

First Semester M.Tech. Degree Examination, June/July 2011

System Modeling and Simulation

Time: 3 hrs.

Max. Marks:100

Note: 1. Answer any FIVE full questions.

2. Use of statistical tables and random number table is permitted.

- 1 a. With a neat flow diagram, explain various steps involved in a simulation study. (10 Marks)
 b. Explain the characteristics of a queuing system, by giving examples. (10 Marks)
- 2 a. Differentiate between the following terms :
 i) System and system environment ii) Endogenous and exogenous activities
 iii) Event and activity iv) Discrete and continuous systems. (08 Marks)
 b. Dr. XYZ is dentist, who schedules all patients for 30 minute appointments. Some of the patients take more than 30 minutes depending on the type of dental work to be done. The following table (Table.2(b)) shows the various categories of work, their probabilities and time actually needed to complete the work.

Table.2(b)

Categories	Filling	Crown	Cleaning	Extraction	Check-up
Time required (minutes)	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 time for patients and total idle time of doctor. Assume that patients show up at the clinic at exactly their scheduled arrival time starting at 8.00 am. Use the following random numbers to handle the above problem : 40, 82, 11, 34, 25, 66. (12 Marks)

- 3 a. Explain the event-scheduling / time-advance algorithm by clearly showing the old and new snapshots. (07 Marks)
 b. Six dump trucks are used to haul coal from a mine to the rail road. There are two loaders and one weighing scale. After loading, the truck travels to the weigh queue, unloads and then returns to the loader queue. Queue discipline is FIFO for both loader and weigh queues. The loading time, weighing time and travel time can be chosen from the following table (Table.3(b)).

Table.3(b)

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. Assume that five trucks are at the loaders and one is at the scale at time zero. Simulate the system to estimate the average loader and scale utilizations. (13 Marks)

- 4 a. Define discrete and continuous random variables. Give one example for each. (04 Marks)
 b. The life of a device used to inspect cracks in aircraft wings is given by X, a continuous random variable, having the following pdf.

$$f(x) = \begin{cases} \frac{1}{2} e^{-x/2}, & x \geq 0 \\ 0, & \text{otherwise} \end{cases}$$

Find the mean and variance of this distribution. Also find $P\left(\frac{1}{3} < x < \frac{2}{3}\right)$. (06 Marks)

- 4 c. The time in hours required to load an ocean going vessel X, is distributed as $N(12, 4)$. Compute the probability that :
- The vessel will be loaded in less than 10 hours
 - Between 10 and 12 hours is needed to load the ship.
- (Take $\Phi(-1) = 0.1587$ and $\Phi(0) = 0.5$) (05 Marks)
- d. Define a Poisson process with mean rate λ . Mention any two properties of Poisson process. (05 Marks)

- 5 a. Use multiplicative congruential method to generate enough random numbers to find the period, given $a = 11$, $m = 16$ and $X_0 = 7$. (05 Marks)
- b. Use autocorrelation test to determine whether 3rd, 8th, 13th and so on numbers in the following sequence are autocorrelated at $\alpha = 0.05$. (Take $Z_{0.025} = 1.96$)
 0.12, 0.01, 0.23, 0.28, 0.89, 0.31, 0.64, 0.28, 0.83, 0.93, 0.99,
 0.15, 0.33, 0.35, 0.91, 0.41, 0.60, 0.27, 0.75, 0.88, 0.68, 0.49,
 0.05, 0.43, 0.95, 0.58, 0.19, 0.36, 0.69, 0.87. (08 Marks)
- c. Explain the acceptance-rejection technique to generate Poisson variates. Use it to generate three Poisson variates with mean $\alpha = 0.2$. (07 Marks)
- 6 a. Briefly explain the steps in developing a useful model of input data. (06 Marks)
- b. Write short notes on multivariate and time series input models. (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 in following table (Table.6(c)).

Table.6(c)

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

Apply the chi-square test to these data to test the hypothesis that the underlying distribution is Poisson at $\alpha = 0.05$. (Take $X_{0.05, 2}^2 = 5.99$) (10 Marks)

- 7 a. With a neat diagram, explain in detail, the process of model building, verification and validation. (10 Marks)
- b. Explain the three-step approach that aids in the validation process. (10 Marks)
- 8 Write short notes on : (20 Marks)
- Terminating and steady-state simulations
 - World views
 - Point estimation and internal estimation
 - Media access control.