NEW SCHEME

CS65

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Sixth Semester B.E. Degree Examination, July/August 2005

Computer Science Engineering

System Simulation and Modeling

Time: 3 hrs.] [Max.Marks : 100

Note: *1. Answer any FIVE full questions.*
2. Statistical tables may be supplied.

1. (a) With an aid of flow diagram, explain various steps in a simulation study. (10 Marks)

(b) Demand for midgets follows the following probability distribution : (10 Marks)

Daily demand	0	1	2	3	4
Probability	0.33	0.25	0.20	0.12	0.10

Stock is examined every 7 days (the plant is in operation every day) and if the stock level has reached 6 units, or less, an order for 10 midgets is placed. The lead time (days until delivery) is probabilistic and follows the following distribution

Lead time (days)	1	2	3
Probability	0.3	0.5	0.2

When the simulation begins, it is the beginning of the week, 12 midgets are on hand, and no orders have been backordered. (Back ordering is allowed). Simulate 6 weeks of operation of this system. Determine different parameters to analyse the system.

2. (a) With an illustrative example, explain the simulation of queuing system. (10 Marks)

(b) Prepare a table using event scheduling /time advance algorithm, until the clock reaches time 15, using the interarrival and service times given below in the order shown. The stopping event will be at time 30. (10 Marks)

Interval times	4	5	2	8	3	7
Service times	5	3	4	6	2	7

3. (a) Explain he linear congruential method for generating random numbers and generate three random members using above method with $X_0 = 27$, $a = 17$, $c = 43$ and $m = 100$. (10 Marks)

(b) Briefly explain the various tests used for testing the random numbers for their desirable properties. (10 Marks)

4. (a) What is acceptance-Rejection technique? Generate three Poisson variates with mean $\alpha = 0.2$. (10 Marks)

(b) Enlist the steps involved in development of a useful model of input data. (4 Marks)

(c) Describe how the method of histograms can be used to identify the shape of a distribution. (6 Marks)

Contd.... 2

Employee	Time	Employee	Time	Employee	Time
1	1.88	17	0.26	35	1.10
2	0.54	18	0.63	36	0.24
3	1.90	19	0.36	37	0.26
4	0.15	20	2.03	38	0.45
5	0.02	21	1.42	39	0.17
6	2.81	22	1.28	40	4.29
7	1.50	23	0.82	41	0.80
8	0.53	24	2.16	42	5.50
9	2.62	25	0.05	43	4.91
10	2.67	26	0.04	44	0.35
11	3.53	27	1.49	45	0.36
12	0.53	28	0.66	46	0.90
13	1.80	29	2.03	47	1.03
14	0.79	30	1.00	48	1.73
15	0.21	31	0.39	49	0.38
16	0.80	32	0.34	50	0.48
		33	0.01		
		34	0.10		

(10 Marks)

(b) Write short note on any TWO of the following :

i) Process oriented simulation tools

ii) Concept of CPU simulation

iii) Three step process used in validation process

iv) Memory simulation

(2×5=10 Marks)

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NEW SCHEME

CS65

Reg. No.

Sixth Semester B.E. Degree Examination, January/February 2006

Computer Science and Engineering

System Simulation and Modelling

Time: 3 hrs.) (Max.Marks : 100

Note: *1. Answer any FIVE full questions.*
2. Tables A.8 of K.S. critical values and A.6 A.3 of cumulative normal distribution are to be supplied from the discrete - event simulation books.

1. (a) Explain the different steps involved in a simulation study. **(8 Marks)**

   (b) Describe a queuing system with respect to arrival and service mechanisms, system capacity, queue discipline, flow diagrams of arrival and service events. **(12 Marks)**

2. (a) Differentiate between discrete and continuous system. **(5 Marks)**

   (b) A small shop has one check out counter. Customers arrive at this counter at random from 1 to 10 minutes apart. Each possible value of inter arrival time has the same probability of occurrence equal to 0.10. The service times vary from 1 to 6 minutes with probability shown below.

Service time	1	2	3	4	5	6
Probability	0.05	0.10	0.20	0.30	0.25	0.10

   Develop simulation table for 10 customers. Find i) average waiting time ii) average service time iii) average time customer spends in the system. Take random digits for arrivals as
   91, 72, 15, 94, 30, 92, 75, 23, 30 and for service times are
   84, 10, 74, 53, 17, 79, 91, 67, 89, 38 sequentially. **(15 Marks)**

3. (a) What are the major concepts in discrete - event simulation? **(5 Marks)**

   (b) One company uses 6 trucks to haul manganese ore from Hospet to its industry. There are two loaders, to load each truck. After loading, a truck moves to the weighing scale to be weighed. The queue discipline is FIFO. When it is weighed a truck travels to the industry and returns to the loader queue. The distributions of loading time, weighing time and travel time are as follows :

Loading times	:	10	5	5	10	15	10	10
Weigh times	:	12	12	12	16	12	16	
Travel times	:	60	100	40	40	80		

   Calculate the total busy time of both loaders, of the scale average loader and scale utilization. Assume 5 trucks are at the loaders and one is at the scale at time '0' Stopping time $T_E = 64min.$ **(15 Marks)**

4. (a) Mention the important considerations for the selection of routines to generate random numbers. **(5 Marks)**

   (b) Explain combined linear congruential generators for developing random numbers. **(5 Marks)**

Contd.... 2

(c) Use the linear congruential method to generate a sequence of four two-digit random numbers, with $X_0 = 27$, $a = 17$, $C = 43$ and $m = 100$. What is the effect of FIFTH two digit random integer on the above numbers? **(10 Marks)**

5. (a) The sequence of numbers 0.54, 0.73, 0.98, 0.11, 0.68 has been generated. Use the Kolmogonov - Smirnov test with $\alpha = 0.05$ to determine if the hypothesis that the numbers are uniformly distributed on the interval $[0, 1]$ can be rejected. Compare $F(X)$ and $S_N(X)$ on a graph. **(8 Marks)**

(b) The 50 two digit values are given below.

