School of Natural and Built Environments

Semester 1, 2005

Water Engineering Hydraulics (CIVE 3009)

General instructions to candidates

Closed Book exam
Students are allowed to bring A4-double sided note
Calculator required (no programmable calculators)
Total time allowed is 3 hours + 10 minutes reading time
Use the provided charts, tables and graph sheets where necessary and attach then with your answer books
Please ensure front of all answer books are completed with your name, student I.D. number

Question 1 – Open channel Hydraulics (50 marks)

a. Define the term Specific Energy in an open channel section. How does it vary with the flow depth at a constant flow rate?

(5 marks)

b. Show that the hydraulic radius (R) of a wide rectangular channel is equal to it's flow depth (d).

(5 marks)

c. A wide rectangular channel carries $3m^3/s/m$ (discharge per one-meter-width of the channel). Flow at A is uniform. Due to topographical variation, channel's bed slope changes at Section B and D. At E, this channel delivers water to the main channel which flows perpendicular to DE. Elevation difference between A and D is 4m. Losses between A and D are negligible. Sketch the flow in this channel.

(8 marks)

d. Estimate critical depth and decide critical-depth-points and the flow types (su critical or super critical) that could occur between sections (eg. A → B). (**Note -** The Channel length between D and E is long enough to establish uniform flow before the channel joins the main channel)

(12 marks)

e. Use the space given in Figure 2 to plot variation of specific energy along the channel (include all the critical-depth-points).

(10 marks)

f. Define profile types you observe in this open channel system.

(10 marks)

Note- Use table 1 and 2 and the Figure 1 as appropriately to answer these questions (you might/might-not need all the rows/columns).

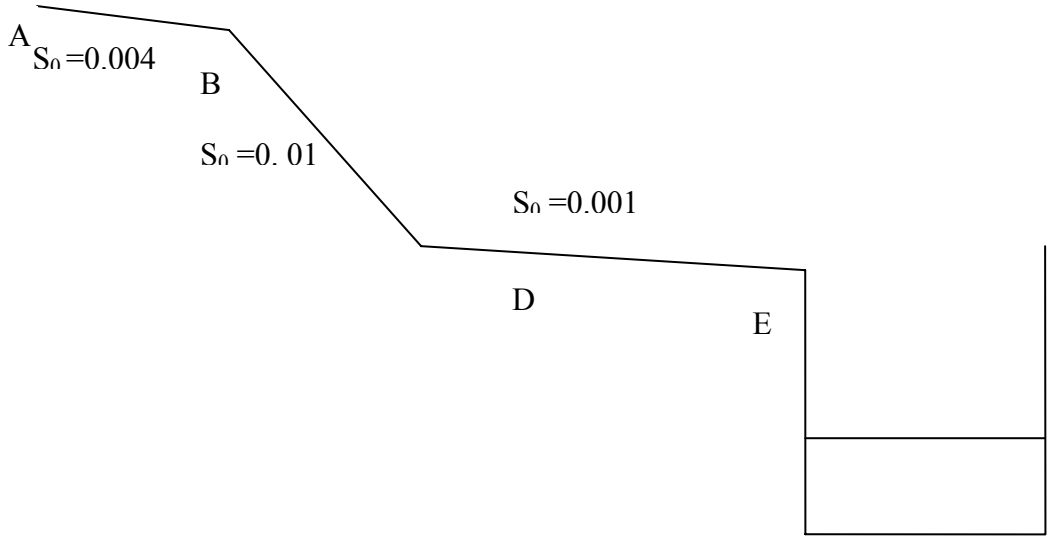

Figure 1 – Open channel system for Question 1

Table 1 for Question 1

Channel Reach			
A→ B			

Table 2 for Question 1

Channel section			
A			
B			

Es

Channel section

Figure 2 for question 1e

Question 2 – Pipe flow (25 marks)

The pipeline shown in the Figure 3 draws water from reservoir A and delivers at C (to the atmosphere). Reduced levels at A, B and C are 200, 100 and 100mAHD respectively. Pipe characteristics are as listed in Table 3.

a. Ignoring all the minor losses, estimate flow (Q) through the pipe line (5 marks)
b. Calculate all the major and minor losses (ignore the loss due to the bend) (8 marks)
c. Draw Total Energy Line (TEL) and Hydraulic Grade Line (HGL). Show all important numerical values in the diagram. (12 marks)

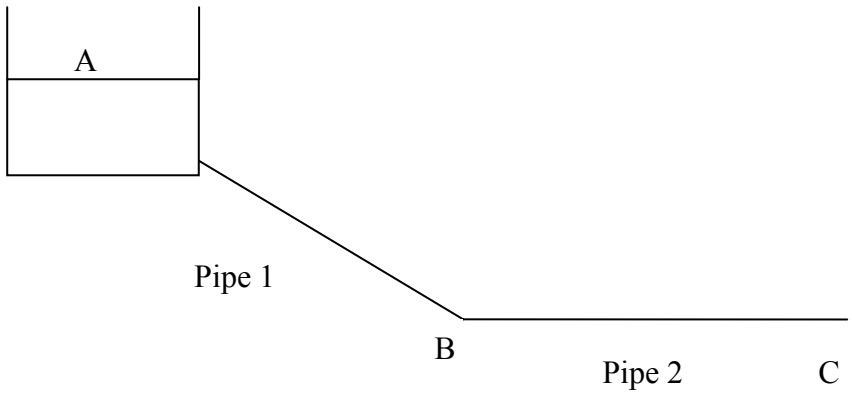

Figure 3 Pipeline system for Question 2

Table 3 for question 2

Pipe	Length (km)	Friction factor	Diameter
Pipe 1	1	0.014	0.3
Pipe 2	2	0.021	0.45

Question 3 - Reservoir routing and Culvert hydraulics (25 marks)

a. Define reservoir routing and River routing

(5 marks)

b. Define the terms 'inlet control' and 'outlet control'. What are the factors that courses to have inlet control condition of a culvert

