ECE 506/CS 513

Introduction to Local and Wide Area Networks

**Homework Assignment #3**

1. Problem #15, p. 87, in TAN.
2. The following questions are related to an M/M/1 queue given that ρ is fixed at 0.6:
3. What is the average number of messages stored in the system?
4. Can a 1 second average time delay per message be achieved? If so, what are the values of λ and μ ?
5. What is the average number of messages in service?
6. Is there a single time at which this average number of messages is in service?
7. Students arrive at an ATM machine in a random pattern with an average inter-arrival time of 3 minutes. The length of transactions at the ATM machine is exponentially distributed with an average of 2 minutes.
8. What is the probability that a student arriving at the ATM will have to wait?
9. What is the average length of the waiting lines that form from time to time?
10. The bank plans to install a second ATM when they are convinced that an arriving customer would expect to wait at least 5 minutes before using the machine. At what average inter-arrival time will this occur? For this arrival rate, find the average residence time and the average number of people queuing.
11. At what inter-arrival time will the queues grow interminably long?
12. A buffer is filled over a single input channel and emptied by a single channel with a capacity of 64 kbps. Measurements are taken in the steady state for this system with the following results:

Average packet waiting time in the buffer = 0.05 seconds

Average number of packets in residence = 1 packet

Average packet length = 1000 bits

**The distributions of the arrival and service processes are unknown and cannot be assumed to be exponential!**

What are the average arrival rate *λ* in units of packets/second and the average number of packets *w* waiting to be serviced in the buffer?

1. A node in a computer network can be modeled as an M/M/1 queue. The capacity of the line out of the node is 1400 bps, and there are 10 bits per message. Under certain conditions, it is known that an average of 50 messages are stored in the system (storage buffer and output line).
2. Under these same conditions, what is the arrival rate?
3. What is the total average time delay through the system?
4. What is the average number of messages stored in the buffer?
5. What is the average queuing delay?
6. What is the traffic intensity?