0.34	0.90	0.25	0.89	0.87	0.44	0.12	0.21	0.46	0.67
0.83	0.76	0.79	0.64	0.70	0.81	0.94	0.74	0.22	0.74
0.96	0.99	0.77	0.67	0.56	0.41	0.52	0.73	0.99	0.02
0.47	0.30	0.17	0.82	0.56	0.05	0.45	0.31	0.78	0.05
0.79	0.71	0.23	0.19	0.82	0.93	0.65	0.37	0.39	0.42

Can the hypothesis that the numbers are independent be rejected on the basis of the length of runs above and below the mean. Take $\alpha = 0.05$. **(12 Marks)**

6. (a) Explain the inverse transformation technique of producing random variates for exponented distribution. **(5 Marks)**

(b) Generate 5 poison variates with mean $\alpha = 0.25$. **(5 Marks)**

(c) Generate 10 three digit random integers using multiplicative congruential method with $X_0 = 117$, $a = 43$, $m = 1000$. **(10 Marks)**

7. (a) Explain the Chi-square goodness of fit test to reject or accept a candidate distribution. **(5 Marks)**

Explain the types of simulation with respect to output analysis. Give at least two examples. **(10 Marks)**

(c) Write a note on model building, verification and validation. **(5 Marks)**

8. (a) The time required for 50 different employees to compute and record the number of hours worked during the week was measured with the following results in minutes. Use Chi-square test, to test the hypothesis that these service times are exponentially distributed. Take the number of class intervals as $k = 6$, $\alpha = 0.05$.

Contd.... 3

USN

NEW SCHEME

Sixth Semester B.E. Degree Examination, Dec.06 / Jan.07
Computer Science & Engineering
System Simulation & Modeling

Time: 3 hrs.] [Max. Marks:100

Note: ***1. Answer any FIVE full questions.***
2. Use of statistical tables is permitted.

1 a. Define simulation. When simulation is the appropriate tool? **(07 Marks)**

b. Differentiate between the following terms :
i) System and system environment.
ii) Endogenous and exogenous activity.
iii) Event and activity. **(06 Marks)**

c. In brief, explain the steps in simulation study. **(07 Marks)**

2 a. Explain simulation of queueing system. **(08 Marks)**

b. Dr. XYZ is a dentist who schedules all patients for 30 minute appointments. Some of the patients take more or less than 30 minutes depending on the type of dental work to be done. The following table shows the various categories of work, their probabilities and time actually needed to complete the work.

Categories	Filling	Crown	Cleaning	Extraction	Checkup
Time required (min)	45	60	15	45	15
Probability of category	0.40	0.15	0.15	0.10	0.20

Simulate the dentist's clinic for 3 hours and determine the average waiting of time for patients and total idle time for doctor. Assume that patients show up at the clinic at exactly their scheduled arrival time starting at 8.00 a.m. Use following random numbers for handling the above problem.
40 82 11 34 25 66 **(12 Marks)**

3 a. Write discrete-event model for single channel queue. **(06 Marks)**

b. Prepare simulation table using event scheduling algorithm for the arrival of 8 customers using inter-arrival and service times given below, **(14 Marks)**

Interval times	4	7	8	1	4	2	5	3	1	4
Service times	5	1	2	3	4	9	5	8	6	1

4 a. Define a random number. Explain statistical properties of random numbers. **(03 Marks)**

b. Using multiplicative congruential method generate 6 random numbers. **(03 Marks)**

c. Test the following sequence of numbers for uniformity by using chi-square test and independence by using poker test. ($\alpha = 0.05$) **(14 Marks)**

0.594	0.928	0.515	0.055	0.507	0.351	0.262	0.797	0.788	0.442
0.097	0.798	0.227	0.127	0.474	0.825	0.007	0.182	0.929	0.852

Contd...2

5 a. Derive an expression for random variate for exponential distribution. (05 Mar
b. Lead times have been found to be exponentially distributed with mean 3.7 da
Generate 5 random lead times from this distribution. (03 Mar
c. How do you identify the distribution with data? Explain histogram method.
(06 Mar
d. Explain Kolmogorov-Smirnov goodness of fit test. (06 Mar

6 a. Differentiate between verification and validation of simulation models. (04 Mark
b. Briefly explain 3-step approach that aids in the validation process. (06 Mark
c. Explain output analysis for terminating simulation. (10 Mark

7 a. Explain about simulation tools. (10 Marks
b. Explain CPU simulation. (10 Marks

8 Write short notes on,
a. Simulation of inventory system.
b. Time advance algorithm.
c. Runs tests.
d. Acceptance – rejection technique. (20 Marks)

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USN

NEW SCHEME

Sixth Semester B.E. Degree Examination, July 2007
Computer Science and Engineering
System Simulation and Modeling

Time: 3 hrs.] [Max. Marks:100

Note : *1. Answer any FIVE full questions.*
2. The statistical tables A.5 and A.6 of "Discrete Event System Simulation" – Jerry Banks book can be provided.

