KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2009/2010

SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE (COMPUTER ENGINEERING)

SCS 306: SIMULATION AND MODELING

DATE: Friday 16th April, 2010 **TIME:** 11.00 a.m. – 1.00 p.m.

INSTRUCTIONS

Answer Question ONE and any other TWO Questions.

QUESTION 1 (30 marks)

(a) (i) Why is the concept of model basic to the technique of simulation? [2 marks]

(ii) What is the difference between observation-based variable and Time-based variable?

Give two examples of each type of variable. [4 marks]

(b) The English test scores for 2009 senior class at Light Academy are normal with a mean 27 points and a standard deviation of 3 points. Consider six seniors from that class, use the Box Muller method to determine the mean and the standard deviation of the sample (Use Random numbers from table 18.1 column 1) [5 marks]

(c) Jobs arrive at a workshop according to a Poisson distribution with a mean of 10 jobs per day. Received jobs are assigned to the three machining centers of the workshops on a strict rotational basis.

Determine one sample of interval between the arrival of two jobs at the first machine center. [5 marks]

For this question use random number in table 18.1 column 2.

(d) Suppose that the equation of a circle is $(x-2)^2 + y^2 = 30.25$

Define the corresponding pdfs f(x) and f(y) and then show how a sample point (x,y) inside or on the circle can be determined using (0,1) random pair (R_1, R_2).

[2 marks]

(e) Electronic components are received randomly at a one-machine repair workshop. The time needed to repair one component is uniform between 2.1 and 3.6 hours. The time between arrivals is exponential with a mean 2.5 hours. Assume the first component (1^{st} job) arrives at time 0, determine the arrival and departure of the first 3 jobs using the (0, 1) random numbers in column 3 of table 18.1.

[5 marks]

(f) Write a program to simulate movement of vehicles at a traffic light. Traffic may flow either East to West or North to South: no turning is allowed. It is known that:

i. Between 5 and 15 vehicle arrive every minute from North.
ii. Between 10 and 30 vehicles arrive every minutes for north;
iii. 20 vehicle can cross the intersection going West in 15 seconds;
iv. 30 vehicle can cross the intersection going south in 15 seconds;

Perform several simulations of one hour each. For each simulation, vary the green-light' time as follows: [4 marks]

E ⟶ W	N ⟶ S (Times in seconds)
30	30
25	35
20	40
15	45
10	50

For every minute, print the queue length in each direction just before the light turns green

[3 marks]

QUESTION 2 (20 MARKS)

a) The demand for an expensive spare part of a passenger jet is 0, 1, 2 or 3 units per week with prob 0.15, 0.2, 0.4 and 0.25 respectively.

The airline maintenance department starts operation with a stock of 5 units and will being the stock level back to units immediately it drops below 3 units.

Device the procedure for determining the demand sample. [5 marks]

How many weeks will elapse until the third replenishment occurs. [5 marks]

For this question, use random number in column 4 table 18.1

b) Show how a random sample can be obtained tram the following geometric distribution. [6 marks]

$f(x) = p(1-p)^x$, $x = 0, 1, 2, \ldots\ldots\ldots..$

the parameter x is the number of (Bernoulli) failures until a success occurs and p is the probability of success, $0 < p < 1$

Generate two sample for $p = 0.6$ using the random numbers in column 5 of table 18.1. [4 marks]

QUESTION 3 (20 MARKS)

(a) Show how a random sample can be obtained from the Weibull distribution whose pdfis defined as $f(x) = \alpha\beta^{\alpha}\ X^{\alpha\text{-}1}\ e^{-(x/\beta)\alpha}$, $x > 0$

Where $\alpha > 0$ is the shape parameter and $\beta > 0$ is the scale parameter.

[10 marks]

(b) Consider a probability distribution that consists of a rectangle franked on the left ‘and on the right sides by two symmetrical right triangle s. The respective ranges for the triangle on the left, the rectangle and the triangle on the right are (a,b), (b,c) and (c,d), a< b< c< d.

Each triangle has the same height as the rectangle.

(i) Develop a sampling procedure [6 marks]

(ii) Determine 2 sample with (a, b, c, d) = (1, 2, 4, 6) using the random numbers in column table 18.1. [4 marks]

QUESTION 4 (20 MARKS)

(a) The following table represents the variation in number of waiting customers in a queue as a function of the simulation time.

Simulation time T (Hours)	No of waiting Customers
$0 < T \leq 3$	0
$3 < T \leq 4$	1
$4 < T \leq 6$	2
$6 < T \leq 7$	1
$7 < T \leq 10$	0
$10 < T \leq 12$	2
$12 < T \leq 18$	3
$18 < T \leq 20$	2
$20 < T \leq 25$	1

Compute the following measures of performance

i. The average length of the queue. [5 marks]

ii. The average waiting time in the queue for those who must wait.
(add illustrative diagrams) [5 marks]

(b) the interarrival time of customers at hair care is described by the following distribution:

$F_1(t) = k_1/t,\ 12 \leq t \leq 20$

The time to get a haircut is represented by the following distribution:

$F_2(t) = k_1/t^2,\ 18 \leq t \leq 22$

The constant k1 and k2 are determined such that f1 (t) and f2 (t) are probability density functions.

Use the acceptance rejection method (and the random numbers in 4th column of table 18.1 to determine when the first customer arrives at T = 0

(Add illustrative diagrams/graphs) [10 marks]

QUESTION 5 (20 MARKS)

a) The North Star Company runs a large machine that contains three identical vacuum tubes are a major cause of down time. The current practice is to replace these tubes when they fail. A proposal has been made that all three tubs be replaced whenever any one of them fails in order to reduce the frequency with which the equipment must be shut down. The objective is to compare these alternatives on a cost basis. The vacuum tubes themselves cost $400 each and installation costs are $100 for replacing one tube, $160 for two and $200 for three. Down times costs are estimated at $900 per hour and the time to replace one, two or three tubes is 30 mins, 50 mins and 60 mins respectively.

Historical data indicates that the time to failure of this type of tube has a distribution as shown below:

Time to failure - weeks	7	8	9	10	11	12
Probability	0.1	0.1	0.2	0.3	0.2	0.1

b) Using the information above and by simulating the operation of this machine over a period of one year, estimate the costs of maintenance under each of the following proposals.

i. Replace each tube as it fails. [8 marks]

ii. Replace all three after any one fails. [8 marks]

Use the following random digits

Random digits										
Tube 1	8	0	0	1	7	2	1	9	9	7
Tube 2	8	8	8	4	8	5	2	3	7	0
Tube 3	5	7	2	0	2	8	6	2	8	5

c) Why are estimates, found in, not very reliable and how would you improve them?

[4 marks]

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