UNIT - 1

INTRODUCTION

June 2012

1. List any three situations when simulation tool is appropriate and not appropriate tool. 6 M

b. Define the following terms used in simulation

i)discrete system ii)continuous system iii) stochastic system iv)deterministic system v)entity vi)Attribute 6 M

c. Draw the flowchart of steps involved in simulation study. 8 M

June 2010

1a) What is simulation? Explain with flow chart, the steps involved in simulation study 10 M

1b) Differentiate between continuous and discrete systems. 5 M

1c)What is system and system environment?List the components of a system,with example. 5 M

Dec 2011

1a. List any five circumstances when the simulation is the appropriate tool and when it is not. 10 M

1b) Explain the steps in a simulation study, with a flow chart 10 M

June 2011

1a) What us system and system environment? Explain the components of a system with an example. 10 M

1b) Explain the various steps in simulation study with the help of a neat diagram 10 M

UNIT - 2

GENERAL PRINCIPLES, SIMULATION SOFTWARE

June 2012

2a)Consider the grocery store with one check out counter. Prepare the simulation table for eight customers and find out average waiting time of customer in queue,idle time of server and average service time .The inter arrival time (IAT) and service time (ST) are given in minutes.

IAT : 3,2,6,4,4,5,8

ST(min) :3,5,5,8,4,6,2,3

Assume first customer arrives at time t=0 10 M

2b) Suppose the maximum inventory level is M 11 units and the review period is 5 days estimate by simulation the average ending units in inventory and number of days when a shortage condition occurs .Initial simulation is started with level of 3 units and an order of 8 units scheduled to arrive in two days time.Simulate for three cycles (15 days) The probability for daily demand and lead time is given below 10 M

Demand	0	1	2	3	4
P	0.1	0.25	0.35	0.2	0.1

Lead time	1	2	3
Propability	0.5	0.3	0.2

RD for demand: 24,35,65,25,8,85,77,68,28,5,92,55,49,69,70

RD for lead time :5,0,3

June 2010

2a) 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:

Services(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

Use 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 0.Depict the simulation in a tabular form. 10 M.

2b) Briefly define any four concepts used in discrete event simulation. 10 M

2c) Explain event scheduling algorithm by generating system snapshots at clock=t and clock=t_t

Dec 2011

2a) One company uses 6 trucks to haul manganese ore from Kolar 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 disciple is FOFO.When it is weighed a truck travels to the industry and returns to the loader queue.The distribution of loading time,weighing time and travel time are as follows:

Loading time: 10 5 5 10 15 10 10

Weigh time: 12 12 12 16 12 16

Travel time 60 100 40 40 80

Calculate the total busy time of both the loaders,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 tg=64 mins 10 M

2b) Explain simulation in GPSS with a block diagram for the single server queue simulation.6 M

2c) Explain the following:

i)system ii)Event list iii)Entity iv)Event

June 2011

2a) With the help of a flow diagram explain the simulation of a single channel queuing s ystem 10 M

2b) A large milling machine has three different bearings that fail in service.The cumulative distribution function of the life of each bearing is identical given in table 1. When a bearing fails,the mill stops,a repair person is called and a new bearing is installed.the delay time of the repair person's arriving at the milling machine is also a randon variuable,with the distribution given in table 2.Downtime for the mill is esrimated at $5/minute.The direct on site cost of the repair person is $15/hour.It takes 20 minutes to change 1 bearing,30 minutes to change 2 bearings and 40 minutes to change 3 bearings .The bearing cost is $16 each.Aproposal has been made to replace all 3 bearings whenever a bearing fails.Management needs an evaluation of this proposal. Simulate the system for 10,000 hours of operaion under proposed method and determine the total cost of the proposed system.

Table 1 Bearing life distribution

Bearing Life(Hrs)	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900
Probability	0.10	0.13	0.25	0.13	0.09	0.12	0.02	0.06	0.05	0.05

Table 2 Delay time distribution

Delay(minutes)	5	10	15
Probability	0.6	0.3	0.1

Consider the following sequence of random digits for bearing life times

Bearing 1	67	8	49	84	44	30	10	15
Bearing 2	70	43	86	93	81	44	19	51
Bearing 3	76	65	61	96	65	56	11	86

