Assignment #1

ECE 686 (Wireless Communication Networks) Dr. Hai Jiang
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Your Last name: _____Your First Name:_____ Your ID:_____

1. Consider an M/M/1 system. The average inter-arrival time is 20 minutes, and the average service time of a customer is 15 minutes. What is the probability of the system having an empty queue? For a customer, please calculate the average queueing time. (**6 points**)

λ=1/20 per minute

μ=1/15 per minute

$\rho = \lambda / \mu = 0.75$.

Probability of an empty queue = $P_0+P_1 = (1- \rho) + \rho(1- \rho) = 0.4375$

Average queueing time : $E[T_q] = \rho/[\mu(1- \rho)] = 45$ minutes.

2. Consider the M/M/m/m system discussed in the last three pages of our Lecture 2. There are m=2 servers. The arrival rate to the system is 15 per hour, while the service rate of each server is 12 per hour. For a server, what is the probability of the server being idle? (**5 points**)

λ=15 per hour

μ=12 per hour

$\rho = \lambda / \mu = 1.25$

$P_0 = [\rho^0 + \rho^1 + \rho^2(1/2!)]^{-1} = 32/97$

$P_1 = \rho P_0 = 40/97$

For each server: when there is 0 customer in the system, the server is idle; when there is 1 customer in the system, the server has probability 0.5 to be idle; when there are 2 customers in the system, the serve is always busy.
So the server's idle probability is: $P_0 + 0.5P_1 = 52/97$.

3. Consider a router in a network. Packet arrivals to the router follow a Poisson process with average arrival rate being 1000 packets per second. The router has a processing unit, which processes packets (i.e., the processing unit transmits the packets to other routers). The processing time of a packet is a random variable following an exponential distribution with mean value 0.0008 second. The buffer of the router can store 5 packets (not including the packet being processed by the processing unit of the router). When a new packet arrives, if the buffer is full, then the new packet will be dropped by the router. Please calculate packet dropping probability at the router. (**5 points**)

This is a M/M/1/N queue.
λ=1000
μ=1250
N=6.

$\rho = \lambda / \mu = 0.8$
Packet dropping probability:
$P_6=(1- \rho) \rho^6/(1- \rho^7)=0.066$