February 22, 2017

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 #	0

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. A new customer chooses to enter Q_1 with probability p_1, Q_2 with probability p_2, and Q_3 with probability $p_3 = 1 - p_1 - p_2$. Customers leaving Q_1 choose to enter Q_2. Customers leaving Q_2 choose to enter Q_3. Customers leaving Q_3 choose to either depart from the system with probability q or (re)enter Q_1 with probability $1 - q$. The average time spent by a customer in Q_1 while visiting this queue once is T_1. The average time spent by a customer in Q_2 while visiting this queue once is T_2. The average time spent by a customer in Q_3 while visiting this queue once is T_3.

A) Compute N_1, N_2, and N_3, defined as the average number of customers in Q_1, Q_2, and Q_3, respectively [pt. 10].

B) Compute T, defined as the average total time spent in the system by a customer [pt. 10].

C) Compute the value of p_3 that would minimize T [pt. 10].

Exercise 2. An Ethernet switch transmits frames at a transmission rate of 10 gigabit per second (Gbps). The frame average length is 900 bytes. The transmitter utilization is 20%. The average number of frames stored in the switch (including the one in transmission) is estimated to be 150.

A) Compute X, defined as the frame average transmission time [pt. 10].

B) Compute T, defined as the average time a frame spends in the switch at steady-state (T includes both waiting and transmission time) [pt. 10].

Exercise 3. The following string of 7 data bits is transmitted (from left to right) "1110111". A CRC is attached at the end of the string during transmission. The CRC is computed using the generator polynomial $g(D) = D^4 + D^2 + D + 1$.

A) Compute $c(D)$, defined as the remainder when $D^4 s(D)$ 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 $e(D) = D^{10} + D^3$. 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]?