Consider the following sequence of random digits for delay time

Delay	3	7	5	1	4	3	7	8

UNIT – 3

STATISTICAL MODELS IN SIMULATION

June 2012

3a) Define the term used in discrete event simulation:

i) System safe ii)list iii) event iv)FEL v) delay vi)system 6M

3b) Six dump trucks are used to haul coal from the entrance of a small mine to railload. Each truck is loaded by one of two loaders. After loading truck moves to scale,to be weighed. After weighing a truck begins to travel time and then returns to loader queue.It has been assumed that five of trucks Are at loader and one at scale at time 0.By using event scheduling algorithm find out busy time of loader and scale and stopping time E is 64 mins. 14 M

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

June 2010

3a) Six dump trucks are used to haul coal from the entrance of a small mine to railload. Each truck is loaded by one of two loaders. After loading truck moves to 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 weighing a truck begins to travel time and then returns 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 0. 5 M:

3b) Define a discrete random variable. explain the binomial distribution. 5 M

3c)a production process manufactures alternators for outboard engines used in recreational boating. On the average,1% of the alternators will not perform up tp 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 conforming the shipment is returned to the alternators manufacturer. What is the probability of returning a shipment. 10 M

Dec 2011

3a) Explain discrete random variables and continuous random variables with examples 10 M

3b) Explain any two discrete distributions 5 M

3c)Explain the following continuous distribution

i) Uniform distribution

ii) Exponential distribution 5 M

June 2011

3a) What do you mean by "world view"?Discuss the various types of world views 10 M

3b) Suppose the maximum inventory level is M 11 units and the review period is 5 days estimate by simulation the average ending units in inventory and number of days when a shortage condition occurs .Initial simulation is started with level of 3 units and an order of 8 units scheduled to arrive in two days time.Simulate for three cycles (15 days) The probability for daily demand and lead time is given below 10 M

Demand	0	1	2	3	4
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Lead time	1	2	3
Propability	0.5	0.3	0.2

RD for demand: 24,35,65,25,8,85,77,68,28,5,92,55,49,69,70

RD for lead time :5,0,3

Dec 2011

4a) Explain the characteristics of a queuing system. List different queuing notations 10 M

4b) Explain any two long run measures of performance of queuing systems 10 M

June 2011

4a)what is the role of maximum density 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 M

4b)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 $\alpha=0.05, Z_{0.025}=1.96$ 10 M

UNIT – 4

QUEUING MODELS

June 2012

4a) the number of Hurricanes hitting the coast of Indian follows poisson distribution with mean α=0.8 per year Determine:

i) The probability of more than two hurricanes in a year

ii) The probability of more than one hurricane in a year 6 M

4b) Explain the terms used in queuing notations of the form A/B/C/N/K 6 M

Ans: A notation system for parallel server queues: *A/B/c/N/K*
A represents the interarrival-time distribution,
B represents the service-time distribution,
c represents the number of parallel servers,
N represents the system capacity,
K represents the size of the calling population

4c) List the steady state parameters of M/G/1 8 M

Ans:

June 2010

4a) Explain the characteristics of a queuing system.List different queuing notations. 10 M

4b) 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 M

Dec 2011

5a) Explain the two different techniques used for generating random numbers with examples 10 M

5b)The sequence of numbers 0.44,0.81,0.14,0.05,0.93 has been generated.Use thwe kolmogonov Smirnov test with α=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 Sn(X) on a graph 10 M

June 2011

5a) what is inverse transform technique? derive an expression for exponential distribution. 10 M

5b) A sequence of 1000 four digit numbers has been generated and analysis indicates the following combinations anf frequencies .Based on poker test check whether the numbers are independent Use α=0.05, $X^2_{0.05,2}$=5.99.

Combination(i)	Oi
Four different digits	565
One pair	392
Two pairs	17
Three like digits	24
Four like digits	2

UNIT – 5

RANDOM-NUMBER GENERATION, RANDOM-VARIATE GENERATION

June 2012

5a)Using multiplicative congruential method, generate random numbers to complete cycle.Explain maximum density and maximum period,A=11,M=16,X_0=7 10 M

5b) Using suitable frequency test find out whether the random numbers generated are uniformly distributed on the interval [0,1] can be rejected.Assume α=0.05 and D_α=0.565.the random numbers are 0.54,0.73,0.98,0.11,0.68 10 M

June 2010

5a)Using multiplicative congruential method, generate random numbers to complete cycle.Explain maximum density and maximum period,A=11,M=16,X_0=7 10 M

