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END SEMESTER EXAMINATION-2015

M.Tech IV Semester

COURSE CODE: 11M1WCI432 MAX. MARKS: 45

COURSE NAME: Performance Evaluation of Networks

COURSE CREDITS: 3 MAX. TIME: 3 HRS

Note: *All questions are compulsory. Carrying of mobile phone during examinations will be treated as case of unfair means.*

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Section A [1 * 9 = 9 Marks]

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a. Suppose that customers arrive at a single-server service station in accordance with a Poisson rate of one per every 12 minutes. The service time is exponential at a rate of one service per 8 minutes. Compute the average number of customers in the system.
b. Prove or disprove: In steady state achieved after several repeated tosses, the coin will behave like an unbiased coin, regardless of the initial state.
c. Draw a state diagram of the DTMC for slotted Aloha.
d. You have been asked to stand in front of JUIT and count the arriving cars that drop the college students. After measuring for over a week, you find that the average number of cars arriving per hour equals the variance of the number of cars per hour. What random variable distribution will accurately model the number of cars arriving per hour?
e. Explain absorbing state with the help of an example.
f. Prove or disprove: For an aperiodic Markov chain, the limits $v_j = \lim_{n\to\infty} p_j(n)$ exist.
g. With the help of diagram explain the CTMC for preventive maintenance model.
h. Explain *Markov reward model* with the help of an example.
i. Consider a client-server system with M clients in which individual think times are exponentially distributed with mean $1/\lambda$ seconds. Assume that service time per request is exponentially distributed with mean $1/\mu$ seconds. The steady state probability that the CPU is idle is _____.

Section B [4.5 * 3 = 13.5 Marks]

1. Consider a queuing system, arrival rate λ, with two servers. The service rates for two servers are μ_1 and μ_2 ($\mu_1 \geq \mu_2$) respectively. Both of the servers share a common queue. The state of the system is defined to be the tuple (n_1, n_2) where $n_1 \geq 0$ denotes the number of jobs in the queue including any at the fastest server, and $n_2 \in \{0,1\}$ denotes the number of jobs at the slower server. Draw a state diagram for the M/M/2 heterogeneous queue. Give the balancing equations in the steady state conditions.

2. Consider a model of a program executing on a computer system with m I/O devices and a CPU. The program will be in one of the m+1 states denoted by 0,1,…m so that in the state 0 the program is executing on the CPU, and in the state i ($1 \leq i \leq m$) the program is performing an I/O operation on device i. Assume that the request for device i occurs at the end of the CPU burst with probability q_i, independent of the past history of the program. The program will finish execution at the end of a CPU burst with probability q_0 so that $\sum_{(i=0 \text{ to } m)} q_i = 1$. We assume that the system is saturated so that on completion of one program, another statistically identical program will enter the system. Model the system with Discrete time Markov Chain.

3. Consider a queuing system with bulk service model. Consider a single-server exponential queuing system in which the server is able to serve two customers at the same time. However, if there is only one customer in line, then she serves that customer by herself. Determine the proportion of customers that are served alone. What is the average number of customers waiting in the system?

Section C [7.5 * 3 = 22.5 Marks]

1.
   a. Consider an M/M/1 queuing system in which the total number of jobs is limited to n owing to a limitation on queue size. Find the steady state probability that an arriving request is rejected because the queue is full. Find the throughput of the system in the steady state.

   b. On a network gateway, measurements show that the packets arrive at a mean rate of 125 packets per second (pps) and the gateway takes about 2 milliseconds to forward them. Using an M/M/1 model, analyze the gateway. What is the probability of buffer overflow if the gateway had only 13 buffers? How many buffers do we need to keep packet loss below one packet per million?

2.
   a. Consider a M/M/m queuing system with arrival rate λ, where $m \geq 1$ servers each with a service rate μ. Compare and contrast two different queuing schemes: separate queues and common queue. The criterion for comparison is average response times $E[R_s]$ and $E[R_c]$ for separate and common queues respectively.

   b. You are given a *k*-out-of-*n* system in which *n* units are active and *m* units are in a standby status. There is a single repairperson with repair rate μ. Give a queuing network that will model the behavior of this system.

3. Write short notes on the following.
   a. Hypo-exponential distribution
   b. PASTA (Poisson arrivals see time averages)
   c. Birth and Death process

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