1 a. What is system and system environment? Explain the components of a system with examples. **(10 Marks)**

b. What are the advantages of simulation? **(05 Marks)**

c. Discuss the types of models of a system. **(05 Marks)**

2 a. Explain the calling population, service time and service mechanisms of a queuing system. **(08 Marks)**

b. A baker bakes 30 dozens of bread loafs each day. Probability distribution of customers is in table1. Customers order 1, 2, 3 or 4 dozens of bread loafs according to the distributions given in table 2. Assume that on each day all the customers order same dozens of bread loafs. The selling price is Rs.5.4/dozen and making cost is Rs.3.5/dozen. The left over bread loafs will be sold for half price at the end of day. Based on 5 days simulation, calculate the profit of the baker. Instead of 30 dozens, if 40 dozens are baked per day will it be more profitable?

Table 1: Probability distribution of customers.

Number of customers/day	8	10	12	14
Probability	0.35	0.30	0.25	0.10

Table 2: Probability distribution of dozens ordered

Number of dozens/ customers	1	2	3	4
Probability	0.40	0.30	0.20	0.10

Random digits for customers -	50	61	73	24	96
Random digits for dozens -	5	3	7	0	8

(12 Marks)

3 a. What are the two categories of activities? Explain the three phases of activity scanning approach. **(06 Marks)**

b. Prepare a table using event scheduling time advance algorithm for a check out counter. Stop the simulation when fifth customer departs. Estimate mean response time and proportion of customers who spent 4 or more minutes in the system. Event notice must have event type, time and customer number. **(14 Marks)**

Inter arrival times	8	6	1	8	3	8	....

Service times	4	1	4	3	2	4	....

Contd.... 2

4 a. What is the role of maximum density and maximum period in generation of random numbers? With given seed 45, constant multiplier 21, increment 49 and modulus 40, generate a sequence of five random numbers. **(10 Marks)**

b. For the following sequence can the hypothesis that the numbers are independent can be rejected on the basis of length of runs up and down when $\alpha = 0.05$.

0.34	0.90	0.25	0.89	0.87	0.44	0.12	0.21
0.46	0.67	0.83	0.76	0.79	0.64	0.70	0.81
0.94	0.74	0.22	0.74	0.96	0.99	0.77	0.67
0.56	0.41	0.52	0.73	0.99	0.02	0.47	0.30
0.17	0.82	0.56	0.05	0.45	0.31	0.78	0.05
0.79	0.71	0.23	0.19	0.82	0.93	0.65	0.37
0.39	0.42						

(10 Marks)

5 a. A sequence of 1000 four digit numbers has been generated and analysis indicates the following combinations and frequencies:

Combination i	Observed frequency O_i
Four different digits	565
One pair	392
Two pairs	17
Three like digits	24
Four like digits	2

Based on Poker test check whether the numbers are independent. Use $\alpha = 0.05$. **(10 Marks)**

b. Explain inverse transform technique for exponential distribution. Show the corresponding graphical interpretation. **(10 Marks)**

6 a. Explain the acceptance – rejection technique. Generate 5 Poisson's variates with mean $\alpha = 0.25$. **(10 Marks)**

b. Explain Chisquare goodness of fit test. Apply it to Poisson assumption with $\alpha = 3.64$, Data size = 100 and

Observed frequency O_i 12 10 19 17 10 8 7 5 5 3 3 1. **(10 Marks)**

7 a. With examples explain output analysis. **(10 Marks)**

b. Explain with a neat diagram model building, verification and validation. **(10 Marks)**

8 Write short notes on:

a. Memory simulation
b. High level computer system simulation
c. Point estimation
d. Errors while generating pseudo random numbers. **(20 Marks)**

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CS65

Sixth Semester B.E. Degree Examination, Dec. 07 / Jan. 08
System Simulation and Modelling

Time: 3 hrs. Max. Marks:100

Note : *1. Answer any FIVE full questions.*
2. Random number Table and statistical Table book may be supplied.

1 a. What is Simulation? State any four merits and demerits of simulation. (10 Marks)
b. Differentiate the following with examples : i) Static and Dynamic model ii) Discrete and continuous system iii) Deterministic and Stochastic model. (06 Marks)
c. State any two situations where simulation can be used with justification. (04 Marks)

2 a. Briefly explain the simulation of Inventory system and the various measures used to evaluate the system. (08 Marks)
b. Prepare a simulation table for a single channel queuing system using event scheduling time advance algorithm, until the clock reaches time 21, using the inter arrival timer and service timer given below in the order shown. The stopping event will be at time 30.

