February 26, 2018

Midterm Exam I

EE/TE 4367: Telecommunications Networks

NOTE: **Please, complete the following table and keep record of your assignment number.**

First Name	
Last Name	
Student ID	
Assignment #	**39**

Exercise 1. Consider the open network (referred to as the system) of three queues, i.e., Q_1, Q_2, and Q_3, at steady state. New customers arrive at rate λ and always enter Q_3. Customers leaving Q_3 choose to either depart from the system with probability $1-p$ or go to Q_1 with probability p. Customers leaving Q_1 always choose to enter Q_2. Customers leaving Q_2 always choose to enter Q_3. The average time spent by a customer in Q_3 while visiting this queue once is T_3. The average number of customers in both Q_1 and Q_2 combined is $\hat{N}$. Your final solutions should only contain λ, p, $\hat{N}$, and T_3.

A) Compute λ_1, λ_2, and λ_3, defined as the arrival rate into Q_1, Q_2, and Q_3, respectively [pt. 10].

B) Compute N_3, defined as the average number of customers in Q_3 [pt. 10].

C) Compute T_{tot}, defined as the average total time spent in the system by a customer [pt. 10].

Exercise 2. The server of a queue completes service time according to a random variable denoted as X (in ms), whose probability density function is

$$f_X(x) = \begin{cases} -\frac{2}{81}x + \frac{2}{9} & 0 \le x \le 9 \\ 0 & \text{otherwise} \end{cases}$$

The server utilization is 30%. The average time spent by a customer in the queue (inclusive of the service time) is 20ms.

A) Compute $E[X] = \bar{X}$, defined as the average service time [pt. 10].

B) Compute λ, defined as the customer arrival rate into the queue. [pt. 10].

C) Compute N, defined as the average number of customers in the queue. [pt. 10].

Exercise 3. The following string of 5 data bits is transmitted (from left to right) "11111". A CRC is attached at the end of the string during transmission. The CRC is computed using the generator polynomial $g(D) = D^3 + D^2 + D + 1$.

A) Compute $c(D)$, defined as the remainder when $D^3 s(D)$ is divided by $g(D)$, using modulo 2 arithmetic, where $s(D)$ is the polynomial representing the string of data bits. Write down the sequence of bits as they are transmitted inclusive of CRC, starting left with the first bit to be transmitted [pt. 10].

B) Assume that at the receiver the sequence of bits is affected by an error, described by $e(D) = D^6 + D^5$. Compute $r(D)$, defined as the remainder when $D^3 s(D) + c(D) + e(D)$ is divided by $g(D)$, using modulo 2 arithmetic. Is the error detected by the receiver, and if so, why [pt. 10]?

C) What is the minimum distance of the used code and why [pt. 10]?