[ENG31]

UNIVERSITY OF BOLTON

SCHOOL OF ENGINEERING

BEng (Hons) CIVIL ENGINEERING

SEMESTER ONE EXAMINATION 2022/23

WATER ENGINEERING AND THE ENVIRONMENT

MODULE NO: CIE6012

Date: Wednesday 11th January 2023 **Time: 14:00 – 17:00**

INSTRUCTIONS TO CANDIDATES:

This is an open book examination.

There are FIVE questions

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 concrete lined trapezoidal channel **(Figure Q1)** with a uniform flow has a water depth of 1.5 m. The base width of the channel is 4.0 m and the side slope (H: V= 1.5:1). Manning's roughness coefficient (n) is 0.015 and the channel bed slope (S)=00012. Calculate the

(a) discharge passing through the cross section of the channel and the

(b) mean flow velocity.

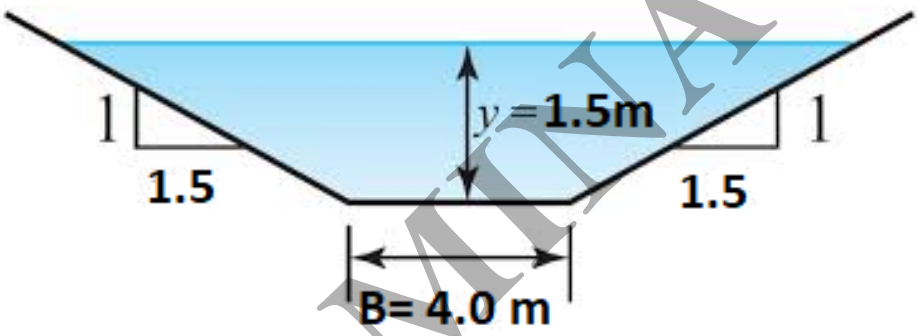

Figure Q1

Total (20 Marks)

Question 2

Given the ordinates of a 4-hr unit hydrograph **Table 1 of Q2.** Derive a 12-hr unit hydrograph for the same catchment.

Table 1 of Q2

Time (hr)	0	4	8	12	16	20	24	28	32	36	40	44	48	52
4-hr UH	0	24	36	60	80	120	100	70	60	42	30	18	10	0

Total (20 Marks)

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Question 3

The ordinates of a 3-hr unit hydrograph (3-hr UH) are given in **Table 1 of Q3**

Table 1 of Q3

Duration (hr)	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42
3-hr (UH)	0	30	60	75	68	60	50	42	38	24	18	12	8	4	0

The hyetograph of the gross rainfall of three successive pulses each of 3 hours duration is given in **Table 2 of Q3**.

Table 2 of Q3

Duration (hr)	0-3	3-6	6-9
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) **(4 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 **(4 Marks)**

Total (20 Marks)

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Question 4

A trapezoidal channel carries a discharge equals 8 m^3/s. The bottom width of the channel is 3 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**).

(5 Marks)

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

(5 Marks)

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

(5 Marks)

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

(5 Marks)

Total (20 Marks)

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Question 5

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

Q = 400 m^3 /s; width = 30m; water depth = 3m; bed slope = $3.5x10^{-4}$.

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