NATIONAL UNIVERSITY OF SINGAPORE

CE5312 – RIVER MECHANICS

(Semester I: AY2015/2016)

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 **FIVE** 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 and straight rectangular channel is controlled by an ideal sharp-crested weir in the downstream. The channel is 10-meter wide and has a constant slope S_0=2/1000. The channel bottom gives a Manning's coefficient n=0.05. It carries a steady flow with a discharge Q=50m^3/s. The height of the weir is W=5m.

(a) Find the normal and critical depth in this channel.

(10 marks)

(b) Find water depth in front of weir.

(5 marks)

(c) Assume the channel is infinitely long in the upstream direction, sketch the water surface profile upstream of the weir.

(5 marks)

(d) Estimate the length of non-uniform region.

(5 marks)

Question 2 [10 marks]

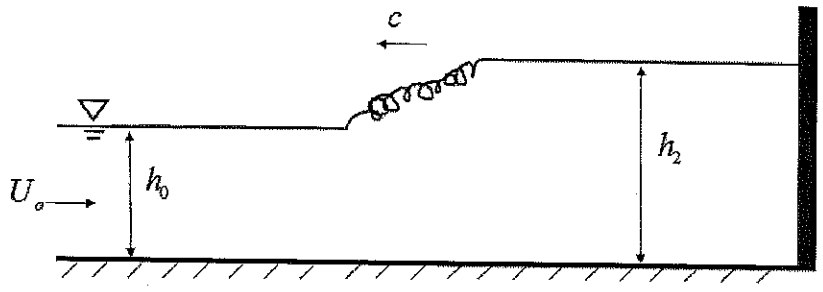
An infinitely long and very wide rectangular channel initially carries a uniform flow at U_0=2m/s and h_0=5m. For some reason, a sluice gate, which was completely open initially, is suddenly closed, as shown in the following figure. This produces a bore that travels upstream into the channel. The region from the bore to the gate can be considered to have a uniform water depth h_2.

(a) Derive two equations that allow you to solve for the celerity of the bore, c, and water depth h_2 (no need to solve them)

(7 marks)

(b) Determine c and h_2.

(3 marks)



Question 3 [25 marks]

A long, rectangular canal of width 8 m carries flow of 48 m^3/s at uniform depth h_0=3 m. At the upstream end (x=0) a hydraulic structure controls the discharge into the canal (x>0). From t=0, the discharge begins to reduce at 8m^3/hour for 5 hours and then remains constant. Neglect channel slope and resistance, and use method of characteristics to solve the following questions.

(a) Obtain an equation for determining h at x=0 with given conditions

(5 marks)

(b) Mathematically prove that the C^+ characteristics initiated on the t-axis from 0<t<5 hours are diverging straight lines, but the C^+ characteristics initiated on the t-axis for t>5 hours are parallel straight lines.

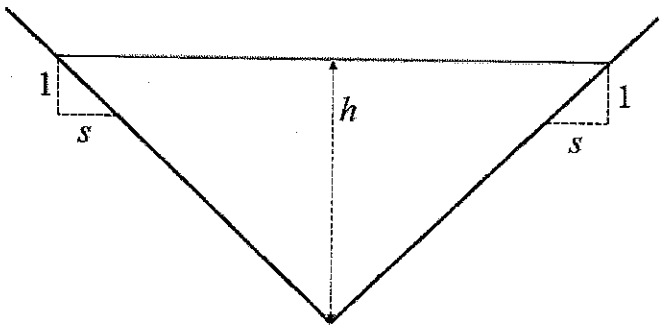
(10 marks)

(c) Determine when h is 2.6m at x=10 km.

(10 marks)

Question 4 [10 marks]

In this question we investigate the celerity of kinematic wave for kinematic-wave routing method. Assuming Manning's formula, determine the kinematic wave celerity for a long straight channel with the triangular cross section shown in the following figure. The water depth is h=2 m and channel slope s=1. Manning's coefficient is n=0.05 and average velocity is U=1 m/s.