Inter arrival time (mins)	8	6	1	8	3	8
Service time (mins)	4	1	4	3	2	4

Compute the cumulative statistics for the following :
i) Busy time of server
ii) Maximum Que length.
iii) Total number of customers who spend 4 or more minutes at the counter.
iv) Total number of departures upto the current simulation time. (12 Marks)

3 a. Define any four concepts in discrete event simulation with suitable examples. (04 Marks)
b. Use the multiplicative conginential method to generate a sequence of four three digit random integers for $X_0 = 117$, $a = 43$ and $m = 1000$. (06 Marks)
c. The sequence of numbers 0.54, 0.73, 0.98, 0.11 and 0.68 has been generated. Use the Kolmogorav - Smirnov test with $\alpha = 0.05$ to determine if the hypothesis that its numbers are uniformly distributed on the interval (0,1) can be rejected. (10 Marks)

4 a. Lead times have been found to be exponentially distributed with mean 3.7 days. Generate five random lead time variates from this distribution using Inverse transform technique. Take $R_1 = 0.01$, $R_2 = 0.13$, $R_3 = 0.35$, $R_4 = 0.65$, $R_5 = 0.53$. (10 Marks)
b. Consider discrete distribution with DMF given by $P(x) = \frac{2x}{k(k+1)}$, $x = 1, 2, \ldots k$. Find an expression for finding the values of Random variates 'X' corresponding to Random number 'R'. (10 Marks)

5 a. Explain in detail the four important steps of development of useful 'Input Model'. (10 Marks)

5. (a) Explain the chi-square goodness of fit test to accept or reject a candidate distribution. (10 Marks)

   (b) Briefly explain the three-step approach, that aids in the validation process. (10 Marks)

6. (a) Discuss how the performance of a simulated system is measured and estimated, with suitable illustrations. (10 Marks)

   (b) With illustrative examples, describe the output analysis for steady state simulations. (10 Marks)

7. (a) Briefly explain the process oriented and event oriented simulation tools. (10 Marks)

   (b) Discuss the concepts of high-level computer simulations by sketching a simulation model at a computer system that services requests from the WWW (World wide Web). (10 Marks)

8. Write short notes on the following :

   (a) Advantages and disadvantages of simulation

   (b) World views

   (c) Model building

   (d) Memory simulation.

(4 × 5=20 Marks)

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b. Discuss how the sample mean is estimated under Normal and POISSON distributions. **(10 Marks)**

6 a. Explain in detail about the model building , verifying and validation in the model building process through a diagram. **(08 Marks)**

b. The demand and lead time for product 'X' are as follows :

Demand	83	103	96	92	109	106	104	112	97	116
Lead time	4.3	6.5	6.3	4.5	7.3	5.8	6.9	6.9	6.0	6.9

Test whether lead time and demand are dependent or not . Comment. **(12 Marks)**

7 a. Discuss in brief the output analysis for steady – state simulations. **(08 Marks)**

b. Explain the C++ code for generating MPP trace. **(12 Marks)**

8 a. Discuss about point estimation and interval estimation. **(08 Marks)**

b. Explain in detail the changes in the computerized representation of the system under I-O transformation. **(12 Marks)**

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CS 65

USN

NEW SCHEME

Sixth Semester B.E. Degree Examination, July 2006
CS
System Simulation and Modeling

Time: 3 hrs.] [Max. Marks:100

Note: 1. *Answer any FIVE full questions.*
2. *Random Number Table and Statistical Table book may be supplied.*

1 a. Explain the concept of system with any one live example. **(05 Marks)**
b. Discuss the various ways of modeling of a system. **(05 Marks)**
c. Briefly discuss about the various steps in a simulation study through an example. **(10 Marks)**

2 a. Discuss in detail about the various elements of any general queuing system. Further explain the need for simulation in this environment and the various measures used to evaluate the system. **(08 Marks)**
b. A news paper seller buys news papers for Rs 3.3 each and sells them for Rs 5 each. Papers not sold at the end of the day are sold as scrap for Rs. 0.5 each. Papers can be purchased in bundles of only 10. There are three types of news days viz.: "Good", " Fair" and "poor" with probabilities 0.35, 0.45 and 0.20 respectively. Determine the optimal number of papers by simulating demands for 20 days. **(12 Marks)**

3 a. Explain in detail the various steps used in Time – Advance algorithm in a discrete event simulation using a live example. **(06 Marks)**
b. Six trucks are used to haul coal from a mine to the rail road. There are two loaders and one weighing scale. After loading, a truck immediately moves to the scale for weighing and servicing is as per FIFS. After weighing a truck , begins a travel time and then afterwards return to the loader queue with the distribution of travel time as:

Travel Time in minutes (mts)	40	60	80	100
Probability	0.4	0.3	0.2	0.1

Further the distribution of loading time and weighing time are as :

Loading Time in mts.	5	10	15
Probability	0.3	05	0.2

Weighing Time in mts.	12	16
Probability	0.7	0.3

Simulate the system to estimate the loader and scale utilization. **(14 Marks)**

4 a. Discuss in brief the various problems or errors which occur while generating Pseudo random numbers. **(10 Marks)**
b. Explain the Two "Goodness of Fit" tests by using an appropriate example. **(10 Marks)**

5 a. Explain how and what for the inverse transform technique is used to sample from two discrete distributions. **(10 Marks)**

Contd...2

b. The number of vehicles arriving at an intersection in a 5 minute period between 7:00 AM and 7:05 AM was monitored for 5 working days over a 20 week period. The Table below gives the data.

Arrivals per period X_i	0	1	2	3	4	5	6	7	8	9	10	11
Frequency in number of days	12	10	19	17	10	8	7	5	5	3	3	1

i) Construct frequency table and find mean.
ii) Assume Poisson distribution and estimate the parameter 'α'.
iii) Check for Goodness of fit using Chi^2 – test for significance level of 5%. **(10 Marks)**

6 a. Explain three step approach for validation process as formulated by Nayler and Finger. **(12 Marks)**

b. Explain Initialization Bias in output analysis of steady state simulation. **(08Marks)**

7 a. Briefly explain the sequence of pipeline stages in ILP – CPU simulation of computer systems. **(10 Marks)**

b. Explain LRU stack evolution technique in simulation of computer memory. **(10 Marks)**

8 Write short notes on :
a. RUNS test.
b. Acceptance – Rejection technique.
c. Point Estimation.
d. Calibration process in model building. **(20 Marks)**

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CS65

Sixth Semester B.E. Degree Examination, June / July 08
System Simulation and Modeling

Time: 3 hrs. Max. Marks:100

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Note : ***1. Answer any FIVE full questions.***
2. Use of statistical tables is permitted.

