COE 755

**Queueing Theory**

Spring 2013

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Exam Preparation Problems

(Birth& Death Process + Markovian Queues)

# I. Markovian Queues

# Problem I

# Show that the mean number of customers in an M/M/1/ queue remains unchanged but that the mean time spent in the system decreases by a factor of k when the arrival rate and the service rate are both increased by a factor of k.

# Problem II

# Suppose a single repairman has been assigned the responsibility of maintaining three machines. For each machine, the probability distribution of running time before a breakdown is exponential with a mean of 9 hours. The repair time is also exponentially distributed with a mean of 2 hours.

# Calculate the steady state probability distribution and the expected number of machines that are not running.

# As a crude approximation, it could be assumed that the calling population is infinite so that the input process is Poisson with a mean arrival rate of 3 every 9 hours. Compare the result of part 1 of this question with those obtained from: (i) an M/M/1 model, and (ii) an M/M/1/3 model.

# Problem III

Consider an M/M/s queue with mean service time 1 minute.

1. Assume that s=1. Draw L and W as a function of the arrival rate. Observe how the curve increases as the arrival rate increases.
2. Same as in (a), but assume that s=2, 3, 4.

# II. Birth & Death Process

# Problem I

Consider the birth-and-death process, where λk=akλ (k>0, 0<a<1), and µk=µ (k>1).

* 1. Find the steady-state probability that there are pk customers in the system
  2. Give an expression for p0.