ECE/CSC 570 – Sections 2, 3, and 601, Computer Networks
Homework #5 (Due on Nov. 13, 2014)

Again, this HW#5 contains a number of questions that are more involved than usual, in order to help you better prepare for the upcoming midterm exam #2. You are strongly encouraged to work on these questions in conjunction with the class exercises in the QoS chapter and those in Routing chapter.

1. **(10 points)** While IP addresses are tied to specific networks, Ethernet addresses are not. Can you think of a good reason why they are not?

2. **(15 points)** Given a network configuration, assume that you want to find the most reliable path from a given node to all the other nodes. Assume that you know the probability of an error for *each* link, and the *reliability* of a path is given by the probability that *none* of the links that belong to the given path is in error. As usual, assume that links are all independent. Can you use Bellman-Ford algorithm for this? Explain.

3. **(30 points, 15 points each)**

   Find the shortest distance path from node A to all other nodes in the network shown below. The link metric shown is for the symmetric cost for each link, i.e., the cost of going from A to B is the same as the cost of going from B to A. Make sure that you show all steps in each algorithm, as done in the class with the table.

   (a) Use Dijkstra's Algorithm

   (b) Use Bellman-Ford Algorithm (assuming that update order is $B \to C \to D \to E \to F$ and then repeat)

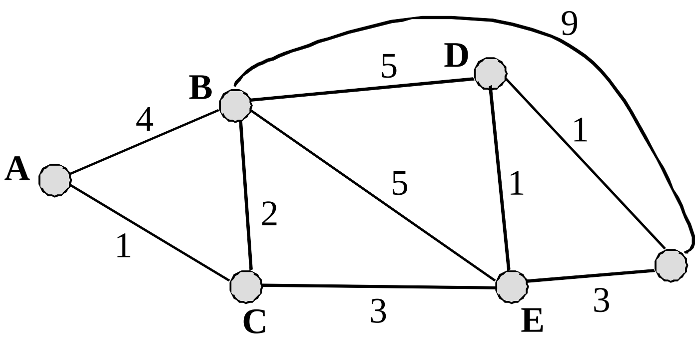

Figure 1: Network for Routing Problem

4. **(10 points)** In the lecture note for "Quality of Service", slide # 30, Show your steps to obtain the figure (f). In particular, explain how you can get the burst length of 62ms (approximate value) there.

5. **(15 points)** In the Class Exercise in slide # 31 (QoS chapter), assume that we have $n = 4$ classes, $w_i = 1$ for all $i = 1, 2, 3, 4$ (thus round robin scheduler), $R = 8$Mbps, $\rho_1 = 1$Mbps, $M_1 = 4$Mbps, and $C_1 = 9$Mbits. Assume the same situation as in the Class Exercise. Let $Q_1(t)$ be the queue length (buffer size) for class 1 at time t. Draw $Q_1(t)$ for $0 \le t \le 10$.

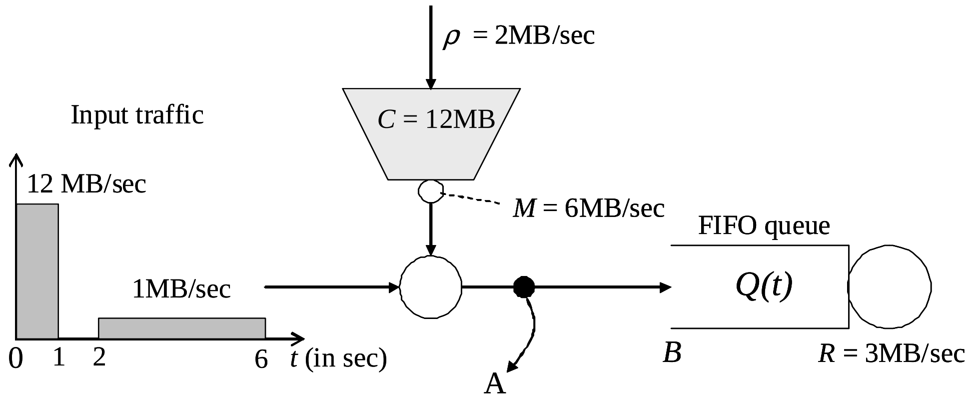

Figure 2: Network for Problem 6

6. **(30 points, 15 points each: taken from the past exam)** Suppose we want to transmit a file of 16 MBytes size to the network. (See Figure 2 above.) The sender transmits the file at a speed of 12 Mbytes/sec for 1 second, nothing for one second, and at a speed of 1Mbytes/sec for another 4 seconds ($2 \le t \le 6$) as shown in the figure. This traffic enters a token bucket as shown below. This 'shaped' traffic (at A) now enters a FIFO queue with link capacity (service rate) of $R =$ 3MBytes/sec and buffer size B MBytes. The parameters for this system are as follows (all units here in MB mean MBytes):

- token generation rate: $\rho = 2$ MB/sec
- token bucket size: $C = 12$ MB
- token bucket drain rate: $M = 6$ MB/sec
- service rate for the FIFO queue: $R = 3$ MB/sec
- Buffer size of the FIFO queue: B to be determined below.

We assume that at time $t = 0$ (initially), the token bucket is full and the FIFO queue is empty.

(a) Draw the traffic output of the token-bucket, i.e., traffic rate at point A as a function of time. Clearly indicate the size and the length of any burst in your graph.

(b) Draw the queue-length $Q(t)$ as a function of time t. What is the minimum buffer size B to ensure that nothing is lost (due to buffer overflow) in the FIFO queue?