5b) Using suitable frequency test find out whether the random numbers generated are uniformly distributed on the interval [0,1] can be rejected.Assume α=0.05 and D_α=0.565.the random numbers are 0.54,0.73,0.98,0.11,0.68 10 M

Dec 2011

6a)Explain inverse transform technique of producing random variates for exponential distridution 5 M

6b) Generate three Poison variates with mean α=0.2 5 M

6c) Explain the types of simulation with respect to output analysis.Give at least two examples. 10 M

June 2011

6a) What is a acceptance-rejection technique? Generate three Poisson variates with mean α=0.2 10 M

6b) For the given sequence of +'s and -'s can the hypothesis that the numbers are independent be rejected on the basis of the length of runs above and below the mean at α=0.05? the critical value is given as 5.99. 10 M

-	-	-	-	+	-	+	+	-	+	+	-	-
-	-	-	-	+	+	+	+	-	+	+	-	+
+	-	-	+	-	+	+	-	+	-	-	-	-

UNIT – 6

INPUT MODELING

June 2012

6a) Develop a random variate generator for X with pdf given below

$F(x) = x, \quad 0<x<1$

$= 2-x \quad 1<x<2$

$= 0 \quad$ otherwise 6 M

6b) Explain with an example,importance of data distribution using histogram. 6 M

6c) The following is set of single digit numbers from a random number generator.Using appropriate test ,check whether the numbers are uniformly.N=50,α=0.05 and $X^2_{0.05.9}$=16.9

6,7,0,6,9,9,0,6,4,6,4,0,8,2,6,6,1,2,6,8,5,6,0,4,7
1,3,5,0,7,1,4,9,8,6,0,8,6,6,7,1,0,4,7,9,2,0,1,4,8 8 M

June 2010

6a) Suggest a step by step procedure to generate random variates using inverse transform technique for exponential distribution. 6 M

6b) Enlist the steps involved in development of a useful model of input data. 6 M

6c) 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/month	0	1	2	3	4	5	6
Frequency of occurance	35	40	13	6	4	1	1

i) Apply the chi square test to these data to test the hypothesis that the distribution is poisson. Use a level of significance of α=0.05

ii) Apply the chi square test to these data to test the hypothesis that the distribution is poisson with mean 1.0 and α=0.05 8 M

UNIT – 7

ESTIMATION OF ABSOLUTE PERFORMANCE

June 2012

7a) Records pertaining to the monthly number of job related injuries at an underground coal mine were being studied by federal agency.the values of past 100 months are as follows:

Injuries/month	0	1	2	3	4	5	6
Frequency of occurance	35	40	13	6	4	1	1

Apply the chi square test to these data to test the hypothesis that the distribution is poisson with mean 1.0 and α=0.05 and $X^2_{0.05.9}$=7.81. 10 M

7b) Differentiate between terminating and steady state simulation with respect to output analysis with an example. 10 M

June 2010

7a) Briefly explain the measures of performance of a simulation system. 10 M

7b) Explain the distinction between terminating or transient simulation and steady state simulation. Give examples. 10 M

Dec 2011

7a) Explain Chi –sqare goodness of fit test.Apply it to poisson assumption with α=3.64.Data size=100 and observed frequency Oi=12,10,19,17,10,8,7,5,5,3,3,1 10 M

7b) List the steps involved in the development of a useful model of input data 5 M

7c) Explain Chi-Square goodness of filter test for exponential distribution with an example. 5 M

June 2011

7a) Wehat do you mean by a verification and validation of simulation models? Explain calibration and validation of models with the help of diagram 10 M

7b) Discuss types of simulations with respect of output analysis with example. 10 M

UNIT – 8

VERIFICATION, CALIBRATION, AND VALIDATION; OPTIMIZATION

June 2012

8a) Explain with a neat diagram verification of simulation model. 10 M

8b) Describe with a neat diagram iterative process of calibrating a model. Which are three steps that aid in the validation process? 10 M

June 2010

8a) Explain with a neat diagram model building,verification and validation process 10 M

8b)Describe the three steps approach to validation by Naylor and Finger. 10 M

Dec 2011

8a) Explain with aneat diagram model building,verification and validation. 10 M

8b) Explain any two output analysis for steady state simulation 10 M

June 2011

8a) Write short notes on

i) Characteristics of queuing system

ii) Errors while generating pseudorandom numbers

iii) Network of queue

iv) Optimization via simulation 20 M