Computer Engineering Department
King Fahd University of Petroleum and Minerals

COE 540: Computer Networks

Midterm Exam
Date: November 29, 2006

Time: 7:00PM – 9:00PM

Instructor: Uthman Baroudi

Student Name:----------
Student ID:----------

	Max	Earned
Question 1	50	
Question 2	50	
Total	100	

Notes:
Trust in Allah
Go over all questions and start with what you know first.
Read, think, state all your assumptions, and then answer and ***SHOW ALL YOUR WORK.*** *Be calm, don't panic*

Probability and Stochastic Processes
Question # 1 (50 marks)

1. **(10 points)** Packets arrive to a service facility at a Poisson rate of 5 packets per second.
    a. Write down an expression for the probability of arrival of at least two messages during a two second interval.

    b. Write down an expression for the probability that the first arrival occur before two seconds have elapsed.

2. **(15 points)** Packets traversing a network will be dropped only due to network congestion. A packet is transmitted two times. Let Z be the number of drops on the first transmission (0 or 1) and W be the total number of drops on both trials. if the network is highly congested and a packet drop has a chance of 30% of occurring, find:
    a. The joint probability distribution of Z and W
    b. The marginal distributions of Z and W
    c. Sketch the marginal distributions of Z and W
    d. The probability that at least 1 drop occurs

3. **(25 points)** Consider a packet stream whereby packets arriving according to a Poisson process with rate 15 packets/sec. "Collision" may occur if two or more packets overlap during their transmission periods. Find the probability of no collision assuming packets have independent and exponentially distributed transmission times with mean 20 msec.

Queuing Theory
Question # 2 (50 marks)

1. **(10 points)** consider three classes of messages arrive at a service facility. Class1 messages arrive at an average rate of 120 per minute and depart after quick examination lasting 200msec. The second class is processed at an average rate of 6 messages per minute and arrives at a rate of 30 per minute. Each message of the third class requires 30 seconds of processing and they arrive at a rate of 10 per minute. Find the average number of messages in the system.

2. **(20 points)** Consider the steady-state condition,
    a. Sketch the Markov chain for a M/M/m queue
    a. Write down the balance equations
    b. Find the state probabilities
    c. Find the average number of customers in the system
    d. Write down the expression for Average response time in the system
    e. Write down the expression for Average queuing time
    f. Write down the expression for the loss probability
    g. Write down the expression for the queuing probability

3. **(20 points)** Queues 1 and 2 of the open Jackson queuing network depicted in the figure receive Poissonian arrival streams with rates 2 and 1 customers/sec respectively. Service times are exponentially distributed with the rates: 3, 6, and 10 customers/sec, respectively. Compute the following using the results of part 2:

    h. Customer stream rate through each of the queues
    i. Average occupancies of the queues and the average total number of customers in the network
    j. Mean delays in the network of customers arriving at queues 1 and 2 as well as the delay of an arriving customer chosen at random.