**Computer Simulation Laboratory**

**B.Tech. 5th Semester**

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**Department: Computer Science and Engineering**

**Faculty of Engineering & Technology**

**M. S. Ramaiah University of Applied Sciences**



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| Faculty | Engineering & Technology |
| Programme | B. Tech. in Computer Science and Engineering |
| Year/Semester | 5th Semester |
| Name of the Laboratory | Computer Simulation Laboratory |
| Laboratory Code | CSC308A |

List of Experiments

1. Introduction to Java simulation and Implementing a Java program for random numbers generation for given scenario
2. Simulation of a single server queue (Grocery centre problem)
3. Simulation of a Two server Queue (Able Baker Problem)
4. Discrete Distributions AND Continuous Distributions
5. Random Number generator using LCG
6. Random Variate Generator using lnverse-Transfonn Technique

Exponential Distribution

Uniform Distribution

1. Test for random numbers

KS test

Chi square Test

1. Simulation of a single server Single queue(M/M/1)

# Laboratory 1: Introduction to java simulation and Random Number Generation

1. Introduction and Purpose of Experiment

Computer simulation provides students to design and implement computer simulation models, conduct simulation experiments and evaluate system performance. This laboratory exercise will help the students to get familiar with using object‐oriented simulation in Java.

Java (Structured Parallel Discrete Event Simulation in Java) system is designed to incorporate the parallel programming technology into discrete event simulations. The java system adopts the approach of augmenting a general-purpose language with essential constructs to support simulation modeling based on the process-oriented modeling technology.

Random numbers are widely used ingredient in the simulation of almost all discrete systems. Simulation languages generate random numbers that are used to generate event times and other random variables. Random number generators have applications in gambling, statistical sampling, computer simulation, cryptography, completely randomized design and other areas where producing an unpredictable result is desirable. The generation of pseudo random numbers is an important and common task in computer programming.

1. Aim and Objectives

Aim

* To use Netbeans and understand using object‐oriented simulation in Java
* To develop programs generating random numbers and Understand its significance in various applications

Objectives

At the end of this lab, the student will be able to

* Explain the features and use of Netbeans IDE to develop java programs for simulation
* Edit, compile and execute java programs successfully using Netbeans IDE

Use different random generation methods for generating random numbers

Create java programs for generating random numbers

1. Experimental Procedure

Students are given a set of programs for generating random numbers using built-in methods. Programs should be edited, compiled and executed using Netbeans IDE.

Random number generation using inbuilt methods/manually

Ex: coin toss, die, and cards

1. Calculations/Computations/Algorithms

Generate a random numbers for coin flip, die and cards

1. Presentation of Results
2. Analysis and Discussions
3. Conclusions

# Laboratory 2: Simulation of a single server queue (Grocery centre problem)

1. Introduction and Purpose of Experiment
2. Aim and Objectives
3. Experimental Procedure

An ATM booth has a single machine to withdraw cash. Customers arrive at the ATM at random times that are from 1 to 8 minutes apart. Each Inter-arrival time has the same probability of occurrence and service times vary from 1 to 6 minutes with the respective probabilities of time taken for service shown in Table 3 below:

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

1. Table 3

Simulate the system for arrival of 1000 customers starting with an empty ATM queue to determine the following:

i. Average waiting time of a customer

ii. Idle time of the ATM machine

iii. Average service time

iv. Average time between arrivals

Use random numbers between 1 to 1000 to determine inter arrival time, and random numbers between 1 to 100 to determine service time.

1. Algorithms
2. Presentation of Results
3. Analysis and Discussions
4. Conclusions

# Laboratory 3: Simulation of a two server Queue (Able Baker Problem)

1. Introduction and Purpose of Experiment
2. Aim and Objectives
3. Experimental Procedure

An ATM booth has a two machine to withdraw cash. Customers arrive at the ATM at random times that are from 1 to 4 minutes apart with the respective probabilities of time taken for arrival shown in Table below. Service times of machine **A**ble vary from 2 to 5 minutes and service times of machine **Baker** vary from 3 to 6 minutes with the respective probabilities of time taken for service shown in Table below:

Simulate the system for arrival of 1000 customers starting with an empty ATM queue to determine the following:

i. Average waiting time of a customer

ii. Total time in the system

**IAT Able Baker**

  

