B.Sc. Engg. CSE 5th Semester

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION **WINTER SEMESTER, 2017-2018**

DURATION: 3 Hours **FULL MARKS: 150**

CSE 4549: Simulation and Modeling

Programmable calculators are not allowed. Do not write anything on the question paper.

There are 8 (eight) questions. Answer any 6 (six) of them.

Figures in the right margin indicate marks.

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1. Jobs arrive at a single-CPU computer facility with interarrival times that are IID exponential random variables with mean 1.5 minutes. Each job specifies upon its arrival the maximum amount of processing time it requires, and the maximum times for successive jobs are IID exponential random variables with mean 1.1 minutes. However, if m is the specified maximum processing time for a particular job, the actual processing time is distributed uniformly between $0.77m$ and $1.04m$. The CPU will never process a job for more than its specified maximum; a job whose required processing time exceeds its specified maximum leaves the facility without completing service. You are asked to develop simulation program to study the computer facility until 5000 jobs have left the CPU assuming that jobs in the queue are ranked in increasing order of their specified maximum processing time.
The system is studied to compute the average and maximum delay in the queue of jobs, the proportion of jobs that are delayed in the queue more than 4 minutes.
   a) What are the state variable(s) and output variable(s) for this simulation model? 6
   b) Identify the set of events for this simulation model. Assume that the simulation terminates by a terminating event. 5
   c) Write down the state equations for this simulation model. 6
   d) Write down the state space for this simulation model. 3
   e) Write down the output equations for this simulation model. 5

2. For the scenario given in Question 1, answer the followings:
   a) Draw a sample path of the system for a few jobs showing the change of the state variable(s) over time. 15
   b) Draw separate flow charts of the event routines (i.e. the event handler functions) for any two of the system events. 10

3. A manufacturing system contains m machines, each subject to randomly occurring breakdowns. A machine runs for an amount of time that is an exponential random variable with mean 8 hours before breaking down. There are s (where s is fixed, positive integer) repairmen to fix broken machines, and it takes one repairmen an exponential amount of time with mean 1.5 hours to complete the repair of one machine; no more than one repairmen can be assigned to work on a broken machine even if there are other idle repairmen. If more than s machines are broken down at a given time, they form a FIFO 'repair' queue and wait for the first available repairmen. Further, a repairmen works on a broken machine until it is fixed, regardless of what else is happening in the system. Assume that it costs the system \$40 for each hour that each machine is broken down and \$20 an hour to employ each repairmen. (The repairmen are paid an hourly wage regardless of whether they are actually working.) Assume that $m = 3$, but the simulation model might accommodate a value of m as high as 20 by changing an input parameter.

The system is studied for 500 hours for each of the employment policies $s = 1, 2,$ and 3 to determine which policy results in the smallest expected average cost per hour. Assume that at time 0 all the machines have just been freshly repaired.

a) Write down the goals and objectives of the simulation. 3

b) What are the state variable(s) and output variable(s) for this simulation model? 6

c) Identify the set of events for this simulation model. Assume that the simulation terminates by a terminating event. 4

d) Write down the state equations for this simulation model. 6

e) Write down the output equations for this simulation model. 6

4. a) Mention few potential application areas of simulation. 5

b) Compare and contrast *Input-output modeling* and *State Space modeling.* 6

c) Describe the properties of *Discrete Event Systems* along with few example scenarios 7

d) Discuss the fundamental limitation of the *Midsquare* method as a random-number generator with appropriate example. 7

5. a) Consider the multiplicative congruential generator under the following circumstance: 10

$$a = 11,\ m = 16,\ X_0 = 7$$

Generate enough values to compute a cycle. What inferences can be drawn? Is maximum period/cycle achieved?

b) Without actually computing any Z_i 's, determine which of the following mixed linear congruential generator (LCGs) have the full period: 15

i. $Z_i = (13\, Z_{i-1} + 13)(mod\ 16)$

ii. $Z_i = (4951\, Z_{i-1} + 247)(mod\ 256)$

6. a) When the basketball player Wilt Chamberlain shot two free throws, each shot was equally likely either to be good (g) or bad (b). Each shot that was good was worth 1 point. Let X denote the number of points that he scored. 15

i. What is the probability mass function of random variable X?

ii. Find and sketch the cumulative distribution function of random variable X.

iii. What is the expected value of random variable X?

iv. What is the variance of random variable X?

b) Suppose that 7.3, 6.1, 3.8, 8.4, 6.9, 7.1, 5.3, 8.2, 4.9 and 5.8 are 10 observations from a distribution with unknown mean μ. Approximate the 95 percent confidence interval for μ. 10

7. a) Develop a random variate generator using the composition method for a random variable with the following distribution: 10

$$f(x) = \begin{cases} 2 - a - 2(1-a)x, & 0 \le x \le 1 \\ 0, & Otherwise. \end{cases}$$

b) Develop a random variate generator using the acceptance-rejection method for a random variable with the following distribution: 10

$$f(x) = 20x\,(1-x)^3, \quad 0 < x < 1$$

c) Generate 3 random variates using this generator. Following random numbers are available 5

0.964, 0.152, 0.759, 0.365, 0.462, 0.785, 0.218, 0.763, 0.568, and 0.631

8. Assume that the numbers of items demanded per day from an inventory on different days are IID random variables and the data in the following Table are those demand size on 45 different days. Analyze the data performing the following steps:

0	5	4	1	3
3	2	3	6	7
1	2	1	6	1
3	3	2	2	3
1	2	5	4	5
3	2	2	6	3
4	2	3	2	2
2	4	2	1	5
1	3	6	0	8

a) Find the following summary statistics of data – coefficient of variation and skewness. Also from the summary statistics comment on the possible distribution. 8

b) Make the histogram of the data. 7

c) From the histogram determine the fitted distribution of the data. 5

d) Find the parameter value(s) of the fitted distribution. 5