Assignment 3

Engineering Background

The goal of this assignment is to review basic knowledge of hydrology and hydraulics necessary for implementation of water resources management. If you are missing any information please review your Hydrology and Engineering Fluid Mechanics course material and the course textbook by Dr. Chin.

Part A (in class)

1. The rainfall data in Table 3.1 were compiled by determining the maximum amount of rainfall that occurred for a given time period during a given year. Use these data to develop IDF curves for 2-,5-, and 10-year return periods.

Table 3.1 Rainfall maxima (cm) for given durations

Year	Duration (h)			
	1	2	4	6
1980	2.1	3.2	3.9	4.1
1981	1.4	1.6	2.2	1.9
1982	1.1	1.3	1.5	1.8
1983	1.2	1.3	1.6	1.9
1984	1.0	1.1	1.4	1.6
1985	1.3	1.4	1.7	2.0
1986	1.3	1.4	1.8	2.2
1987	1.1	1.2	1.4	1.6
1988	1.1	1.2	1.4	1.7
1989	1.0	1.0	1.3	1.4
1990	1.0	1.1	1.4	1.6
1991	1.1	1.2	1.4	1.6
1992	1.2	1.3	1.6	1.9
1993	1.0	1.2	1.4	1.6
1994	1.1	1.3	1.5	1.9
1995	1.1	1.2	1.8	1.9
1996	1.1	1.2	1.4	1.7
1997	1.7	2.6	3.2	3.4
1998	1.1	1.3	1.8	1.9
1999	1.0	1.1	1.3	1.6

2. The 60-minute unit hydrograph for 14.868-km^2 urban catchment is given in Table 3.2.

Table 3.2 The 60-min unit hydrograph

Time (h)	Runoff (m^3/s)
0	0
1	1.8
2	6.1
3	8.4
4	6.5
5	5.2
6	4
7	3
8	2.2
9	1.6
10	1.1
11	0.7
12	0.4
13	0.2
14	0.1
15	0

a. Verify that the unit hydrograph is consistent with a 1-cm rainfall excess; and
b. Estimate the runoff hydrograph for a 60-min rainfall excess of 3.2 cm.

3. The surface of 2-ha catchment is characterized by a runoff coefficient, *C* = 0.5, Manning *n* for overland flow of 0.25, an average overland flow length of 60 m, and an average slope of 0.5%. Calculate the time of concentration using the Kinematic wave equation.

The drainage channel is to be sized for the peak runoff resulting from a 10-year rainfall event. The 10 year IDF curve is given as: $i = \frac{150}{(t+8.96)^{0.78}}$, where *i* is the average rainfall intensity in cm/hr and *t* is the rainfall duration in minutes. The minimum time of concentration is 5 minutes. Determine the peak runoff rate that should be used for the design of drainage channel.

4. Reservoirs A, B, C and D are connected as shown in the Figure 3.1. The water elevation in reservoirs A, B, C and D are 250 m, 200 m, 170 m and 180 m, respectively. The four pipes connecting the reservoirs meet at the junction J with pipe lengths AJ=1400 m, BJ=1100 m, DJ=850 m and JC=1000 m. The diameter of all pipes is equal to 800 mm. All pipes are made up of ductile iron and the water temperature is 20^0C. Assuming turbulent flow and equivalent sand roughness k_s=0.26 mm (ductile iron):

a. calculate the friction factor *f* using the modified Colebrook equation for turbulent flow defined below

$$\frac{1}{\sqrt{f}} = -2\log\left(\frac{k_s}{3.7D}\right)$$

b. set the energy and continuity equations for finding the flows in all pipes.

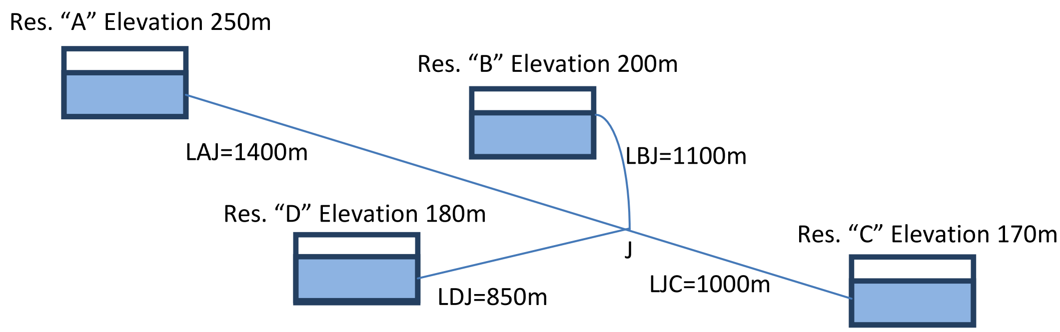

Figure 3.1 Schematic presentation of reservoir network

Part B (at home)

5. Use the data from Problem 3. If an error of 15% is present in each of assumed site parameters:

a. determine which parameter gives the highest peak runoff when the 15% error is included;

b. determine which parameter gives the lowest peak runoff when the 15% error is included;

c. if the 15% error occurs simultaneously in all the drainage parameters what would be the design peak discharge at the inlet.

6. For the data from Problem 2 estimate the runoff hydrograph for 30 minute rainfall excess of 15 cm.

7. For the data from Problem 4 calculate the flows in and out of each reservoir.

8. Water flows at 8.4 m/sec in a trapezoidal channel with a bottom width of 2 m and side slopes of 2:1 (H:V). Over a reach of 100 m length, the bottom width expands to 2.5 m, with the side slopes remaining constant at 2:1. If the depth of flow at the entrance and exit sections of the reach is 1 m and the channel slope is 0.001, calculate the head loss between the sections. What is the power in kilo-watts (KW) that is dissipated?

(Hint: Use $P=\gamma_w Q h_L$ to calculate the dissipated power)

Due to Thursday, February 2, 2012