1 a. Define simulation, simulation model, entities, measures-of-performance and activities. **(05 Marks)**

b. List three circumstances under which simulation is the appropriate tool and two circumstances under which simulation is not the appropriate tool. **(05 Marks)**

c. Explain in brief with a neat figure the steps involved in a simulation study. **(10 Marks)**

2 a. Explain in brief a simple queuing model and represent it using queuing notation. **(05 Marks)**

b. List and describe in brief the five elements / characteristics of the queuing system. **(05 Marks)**

c. A grocery store has one checkout counter. Customers arrive at this check out counter at random from 1 to 8 minutes apart and each inter arrival time has the same probability of occurrence. The service times vary from 1 to 6 minutes with probabilities as given below.

Service (minutes)	1	2	3	4	5	6
Probability	0.10	0.20	0.30	0.25	0.10	0.05

Simulate the arrival of 5 customers and calculate i) Average waiting time for a customer ii) Probability that a customer has to wait iii) Probability of a server being idle iv) Average service time and v) Average time between arrivals. Use the following sequence of random numbers.

Random digits for arrival :	913	727	015	948	309	922
Random digits for service time :	84	10	74	53	17	79

Assume that first customer arrives at time 0. Depict the simulation in a tabular form. **(10 Marks)**

3 a. Briefly define any five concepts used in discrete event simulation. **(05 Marks)**

b. Identify the concepts in the following example (i.e example of Q 3(c) drawing relevant figure. **(05 Marks)**

c. Six dump trucks are used to haul coal from the entrance of a mine to railroad. Each truck is loaded by one of two loaders. After loading, a truck immediately moves to the scale, to be weighed as soon as possible. Both the loaders and the scale have a first – come, first served waiting line for trucks. Travel time from a loader to scale is considered negligible. After being weighed a truck begins travel time (during which time truck unloads) and then afterwards returns to the loader queue. The activities of loading time, weighing time and travel time are given in the following table.

Loading Time	10	5	5	10	15	10	10
Weighing Time	12	12	12	16	12	16	
Travel Time	60	100	40	40	80		

End of simulation is completion of two weighings from the scale. Depict the simulation table and estimate the loader and scale utilizations. Assume that five of the trucks are at the loaders and one is at the scale at time O. **(10 Marks)**

4 a. Differentiate between truly random numbers and pseudo random numbers. Mention four properties that random numbers should possess. **(05 Marks)**

b. Using multiplicative congruential method for generating random numbers, list the random numbers and find the period of generator for a = 13, m = 64 and $X_0 = 2$. **(05 Marks)**

c. A sequence of 1000 (one thousand) four digit numbers has been generated and an analysis indicates the following combinations and frequencies.
Four different digits = 565, One pair = 392, Two pairs = 17, Three like digits = 24 and remaining are four like digits. Based on the poker test, test whether these numbers are independent. Use level of significance = 0.05. **(10 Marks)**

5 a. Elaborate the need for generating random variats. Given probability mass function pmf of random variates and a set of uniform random numbers over the range (0,1), describe the method to generate random variates. **(10 Marks)**

b. Given the uniform distribution on {1, 2, .., k} with pmf $p(x) = \frac{1}{k}$, x = 1, 2, .., k, generate the random variates for the five random numbers (0.81, 0.12, 0.34, 0.56 and 0.93). Derive the formula used. Use K = 10 for generating random variates. **(10 Marks)**

6 a. Explain the need for input modeling and histogram method of identifying the input distribution. **(05 Marks)**

b. The number of vehicles arriving at a junction in a five minute period was observed for 100 days. The resulting data is as follows:

No. of arrivals	0	1	2	3	4	5	6	7	8	9	10	11
Frequency	12	10	19	17	10	8	7	5	5	3	3	1

It is presumed that the arrivals follow a Poisson distribution with parameter $\alpha = 3.64$. Using Chi –square test, determine whether the assumption that arrivals follow Poisson distribution can be accepted at a 0.05 level of significance.
(Note : Expected values used should be ≥ 5 for calculation and put the values and calculated values in a tabular form). **(15 Marks)**

7 a. Differentiate between verification and validation of a simulation model. With a neat diagram, explain the relation between model building, verification and validation. **(10 Marks)**

b. Describe the three step approach which has been used as an aid in the validation process. **(10 Marks)**

8 Write short notes on:
a. Terminating and steady state simulations **(05 Marks)**
b. Point estimation of performance parameters. **(05 Marks)**
c. CPU simulation **(05 Marks)**
d. Memory simulation. **(05 Marks)**

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2002 SCHEME

CS65

Sixth Semester B.E. Degree Examination, Dec.08 / Jan.09
System Simulation and Modeling

Time: 3 hrs. Max. Marks:100

Note : ***Answer any FIVE full questions.***

1 a. With an example, define a model of a system. Give the classification of different types of models of a system. **(04 Marks)**

b. With necessary example, state any two situations where simulation is not appropriate tool to use. **(04 Marks)**

c. With a neat flow-chart, briefly explain the different steps involved in a simulation study. **(12 Marks)**

2 a. Explain any four characteristics of a queueing system. **(08 Marks)**

b. A small grocery store has only one checkout counter. Customers arrive at this counter at random from 1 to 10 minutes apart. Each possible value of interarrival time has the same probability of occurrence equal to 0.10. The service times vary from 1 to 6 minutes apart with probabilities shown below.

