Homework 1

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. Customers arrive at a fast-food restaurant at a rate of 5 per minutes and wait to receive their order for an average of 5 minutes. Customers eat in the restaurant with probability $p = 0.6$ and carry out their order without eating with probability $1 - p = 0.4$. A meal requires an average of 20 minutes to be consumed at the restaurant.

A) What is the average number of customers in the restaurant? [pt. 10].

Exercise 2. Consider the open network of queues shown in Figure 1. Customers enter the network at rate

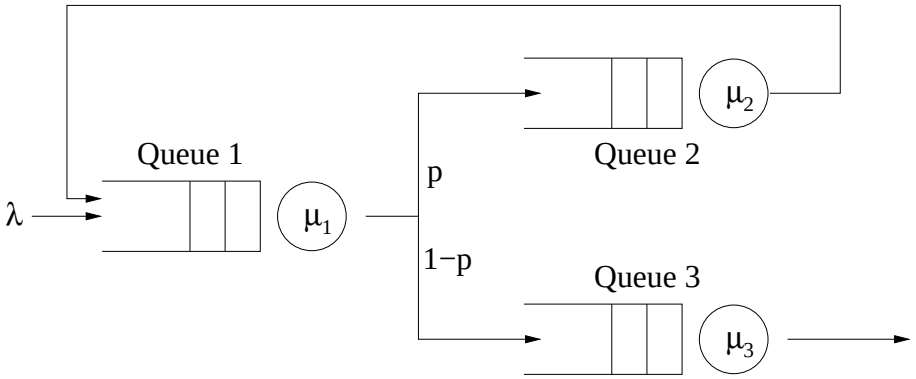

Figure 1: Open queueing network.

λ immediately reaching queue 1. Customers leaving queue 1 will choose queue 2 with probability p, and queue 3 with probability $(1 - p)$. All customers leaving queue 2 return to queue 1. Let N_1, N_2 and N_3 be the average number of customers in queue 1, 2, and 3, respectively.

A) What is the expected total time spent in the system by a customer (defined as T)? [pt. 10].

B) What is the expected time spent in queue 2 by a customer visiting the queue only once (defined as T_2)? [pt. 10].

Exercise 3. Consider the open network of two queues shown in Figure 2. Customers enter the network at

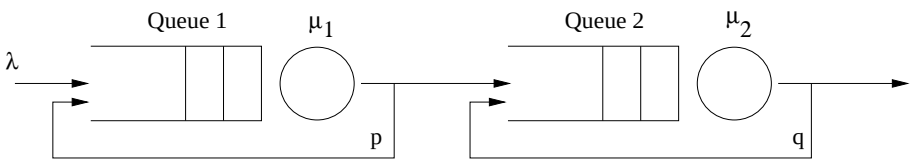

Figure 2: Open queueing network.

rate λ immediately reaching queue 1. Customers leaving queue 1 will either choose queue 2 with probability $(1 - p)$, or return to queue 1 with probability p. Customers leaving queue 2 will either depart from the system with probability $(1 - q)$, or return to queue 2 with probability q.

A) Compute the average number of times the same customer enters queue 1 [pt. 10].

B) Assuming that each time a customer enters queue 1, it will stay in the queue for an average time of $T_1^{(1)}$ (including both waiting and service time), compute the average number of jobs in queue 1, i.e., N_1 (note that the same customer may enters queue 1 multiple times, but in this question $T_1^{(1)}$ represents the average time spent in the queue during one single visit to the queue) [pt. 10].

C) Assuming that the average number of jobs in queue 2 is N_2, compute the average time a customer spends in the entire network of queues, i.e., the time elapsed from the moment the customer enters queue 1 for the first time and the moment the customer leaves the second queue and decides not to return to queue 2 [pt. 10].