	48	54	60	66	72	78
6-hr (UH)	0	36	68	80	74	66	58	38	24	18	12	8	4	0

The hyetograph of the gross rainfall of three successive pulses each of 6 hours duration is given in **Table 2 of Q2 (a)**.

Table 2 of Q2 (a)

Duration (hr)	0-6	6-12	12-18
Gross Hyetograph (cm)	3.5	5.5	4.5

Assume the losses are 0.25 cm/hr. Baseflow is constant = 20 m^3/s. Determine

1. The hyetograph of the effective rainfall (Excess rainfall)

(2 Marks)

2. The direct runoff hydrograph (DRH)

(6 Marks)

3. The total runoff hydrograph (TRH)

(2 Marks)

4. Plot the UH and the TRH on the same graph

(4 Marks)

(b) Given the ordinates of a 4-hr unit hydrograph **Table 2 of Q2 (b)**, derive a 12-hr unit hydrograph for the same catchment.

Table 2 of Q2 (b)

Time (hr)	0	4	8	12	16	20	24	28	32	36	40	44	48
4-hr UH	0	24	48	80	120	144	110	76	60	42	30	12	0

(6 Marks)

Total 20 Marks

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Question 3

The **Table 1 of Q3** shows a flood hydrograph of a river catchment generated from a storm of 3-hr duration. Assume a constant baseflow equal 4 m^3/s. The area of the river catchment is 397.44 km^2.

Table 1 of Q3

Duration (hr)	0	3	6	9	12	15	18	21	24	27	30	33	36
Flood hydrograph (m^3/s)	12	36	60	80	88	76	64	54	48	36	28	16	6

(a) Calculate the volume of total runoff and the volume of Direct runoff

(6 Marks)

(b) Derive the ordinates of the 3-hr unit hydrograph.

(8 Marks)

(c) Plot the Flood hydrograph and the derived unit hydrograph on the same graph.

(6 Marks)

Total 20 Marks

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Question 4

A trapezoidal channel carries a discharge equals 10 m^3/s. The bottom width of the channel is 4 m, the side slope (H:V= 1.5:1). Assume a range of water depths between 0.25 m and 3.5m. Take the incremental increase in water depth = 0.25 m.

(a) Calculate the values of specific energy corresponding to each assumed water depth (**present your calculation in a table**).

(8 Marks)

(b) Plot the relationship between the calculated values of specific energy and the assumed water depths.

(4 Marks)

(a) Estimate the critical depth and the minimum specific energy (**use the plotted figure in <u>part (b)</u> above**).

(4 Marks)

(b) Estimate the alternate depths when the specific energy = 2.5m (**use the plotted figure in <u>part (b)</u> above**).

(4 Marks)

Total 20 Marks

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Question 5

A river of a rectangular section has the following hydraulic characteristics:

Q = 420 m^3 /s; width = 50m; water depth = 4m; bed slope = $3.6x10^{-4}$.

The sediment has a sediment diameter d=0.012m; specific gravity s = 2.65. Given at water temperature T= 20˚C (ν= 1x 10^{-6} m^{-2} /s); ρ_w =1000 kg/m^3. Estimate the bed load transport using the Meyer Peter & Muller models.

Total 20 Marks

END OF QUESTIONS