Service time :	1	2	3	4	5	6
Probability	0.10	0.20	0.30	0.25	0.10	0.05

Develop simulation table for 10 customers and find the following:

i) The average time between arrivals.

ii) The probability that a customer has to wait in the queue.

iii) The average service time.

Random digits for arrivals : 91, 72, 15, 94, 30, 92, 75, 23, 30

Random digits for service times : 84, 10, 74, 53, 17, 79, 91, 67, 89, 38 **(12 Marks)**

3 a. With respect to discrete event simulation, differentiate between the terms activity and delay. **(06 Marks)**

b. What are pseudo random numbers? List the errors, which occur during the generation of pseudo random numbers. **(06 Marks)**

c. Use linear congruential method to generate a sequence of three random numbers for $X_0 = 27$, $a = 8$, $C = 47$ and $m = 100$. **(08 Marks)**

4 a. Consider the 60 two-digit numbers in the sequence given below. Test whether the 2^{nd}, 9^{th}, 16^{th}, ... numbers in the sequence are autocorrelated, where $\alpha = 0.05$ **(10 Marks)**

0.30	0.48	0.36	0.01	0.54	0.34	0.96	0.06	0.61	0.85
0.48	0.86	0.14	0.86	0.89	0.37	0.49	0.60	0.04	0.83
0.42	0.83	0.37	0.21	0.90	0.89	0.91	0.79	0.57	0.99
0.95	0.27	0.41	0.81	0.96	0.31	0.09	0.06	0.23	0.77
0.73	0.47	0.13	0.55	0.11	0.75	0.36	0.25	0.23	0.72
0.60	0.84	0.70	0.30	0.26	0.38	0.05	0.19	0.73	0.44

Table Q4 (a)

b. Explain the inverse transformation technique of producing random variates for exponential distribution. **(05 Marks)**

c. Generate three Poisson variates with mean $\alpha = 0.2$. **(05 Marks)**

5 a. List the steps involved in the development of a useful model of input data. **(04 Marks)**

b. Explain how the method of histograms can be used to identify the shape of a distribution. **(06 Marks)**

c. Explain with a neat diagram, the model building, verification and validation. **(10 Marks)**

6 a. Explain the types of simulation with respect to output analysis. Give an example. (06 Marks)
b. Discuss in brief the output analysis for steady-state simulations. (06 Marks)
c. Discuss about point and interval estimations. (08 Marks)

7 a. Briefly explain the process-oriented and event-oriented simulation tools. (10 Marks)
b. Explain the concept of CPU simulation and memory simulation. (10 Marks)

8 Write short notes on:
a. Data collection in input modeling.
b. Model calibration.
c. Queueing notations.
d. Secondary properties of random numbers. (20 Marks)

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2002 SCHEME CS65

Sixth Semester B.E. Degree Examination, June-July 2009
System Simulation and Modeling

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. What is simulation? State any two of its merits and two limitations. State any two situations where simulation can be used. **(05 Marks)**

b. Discuss the types of models of a system. **(05 Marks)**

c. Explain various steps in a simulation study. Write the flow chart for simulation study. **(10 Marks)**

2 a. Describe a queuing system with respect to arrival and service mechanisms, system capacity, queue discipline, flow diagrams of arrival and service events. **(08 Marks)**

b. A newspaper seller classifies his days into "good" and "bad" ones with probability 0.4 and 0.6 respectively. The amounts of newspaper sold are given by the distributions below.

Good	Copies sold	Probability
	150	0.05
	200	0.1
	250	0.2
	300	0.35
	350	0.3

Bad	Copies sold	Probability
	150	0.1
	200	0.3
	250	0.4
	300	0.15
	350	0.05

He can buy a copy of the newspaper himself by 1 euro and he sell it with the price of 1.8 euros. Unsold copies must be thrown away. Based on 5 days of simulation calculate the profit of the newspaper seller. Instead of 250 newspapers per day if 300 newspapers per day are purchased will it be more profitable.

Random digits for type of day:	3	0	4	7	8
Random digits for number of copies sold:	70	37	93	07	45

(12 Marks)

3 a. Explain the various steps used in Time-advance algorithm. **(04 Marks)**

b. Six trucks are used to haul coal from the entrance of a small mine to the railroad. Each truck is loaded by one of two loaders. After loading, a truck immediately moves to the scale, to be weighed. Both the loaders and the scale have FCFS waiting line for trucks. After being weighed, a truck begins a travel time and then after ward returns to the loader queue. It is assumed that 5 of the trucks are at the loaders and one is at the scale at time 0. The activity times are given in the following table:

Loading time (min)	10	5	15	5	10
Weighing time (min)	12	16	12	12	12
Travel time (min)	40	60	80	60	40

Simulate the system for 25 minutes, estimate the loader and scale utilization. **(16 Marks)**

