SULTAN QABOOS UNIVERSITY

Department of Civil and Architectural Engineering
B.Sc. Civil Engineering Examinations, Spring Semester 2004

HYDRAULICS **CIVL 4146**

May 26, 2004 9:00-12:00

The following is provided for this examination:

Answer booklet

Candidates are permitted to bring into the examination room:

Calculator (programmable or non-programmable).

Instructions to candidates:

Answer all the questions

The paper consists of SIX questions.

Time allowed: 3 hours

Answer all the questions. Assume water density as **1000 kg/m^3** wherever required.

1.

(a) Using Darcy-Weisbach equation, Colebrook equation (for friction factor) and Manning's formula, derive a relationship between Manning's *n* and relative roughness. **[10%]**

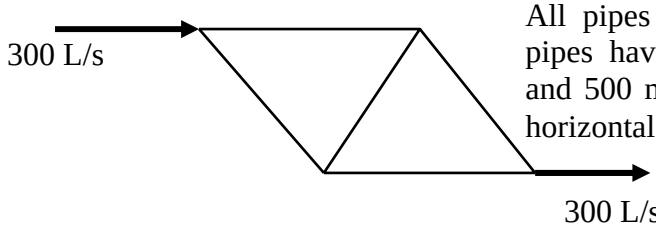
(b) Compute Manning's *n* from the relationship derived in Part (a) for a concrete pipe having 30 cm diameter (*e*=3mm) and compare it with the standard value of *n* provided for this material in Table 1. **[10%]**

2. At a firefighters convention, a certain competition puts two contestants in mock competition. Each is armed with a fire hose (water jet) and a shield. The objective is to push your opponent backward a certain distance with the water jet. A choice of shields is offered. One shield is a flat garbage can lid; the other is a hemispherical lid that directs the water back to your opponent. Which shield would you choose? Show all the relevant calculations. **[15%]**

3.

(a) The flow correction for the pipe flow in a network loop for Hardy-Cross method is given as $\Delta = -\frac{\sum KQ_a^p}{\sum \left|qQ_a^r\right|}$. Using Hazen-Williams formula, derive the values of *p*, *q*, *r* and *K* in the above relationship. **[15%]**

(b) Using the relationship in Part (a) find out the first correction for the following network: **[10%]**



All pipes are galvanized iron pipes having 30 cm diameter and 500 m length lying in the horizontal plane.

4. A flow of 2000 L/s is carried in a rectangular channel 1.8m wide at a depth of 1m.

(a) Will critical depth occur at a section where a hump 400 mm high is installed across the bed **[10%]**

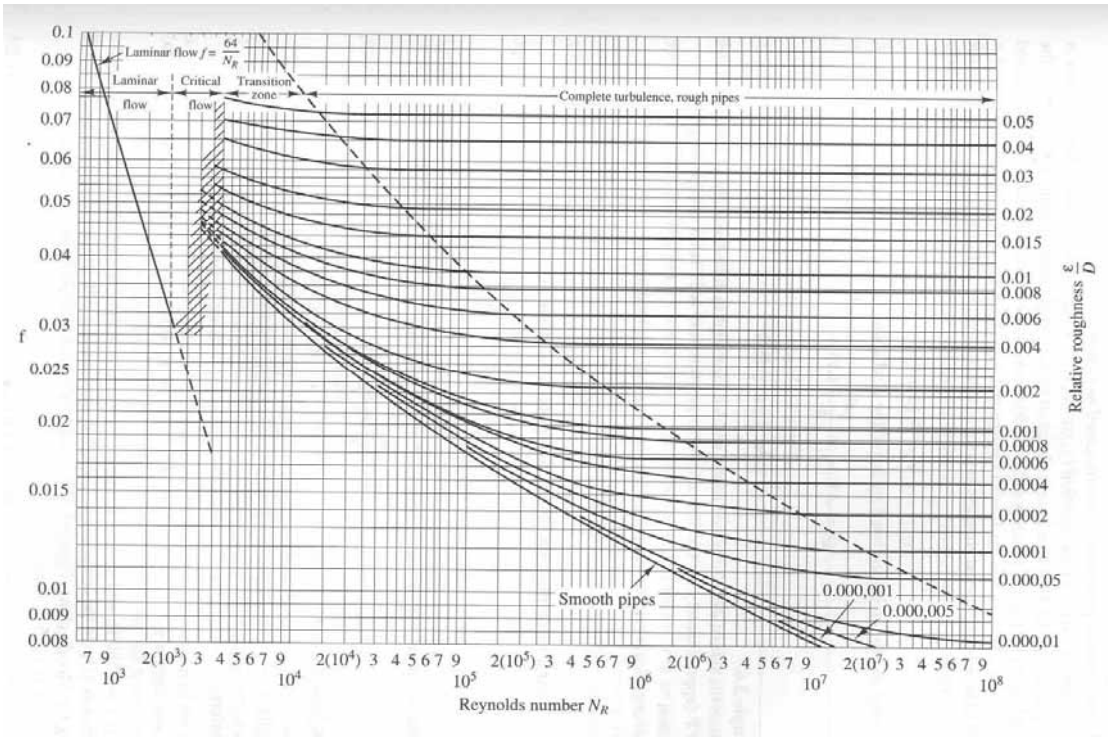
(b) What height of the hump will just cause the critical depth **[5%]**

