NATIONAL UNIVERSITY OF SINGAPORE

FACULTY OF ENGINEERING

EXAMINATION FOR

(Semester I: 2012-2013)

CE5312 - RIVER MECHANICS

Nov/ Dec 2012 - Time allowed: 2.5 hours

INSTRUCTIONS TO CANDIDATES

1. This examination paper contains **FOUR(4)** questions and comprises **FOUR(4)** printed pages.
2. Answer ALL **FOUR(4)** questions.
3. All questions carry equal marks.
4. This is an "**OPEN BOOK**" examination.

.../2

Question 1

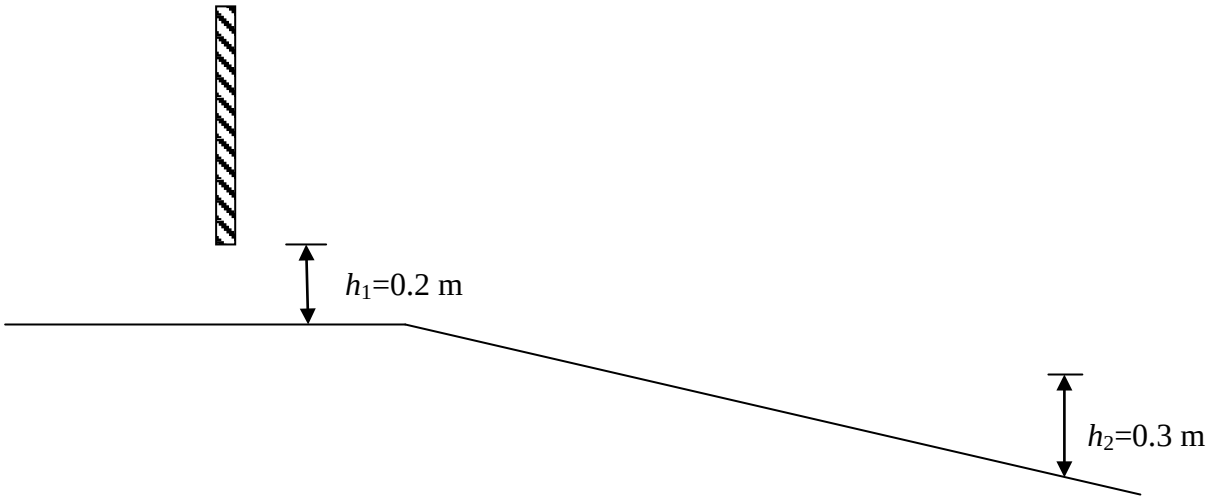
A sluice gate controls the flow discharge in a flat 5-m-wide rectangular channel followed by another long channel with the same cross section configuration and a bottom slope of S=0.01 & roughness coefficient of n=0.01, as sketched below. If the flow depth immediately downstream of the sluice gate is h_1=0.2 m and the flow depth far downstream of the long channel is h_2=0.3 m (in the middle of the long channel), respectively, determine the following:

(a) Determine the water depth upstream of the sluice gate. [10 marks]

(b) Determine the critical and normal depths on both channels downstream of the sluice gate. [5 marks]

(c) Given the flat channel behind the sluice gate is short, sketch the water surface profile in the entire channel section. [5 marks]

(d) Calculate the flow force applied onto the sluice gate. [5 marks]



Question 2

(a) A triangular channel has side slopes of 2:1 (H:V) and the bottom slope of the channel is S=0.001 and the roughness coefficient of n=0.015. The channel is designed to carry water at a flow rate of 100 m^3/s. Calculate the water depth 100m upstream of the exit of the channel, given the condition that the water surface level in the reservoir is 8 m higher than the channel bottom at the exit. [15 marks]

(b) For this particular channel cross section, derive the expression of the flow rate as the function of S and n at the critical flow condition. [5 marks]

(c) During the flood period, the channel carries more water. Discuss all possible types of water surface profiles in the channel. [5 marks]

Question 3

A wide canal discharges water into the sea via an inflatable barrage which spans across the entire width of the canal at the mouth. The sea has a tidal range of 1.5 m (high water to low water levels) and the tidal period is 12.5 hours. When the tide is at its maximum level, the water depth at the river mouth and the rest of the river is 5 m. There is no flow in canal when the tide starts to fall from its highest level and the barrage is lowered quickly to a position which limits the water level to maintain a depth of 4 m in the canal. Assume that the canal bed is horizontal and flow resistance is negligible as a first approximation.

It is desirable to determine the water depth at a location 'B' which is 5 km from the river mouth. Assume that the tide starts to fall from the highest level at a reference time of $t = 0$

(a) What is the time when the tidal level reaches the 4 m depth in the canal? [2 marks]

(b) What is the water depth at location 'B' at $t = 2$ *hrs*? Show your working equations. [15 marks]

(c) What are the discharges per unit width at 'B' and the river mouth at $t = 2$ *hrs*? [8 marks]

Question 4

A large lake with very steep banks covers an area of $2(10^6)\ m^2$ and discharges water into a steep rectangular channel of $8\ m$ width. The flow through the lake is initially steady with a flow of about $30\ m^3/s$. Rain which fall over the catchment upstream of the lake gives rise to an inflow hydrograph given below. The time is referenced to zero.

Time (hrs)	Inflow (m^3/s)
0	30
6	48
12	80
18	90
24	85
30	70
36	50
42	36
48	30

(1) Derive the following finite difference equation from the basic continuity equation expressing the relationship between the inflow, outflow & storage volume of the reservoir.

$$M_2 = M_1 + \frac{I_1 + I_2}{2} - Q_1 \quad where \quad M = \frac{\forall}{\Delta t} + \frac{Q}{2}$$

where the subscripts 1 and 2 refer to times t and $t + \Delta t$, I and Q refer to the inflow and outflow respectively. $\forall$ is the reservoir capacity. [3 marks]

(2) What is the outflow relationship with h where h is the lake level above the outlet? [3 marks]

(3) Using the result from (2) above, construct a tabulation list of *h, Q,* $\forall$ *and* M. You may adopt a $\Delta t = 6\ hrs$ and incremental elevations of 0.25 m. [7 marks]

(4) Route the inflow hydrograph through the lake showing your working up to $t = 18\ hrs$. Explain your methodology clearly explaining the results in your flow routing. [12 marks]

- END OF PAPER -