4 a. Define a random number. Explain statistical properties of random numbers with example. **(05 Marks)**

b. Generate 4 three digit random numbers using multiplicative congruential method with X_0=117, a = 43 and m = 1000. **(06 Marks)**

c. The sequence of numbers 0.54, 0.73, 0.98, 0.11, 0.68 has been generated. Use the Kolmogorov-Smirnov test with $\alpha = 0.05$ to determine if the hypothesis that the numbers are uniformly distributed on the internal [0, 1] can be rejected. Compare F(x) and $S_N(X)$ on a graph. $D_{0.05, 5} = 0.565$. **(09 Marks)**

5 a. When to use random variate generation? What is the difference between random number generation and random variate generation? Explain with example. (05 Marks)

b. Explain the inverse transformation technique of producing random variates for exponential distribution. Generate exponential variates X_i with mean 1. Given random numbers R_i=0.1306, 0.0422, 0.6597, 0.7965, 0.7696. (08 Marks)

c. What is acceptance-rejection technique? Generate 3 Poisson variates with mean $\alpha = 0.2$. Use the following random nos. 0.4357, 0.4146, 0.8353, 0.9952, 0.8004. (07 Marks)

6 a. What is the need for input modeling? Explain the steps involved in the development of a useful model for a given set of input data. (06 Marks)

b. The time required for 50 different employees to compute and record the number of hours during the week was measured with the following results in minutes. Use Chi-square test, to test the hypothesis that these service times are exponentially distributed. Take the number of class intervals as K = 6, $\alpha = 0.05$.

Employee	Time	Employee	Time	Employee	Time	Employee	Time	Employee	Time
1	1.88	11	3.53	21	1.42	31	0.39	41	0.80
2	1.54	12	0.53	22	1.28	32	0.34	42	5.50
3	1.90	13	1.80	23	0.82	33	0.01	43	4.91
4	0.15	14	0.79	24	2.16	34	0.10	44	0.35
5	0.02	15	0.21	25	0.05	35	1.10	45	0.36
6	2.81	16	0.80	26	0.04	36	0.24	46	0.90
7	1.50	17	0.26	27	1.49	37	0.26	47	1.03
8	0.53	18	0.63	28	0.66	38	0.45	48	1.73
9	2.62	19	0.36	29	2.03	39	0.17	49	0.38
10	2.67	20	2.03	30	1.00	40	4.29	50	0.48

Use $\chi^2_{0.05,4} = 9.49$ (14 Marks)

7 a. Explain in detail about the model building, verifying and validation process through a diagram. (10 Marks)

b. What is output analysis? State its purpose. Explain point estimation and interval estimation. (10 Marks)

8 a. Discuss the concept of high-level computer simulations by sketching a simulation model of a computer system that services requests from the world wide web (08 Marks)

b. Explain CPU and memory simulation. (06 Marks)

c. Explain about simulation tools. (06 Marks)

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2002 SCHEME

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CS65

Sixth Semester B.E. Degree Examination, Dec.09/Jan.10
System Simulation and Modeling

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. What is a system, simulation and system environment? List the advantages and disadvantages of simulation. **(10 Marks)**

b. With the help of an example, explain the components of a system. **(06 Marks)**

c. Differentiate between:
i) Discrete and continuous systems
ii) Static and dynamic model
iii) Deterministic and stochastic simulation
iv) Endogenous and exogenous event. **(04 Marks)**

2 a. Explain in detail the simulation of quenching model. **(08 Marks)**

b. A baker bakes 30 dozens of bread loafs each day. Probability distribution of customers is in table 1. Customers order 1, 2, 3 or 4 dozens of bread loafs according to the distributions given in table 2. Assume that on each day all the customers order same dozens of bread loafs. The selling price is Rs. 5.4/ dozen and making cost is Rs. 3.8/ dozen. The left over bread loafs will be sold for half price at the end of day. Based on 5 days simulation, calculate the profit of the baker. Instead of 30 dozens, if 40 dozens are baked per day will it be more profitable?

Table 1 : Probability distribution of customers

Number of customers / day	8	10	12	14
Probability	0.35	0.30	0.25	0.10

Table 2 : probability distribution of dozens ordered

Number of dozens / customers	1	2	3	4
Probability	0.40	0.30	0.20	0.10

Random digits for customers –	50	61	73	24	96
Random digits for dozens –	5	3	7	0	8

(12 Marks)

3 a. Explain time- advance algorithm with an example. **(06 Marks)**

b. What is world view? Explain three phases of activity scanning approach. **(06 Marks)**

c. Briefly explain manual simulation using event scheduling for single channel queue. **(08 Marks)**

4 a. Briefly explain the different characteristics of quenching systems. **(05 Marks)**

b. Explain LCG with the constraints on a, c and m. Also discuss the properties of LCG. **(08 Marks)**

c. Generate random numbers for seed 2, constant multiplier 13, increment 0 and modulus of 2^6. **(07 Marks)**

5 a. Differentiate between chi-square and K–S Test. **(04 Marks)**

b. Using X_0^2 test, test for hypothesis that the data given follows uniform distribution at $\alpha = 0.05$. The critical value is 16.9.

O_i	8	8	10	9	12	8	10	14	10	11

(08 Marks)

c. Determine the hypothesis of independence for runs above or below the mean for the sequence of numbers given below :

0.41	0.68	0.89	0.94	0.74	0.91	0.55	0.62	0.36	0.27
0.19	0.72	0.75	0.08	0.54	0.02	0.01	0.36	0.16	0.28
0.18	0.01	0.95	0.69	0.18	0.47	0.23	0.32	0.82	0.53
0.31	0.42	0.73	0.04	0.83	0.45	0.13	0.57	0.63	0.29

Also for $\alpha = 0.05$ $Z_\alpha = 1.96$.