Assume no friction anywhere in the channel and show all the calculations.

5. A 1.6m wide rectangular open channel with n=0.013 carries 1900L/s of water. At one point the water depth is found to be 1.3m; 320m downstream it is measured at 1m. Calculate the bed slope of the channel using one reach. **[15%]**

6. A vertical jet of water issuing upward from a nozzle at a velocity of 15m/s will rise to a height of approximately 10m on the earth. To get a water jet to rise to a height of 40m on the moon, where the gravity is one-sixth of that on earth, what must be the jet velocity? Neglect atmospheric resistance. **[10%]**

The following information may be useful in solving the problems:



$$V = 0.85 C_H R^{0.63} S^{0.54} \qquad V = \frac{1}{n} R^{2/3} S^{1/2} \qquad h_E = \frac{(V_1 - V_2)^2}{2g}$$

$$h_f = f\frac{L}{D}\frac{V^2}{2g} \qquad u = \frac{P_1 - P_2}{4\mu L}\left(r_0^2 - r^2\right) \qquad \sum F = \rho Q(V_2 - V_1)$$

$$Q = \frac{\pi D^4 (P_1 - P_2)}{128\mu L} \qquad \frac{1}{\sqrt{f}} = -2\log\left(\frac{e/D}{3.7} + \frac{2.51}{N_R\sqrt{f}}\right) \qquad h_c = K_c\frac{V_2^2}{2g}$$

$$\frac{dy}{dx} = \frac{S_0\left[1 - \left(y_n/y\right)^{10/3}\right]}{\left[1 - \left(y_c/y\right)^3\right]} \qquad \frac{Q^2 T}{gA^3} = 1 \qquad \Delta x = \frac{\left[\left(y + \alpha\frac{V^2}{2g}\right)\right]_2^1}{\bar{S}_f - S_0}$$

Table 1: Roughness parameters for different pipe materials

Material	e (mm)	n	C_H
Riveted steel	0.9-9.0	0.015	110
Concrete	0.3-3.0	0.015	110
Ductile and cast iron	0.26	0.013	120
Galvanized iron	0.15	0.012	120
Asphalt-dipped ductile/cast iron	0.12	0.012	140
Commercial steel or wrought iron	0.046	0.01	140
Copper or brass tubing	0.0015	0.01	130
Glass, plastic (PVC)	≈ 0	0.01	140

Table 2: Values of loss coefficient for sudden contraction

V_2 (m/s)	Ratio of smaller to larger pipe diameters, D_2/D_1									
	0.0	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
1	0.49	0.49	0.48	0.45	0.42	0.38	0.28	0.18	0.07	0.03
2	0.48	0.48	0.47	0.44	0.41	0.37	0.28	0.18	0.09	0.04
3	0.47	0.46	0.45	0.43	0.40	0.36	0.28	0.18	0.1	0.04
6	0.44	0.43	0.42	0.40	0.37	0.33	0.27	0.19	0.11	0.05
12	0.38	0.36	0.35	0.33	0.31	0.29	0.25	0.20	0.13	0.06