(8 marks)

c. Figure 4 shows SIC curves for a reservoir with a 40m long spillway. Initial water level (H) of the reservoir (just before this flood arrived) was at 0.1m above the Full Supply Level (FSL), Estimate the attenuation and translation of the flood peak due to the reservoir. (Note- use table 4 as you wish)

(12 marks)

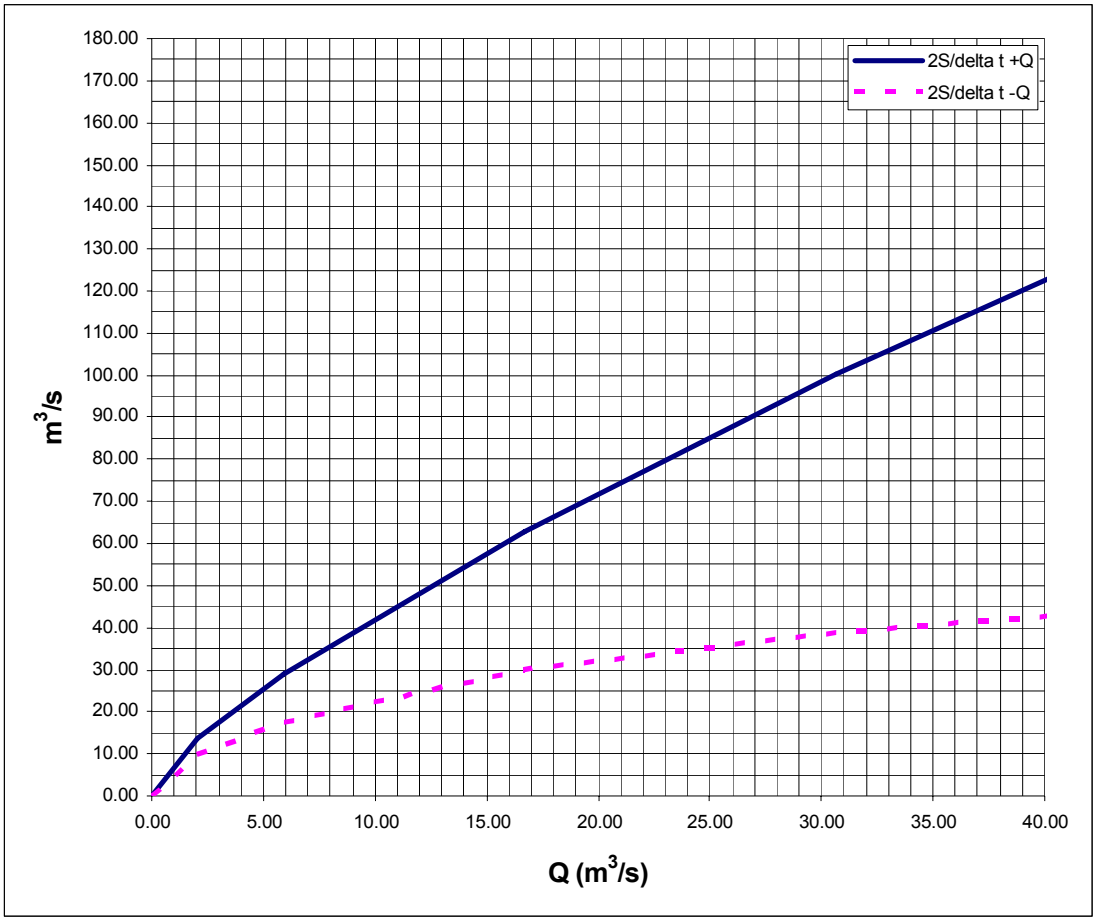

Figure 4 for Question 3

Table 4 for Question 3

Reservoir characteristics			Derived graphs	
H m	S m^3*10^6	Q $m^3/3$	2S/delta t +Q m^3/s	2S/delta t - Q m^3/s
0	0	0.00	0.00	0.00
0.1	0.5	2.09	13.66	9.49
0.2	1	5.90	29.05	17.24
0.4	2	16.70	62.99	29.60
0.6	3	30.67	100.12	38.77
0.8	4	47.23	139.82	45.37
1	5	66.00	181.74	49.74
1.2	6	86.76	225.65	52.13
1.5	7.5	121.25	294.86	52.36
2	10	186.68	418.16	44.81

Table 5 for Question 3

Time (days)	Inflow (m3/s)			
0	2.0			
1	8.0			
2	12.0			
3	28.0			
4	22.0			
5	18.0			
6	12.0			