Question 5 [30 marks]

Assume Manning's formula is always applicable. In a very wide river, the bottom is assumed always flat and covered by uniform sands d=0.2mm (you can take the bottom roughness k_s=d). The flow can be considered steady and uniform, and the discharge per unit width is maintained at $10m^2/s$. Neglect the bottom slope here.

(a) Determine the minimum (or maximum) water depth h_c that can initiate sediment movement, and discuss why this is the minimum (or maximum) water depth.

(14 marks)

Use default value h_c=14.1m hereafter:

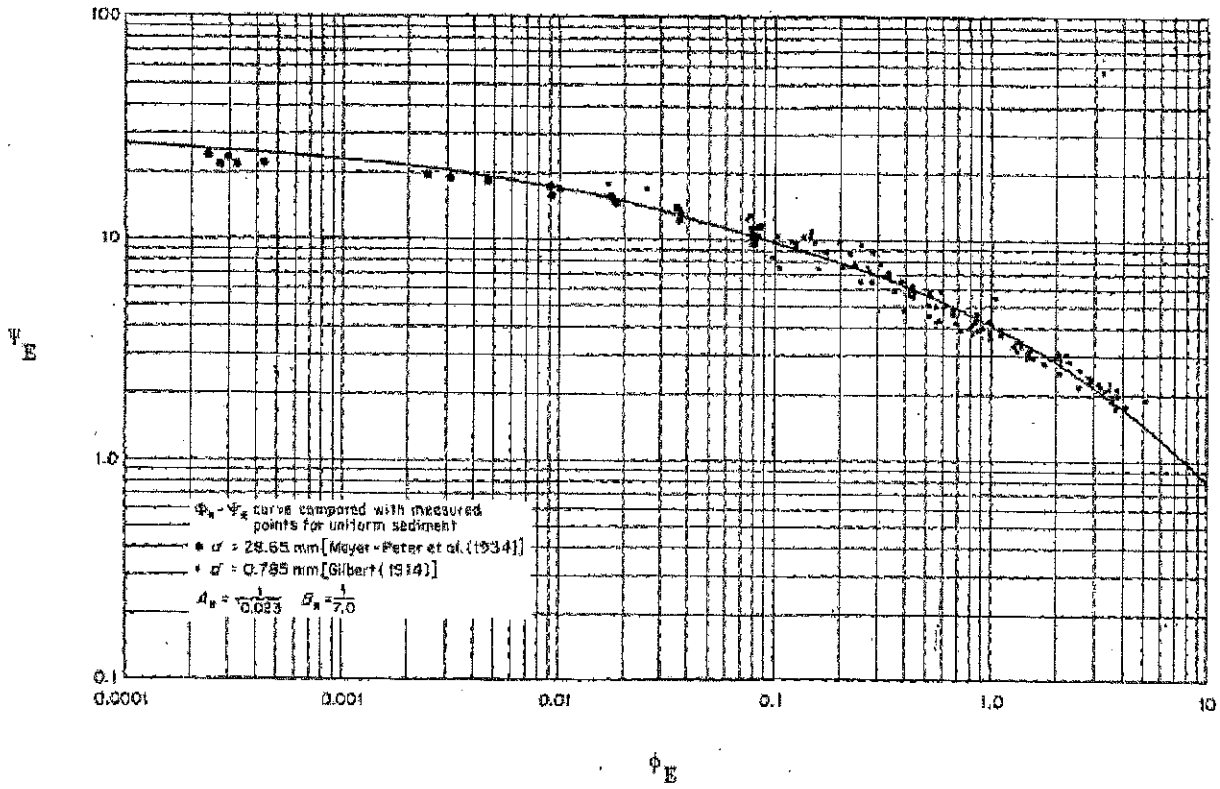
(b) For h=0.7h_c, determine bedload sediment transport rate.

(8 marks)

(c) For h=1.1h_c, determine bedload sediment transport rate.

(8 marks)

Einstein's bedload transport diagram (if you want to use it):



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