The University of British Columbia
Computer Science 405
Practice Midterm

1. (15) Describe the difference between:

    a. (3) Discrete time and continuous time simulation.

    b. (3) Real-time and offline simulation.

    c. (3) An event and an event notice.

    d. (3) An activity and a delay.

    d. (3) A system and a state.

2. (15) Briefly explain these concepts:

   a. (3) Simulation by process interaction.

   b. (3) Central limit theorem.

   c. (3) Monte Carlo simulation.

   d. (3) Poisson process.

   e. (3) A critical queuing system.

3. (8) Would you recommend to perform a simulation prior to implementing the ideas below? Briefly argue why or why not.

   a. A large supermarket considers firing 25% of its checkout cashiers to save money.

   b. A pharmaceutical company considers testing a new drug which supposedly slows aging on humans.

   c. An architect has come up with a plan for a concert hall in the form of a pyramid. There is some concern this will affect the acoustics.

   d. An airplane manufacturer thinks a jet in the shape of a "W" may have better performance than a "V" shaped jet and considers spending $100000000 on developing such a machine.

4. (30) People arrive at a self-service cafeteria at the rate of one every 30 ± 20 seconds. (This notation indicates a uniform distribution over the interval [10 50].) 40% go to the sandwich counter, where one worker makes a sandwich in 60 ± 30 seconds. The rest go to the main counter, where one server spoons the prepared meal onto a plate in 45 ± 30 seconds. All customers must pay a single cashier, which takes 25 ± 10 seconds. For all customers, eating takes 20 ± 10 minutes. After eating, 10% of the people go back for dessert, spending an additional 10 ± 2 minutes in the cafeteria.

   Construct an event scheduling simulation of this situation, appropriate for measuring the average time spent in the cafeteria per customer. The simulation will have to run for 24 hrs. Define the state space variables. Define the event set. Provide the rules for processing each event. Define the initial state and the initialization of the future event list. You don't have to explain the event scheduling algorithm itself.

5. (10)

a. (5) How can we generate random numbers on $[-1\ 1]$ with pdf $P(x) = \frac{3}{2}x^2$ from a uniform random number generator on $[0\ 1]$?

b. (5) Let r be random numbers uniform on $[0\ 1]$. What is the pdf $P(x)$ of $x = 1/r$? Does it have the correct property of a pdf, namely $\int_{-\infty}^{\infty} P(x)dx = 1$?

6. (12) Customers arrive at a store according to a Poisson process. The mean interarrival time is 2 minutes.

   a. (3) What is the probability that at least 2 customers arrive during a time interval of 4 minutes?

   b. (3) The first customer arrived after 1 minute. What is the probability that the second customer arrives less than 1 minute later?

c. (3) The first customer arrived after 10 minutes. What is the probability that the second customer arrives less than 1 minute later?

d. (3) After the store has been open for 8 hours, the number of customers n are counted. What is the probability distribution for n? Give a formula.

7. (10) A random variable x can take on discrete values (negative integers and 0) as well as continuous values (positive real numbers). It can be modeled by a pdf $P(x)$ for the continuous values and a pmf $p(x)$ for the discrete values.

   a. (5) Write down a condition that states that the chance of x taking on *any* value is 1.

   b. (5) Write down a formula for the expectation value $< x >$ of x.