(08 Marks)

6 a. Explain in detail the inverse transform technique for exponential distribution. **(10 Marks)**

b. Explain chi-square goodness of fit test to accept or reject a candidate distribution. **(10 Marks)**

7 a. Discuss with the help of neat diagram model building. Verification and validation with diagram. **(10 Marks)**

b. Explain iterative process of calibrating a model. **(10 Marks)**

8 Write short notes on :

a. Point estimation

b. Memory simulation

c. High level computer system simulation

d. Interval estimation.

(20 Marks)

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06CS82

Eighth Semester B.E. Degree Examination, May/June 2010
System Modeling and Simulation

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART- A

1 a. What is simulation? Explain with flowchart, the steps involved in simulation study. **(10 Marks)**

b. Differentiate between continuous and discrete systems. **(05 Marks)**

c. What is system and system environment? List the components of a system, with example. **(05 Marks)**

2 a. A grocery store has one checkout counter. Customers arrive at this checkout counter at random from 1 to 8 minutes apart and each interval time has the same probability of occurrence. The service times vary from 1 to 6 minutes, with probability given below :

Service (minutes)	1	2	3	4	5	6
Probability	0.10	0.20	0.30	0.25	0.10	0.05

Simulate the arrival of 6 customers and calculate :
Average waiting time for a customer
Probability that a customer has to wait
Probability of a server being idle
Average service time and
Average time between arrival.
Use the following sequence of random numbers :

Random digit for arrival	913	727	015	948	309	922
Random digit for service time	84	10	74	53	17	79

Assume that the first customer arrives at time θ. Depict the simulation in a tabular form. **(10 Marks)**

b. Briefly define any four concepts used in discrete event simulation. **(04 Marks)**

c. Explain event scheduling algorithm by generating system snapshots at clock=t and clock = t_1. **(06 Marks)**

3 a. Six dump trucks are used to have coal from the entrance of a mine to a railroad. Each truck is loaded by one of the two loaders. After loading, a truck immediately moves to the scale, to be weighed as soon as possible. Both the loader and the scale have first-come first-served waiting line for trucks. Travel time from a loader to scale is considered negligible. After being weighed, a truck begins travel time [during which time truck unloads] and then afterwards return to loader queue. The activities of loading, weighing and travel time are given in the following table :

Loading time	10	5	5	10	15	10	10
Weighing time	12	12	12	16	12	16	
Travel time	60	100	40	40	80		

End of simulation is completion of two weighings from the scale. Depict the simulation table and estimate the loader and scale utilizations. Assume that five of the trucks are at the loaders and one is at the scale at time θ. **(05 Marks)**

b. Define a discrete random variable. Explain the binomial distribution. **(05 Marks)**

c. A production process manufactures alternators for outboard engines used in recreational boating. On the average, 1% of the alternators will not perform up to the required standards when tested at the engine assembly plant. When shipment of 100 alternators is received at the plant, they are tested, and if more than two are non confirming; the shipment is returned to the alternators manufacturer. What is the probability of returning a shipment? **(10 Marks)**

4 a. Explain the characteristics of a queuing system. List different queuing notations. **(10 Marks)**

b. A tool crib has exponential interarrival and service times, and it serves a very large group of mechanics. The mean time between arrivals is 4 minutes. It takes 3 minutes on the average for a tool crib attendant to service a mechanic. The attendant is paid $ 10 per hour and the mechanic is paid $ 15 per hour. Would it be advisable to have a second tool-crib attendant? **(10 Marks)**

PART- B

5 a. What are pseudo random numbers? What are the problems that occur while generating pseudo random numbers? **(06 Marks)**

b. Explain combined linear congruential method for random number generation. **(06 Marks)**

c. The sequence of numbers 0.54, 0.73, 0.98. 0.11 and 0.68 has been generated. Use the Kolmogorov-Smirnov test with $\alpha = 0.05$ to determine if the hypothesis that the numbers are uniformly distributed on the interval [0, 1] can be rejected. **(08 Marks)**

6 a. Suggest a step by step procedure to generate random variates using inverse transform technique for exponential distribution. **(06 Marks)**

b. Enlist the steps involved in development of a useful model of input data. **(04 Marks)**

c. Records pertaining to the monthly number of job-related injuries at an underground coal mine, were being studied by a federal agency. The values for the past 100 months were as follows :

Injuries per month	0	1	2	3	4	5	6
Frequency of occurrence	35	40	13	6	4	1	1

i) Apply the chi-square test to these data to test the hypothesis, that, underlaying distribution is Poisson. Use a level of significance of $\alpha = 0.05$.

ii) Apply the chi-square test to these data to test the hypothesis, that, the distribution is Poisson with mean 1.0. Again let $\alpha = 0.05$. **(10 Marks)**

7 a. Briefly explain the measure of performance of a simulation system. **(10 Marks)**

b. Explain the distinction between terminating or transient simulation and steady state simulation. Give examples. **(10 Marks)**

8 a. Explain with a neat diagram, model building, verification and validation process. **(10 Marks)**

b. Describe the three steps approach to validation by Naylor and Finger. **(10 Marks)**

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