Total Marks: 50  
Due Date: December 3, 2005 at 11:55 PM. Late Submissions will not be accepted.  
Submission guideline:  
Your work must be submitted using the submit system. Write-up your work using the  
word processing software of your choice and submit it either in PS or PDF format. If  
possible, also provide your TA with a hardcopy of your work.  
For this assignment, it is important that you show all steps and state all assumptions.  

1. An automatic car wash was monitored for 5 hours. During this time, 30 cars receive a  
   wash and depart the car wash. During the observation period, the car wash facility  
   was found to be idle for 20% of the time. Based on this information, answer the  
   following:  
   a. What is the average throughput (measured in cars/minute) at the facility?  
   b. What is the average service time at the car wash (in minutes)?  
   c. What is the average residence time in the facility (in minutes)?  
   d. What is the average number of cars waiting to enter the wash?  

2. An interactive system is supporting 100 users with 15 second think times and a  
   system throughput of 5 interactions/second. Answer the following: (Source: LZGS84)  
   a. What is the response time of the system?  
   b. Suppose that the service demands of the workload evolve over time so that the  
      system throughput drops to 50% of its former value. Assuming that there are  
      still 100 users with 15 second think times, calculate their response times?  
   c. How do you account for the fact that response time in part (b) is more than  
      twice that in part (a)?  

3. At a trendy downtown nightclub, it is observed that 30 customers arrive per hour. The  
   manager of the club estimates that, on average, approximately 60 customers are  
   present in the club at any given time. Calculate the average time duration of a  
   customers stay in the nightclub?  

4. A two-runway (one each for landing and takeoff) airport is being designed for  
   propeller driven aircrafts. The time to land an airplane is known to be exponentially  
   distributed, with mean of 1.5 minutes. If airplane arrivals are assumed to be Poisson,  
   what arrival rate can be tolerated if the average wait time in sky is not to exceed 3  
   minutes? (Source: BCNN05)  

5. Arrivals to an airport are all directed to the same runway. At a certain time of the day,  
   these arrivals form a Poisson process with rate 30 per hour. The time to land an
airplane is a constant 90 seconds, Determine $E[n]$, $E[n_q]$, $E[r]$, and $E[w]$ for this airport. (Source: BCNN05)

6. Study the effect of pooling servers (having multiple servers draw from a single queue, rather than each having their own queue) by comparing the performance measures for two $M/M/1$ queues, each with rate $\lambda$ and service rate $\mu$, to an $M/M/2$ queue with arrival rate $2\lambda$ and service rate $\mu$ for each server. (Source: BCNN05)

7. Suppose that packet arrivals at a router can be accurately modeled as a Poisson process. The packet arrival rate is 1000 packets/second and the mean time to transmit (i.e., put packet on the outgoing link) a packet is 0.1 milliseconds. Based on this information, answer the following: (Source: Dr. Mary Vernon)
   a. What is the link utilization?
   b. If the packet transmission times are assumed to be exponentially distributed, what is the average time spent by a packet in the router? What is the average queue length at the router?
   c. Repeat part (b) assuming that 20% of the packets are “small” packets with transmission time of 0.01 milliseconds and 80% are “big” packets with transmission time of 0.12 milliseconds.