NATIONAL UNIVERSITY OF SINGAPORE

CE5312 – RIVER MECHANICS

(Semester I: AY2014/2015)

Time Allowed: 2.5 Hours

INSTRUCTIONS TO CANDIDATES

1. Please write your student number only. **Do not write your name**.
2. This assessment paper contains **FOUR** questions and comprises **FIVE** printed pages.
3. Answer **ALL** questions. All questions carry equal marks.
4. Please start each question on a new page.
5. This is an "OPEN BOOK" assessment.

Question 1 [25 marks]

A long triangular channel has two side slopes of 2:1 (H:V) and a bottom slope of S=0.001with Manning coefficient of n=0.015. The channel delivers water at a flow rate of 100 m^3/s to a downstream reservoir whose surface level is 3.0 m above the channel bottom at its exit.

(a) Sketch the water surface profile from the middle of the channel to the reservoir;

[10 Marks]

(b) Estimate the water depth 100 m upstream of the exit of the channel.

[15 marks]

Question 2 [25 marks]

A triangular channel with 1:1 side slopes is set on a slope of 0.0005 and has an n value of 0.02. It drains a lake with a constant water level of 2.5 m above the invert of the channel at its upstream end. The channel ends in a free overfall.

(a) What is the discharge in the channel for a channel length of 3000 m?

[15 marks]

(b) Explain how you would proceed to find the discharge in the channel for a length of 70 m? Show your steps clearly, preferably in tabulation form. Hint: If the critical depth is 1.85 m at the free overfall, use a one-step method to determine the M2 profile depth at the lake outlet.

[10 marks]

Question 3 [25 marks]

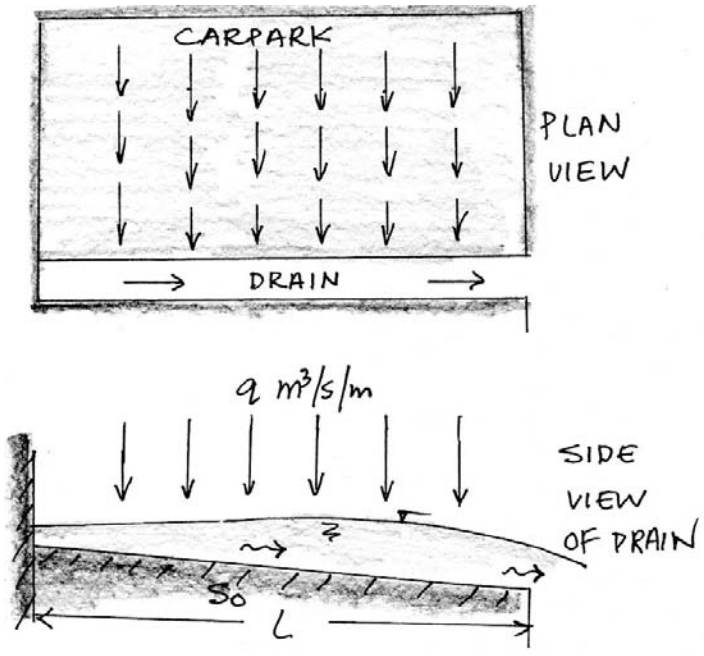

Fig. Q3

A drain with rectangular cross section removes water from a parking lot as shown in Fig. Q3. The drain is set on a slope of $S_0 = 0.02$ and it has a width of $B = 2$ m and a Manning 'n' of 0.02. The inflow during a certain rain storm is $q = 0.0255$ m^3/s per metre uniformly over the entire length $L = 30$ m of the drain.

(a) Verify that for this rain storm, the critical depth is at the open end of the drain.

[10 marks]

(b) Adopting the finite difference formulation given below, check if the depth of flow at the mid-length ($x = L/2$) is about 172 mm. Hint: Use a one step procedure.

[15 marks]

For a rectangular channel of width B and slope S_0 with uniform lateral inflow of q m^3/s/m, the position of the critical depth may be found from the following equation, with x measured in the direction of the flow,

$$x_c = \frac{8q^2}{gB^2\left(S_0 - \frac{Pg}{C_c^2 B}\right)^3}$$

where P is the wetted perimeter and C_C is the Chezy C value. The following relationship between the Manning 'n' value and the Chezy C may be used.

$$C_c = \frac{R^{1/6}}{n}$$

The finite difference formulation for solving the dynamic equation for this problem is given by

$$\Delta h = \left(S_0 - S_{f_{avg}}\right)\Delta x - \frac{1}{g}\left(\frac{U_1 + U_2}{Q_1 + Q_2}\right)\left(Q_1 \Delta U + U_2 \Delta Q\right)$$

where the subscripts 1 and 2 represent conditions upstream and downstream of the section Δx.

Question 4 [25 marks]

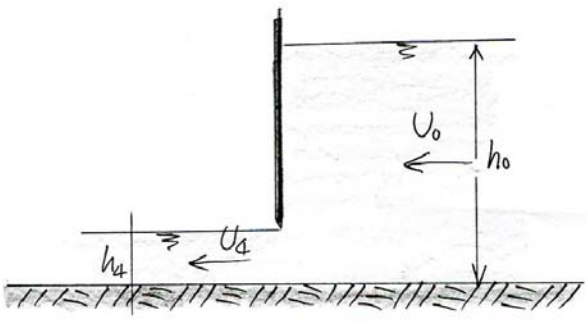

Fig. Q4

Fig. Q4 shows the flow under a sluice at the initial steady state condition. The upstream depth is 3 m and the downstream depth is 0.3 m. If the sluice gate is suddenly raised completely out of the water,

(a) Draw to reasonable expectations with appropriate labels, the characteristic lines and the surface profiles describing the waves that result from the gate action. [4 marks]

(b) What are the depth and discharge at the gate soon after the gate has been raised? [12 marks]

(c) Determine the height and speed of the surge. [6 marks]

(d) What is the length of the surge 60 seconds after lift off of the sluice gate? [3 marks]

Note: Marks distribution for (b) and (c) is approximate and will depend on the setting up of the equations for the solution of the problem.

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