Breadth Screening Exam
Modeling and Analysis of Computer Systems

University of Wisconsin
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Directions: Answer four of the five questions below. Define the notation you use, the assumptions you make, and/or explain your reasoning in deriving each answer whenever appropriate.

Question 1

Consider a *closed* queueing network consisting of just one single-server FCFS center. Service times are independent and identically distributed with mean $E(X)$ and distribution function $F_X(x)$. What is the throughput and mean response time as a function of the customer population, N?

Question 2

(a) Consider a queueing network with three queues in tandem (*i.e.*, three queues connected serially). Suppose that the service rates of the three servers, μ_1, μ_2, and μ_3, are constrained such that $\mu_1 + \mu_2 + \mu_3 = \mu$. For what values of the three service rates (in terms of μ) is the system response time minimized? Explain why the response time is minimized at these values.

(b) For the queueing network in part (a), will minimizing the response time have greater impact if the queueing network is open or if it is closed? Explain.

Question 3

Give the Mean Value Analysis equations for mean response time, throughput, and mean queue length at a FCFS queue in an open single-class queueing network. Give the corresponding equations for a PS queue in the same network. Simplify the equations for mean queue length, to get an expression in terms of the input parameters of the model.

Question 4

Consider the single-class m-server queue, in which the rate of each server is $\frac{\mu}{m}$. If the arrival process is Poisson and service demand is exponentially distributed, then mean response time is minimized at $m = 1$. For what workload characteristics might mean response time be minimized at some value $m > 1$? Under these circumstances, suggest a reasonable hypothesis for how mean response time might vary, qualitatively, with m. Explain the reasoning behind your hypothesis.

Question 5

(a) What is the difference between a *discrete time* model and a *discrete event* model?

(b) Can two events take place at the same simulation time in a discrete event model? If the answer is **no** explain why, if the answer is **yes**, explain how the event scheduler of a simulation system should decide which event should be executed first.

(c) When does a subset of the descriptive variables of a discrete event model constitute a set of state variables for the model?

(d) What is the difference between an *incomplete* model and an *inconsistent* model?