Use random numbers between 1 to 1000 to determine inter arrival time, and random numbers between 1 to 100 to determine service time

1. Algorithms
2. Presentation of Results
3. Analysis and Discussions
4. Conclusions

# Laboratory 4: Discrete Distributions AND Continuous Distributions

1. Introduction and Purpose of Experiment
2. Aim and Objectives
3. Experimental Procedure

Design and Implement a Java program for the following **Discrete Probability Distribution**

* 1. Binomial distribution
     1. To find the number of successes in **n** independent Bernoulli trials, given that **X** has a binomial distribution
     2. Calculate the
        1. Mean, E(X)
        2. Variance, V(X)
  2. Geometric distribution
     1. To identify the number of Bernoulli trials, *X*, to achieve the 1st success
     2. Calculate the
        1. Mean, *E(X)*
        2. Variance *V(X)*
  3. Negative binomial distribution

1. To identify the number of Bernoulli trials, X, until the kth success
2. Calculate the Mean, E(X) and Variance V(X)
   1. Develop and implement a Java program by selecting suitable distribution function for given scenario:If 40% of the assembled ink-jet printers are rejected at the inspection station. Your program should identify:
3. Probability that the first acceptable ink-jet printer is the third one inspected. Considering each inspection as a Bernoulli trial with q=0.4 and p=0.6.
4. Probability that the third printer inspected is the second acceptable printer
5. Design and Implement a Java program for the following **Continuous Distribution**

A computer repair person is “beeped” each time there is a call for service. If the number of beeps per hour is Poisson distributed (α = 2 beeps per hour). Then design and implement a Java program to determine the following.

* + 1. The probability of exactly three beeps in the next hour:
    2. The probability of two or more beeps in a 1-hour period:

1. Algorithms
2. Presentation of Results
3. Analysis and Discussions
4. Conclusions

# Laboratory 5: Random Number generator using LCG and MCG

1. Introduction and Purpose of Experiment
2. Aim and Objectives
3. Experimental Procedure
4. Develop and implement a Java program to generate pseudorandom numbers based on the linear congruential random number generator to produce a sequence of 20 integers, 12 between 0 and y following a recursive relationship: Use 0, and.
5. Modify the above program for multiplicative congruential method to determine the period of the generator for, and0,.

Satisfy the following property of max period

1. Generate random numbers with longest possible period is
2. Generate random numbers with longest possible period is
3. Algorithms
4. Presentation of Results
5. Analysis and Discussions
6. Conclusions

**The max period(P) is:**

* + For m a power of 2, say m = 2b, and c ≠0, the longest possible period is P = m = 2b , which is achieved provided that c is relatively prime to m (that is, the greatest common factor of c and m is 1), and a = 1 + 4k, where k is an integer.

1. For m a power of 2, say m = 2b, and c = 0, the longest possible period is P = m / 4 = 2b-2 , which is achieved provided that the seed X0 is odd and the multiplier, a, is given by a = 3 + 8k or a = 5 + 8k, for some k = 0, 1,...
2. For m a prime number and c = 0, the longest possible period is P = m - 1, which is achieved provided that the multiplier, a, has the property that the smallest integer k such that ak - 1 is divisible by m is k = m - 1,

# Laboratory 6: Random Variate Generator using lnverse-Transfonn Technique

1. Introduction and Purpose of Experiment
2. Aim and Objectives
3. Experimental Procedure

Design and implement a Java program to determine a sequence of 10 random variates by generating a sequence of random numbers using the flowing distributions:

* + 1. Uniform distribution in the interval [10, 20]
    2. Exponential distribution with mean value 5
    3. Normal distribution with mean 3.1 and sigma 0.6

1. Algorithms
2. Presentation of Results
3. Analysis and Discussions
4. Conclusions

# Laboratory 7: Tests for Random Numbers using Frequency Tests

1. Introduction and Purpose of Experiment
2. Aim and Objectives
3. Experimental Procedure

**K-S Test**

Design and implement a Java program to test the generated random numbers 0.44, 0.81, 0.14, 0.05, 0.93 for uniformity by using the Kolmogorov-Smirnov test with the level of significance α= 0.10

**Chi-Square test**

A public opinion poll surveyed a random sample of 1000 voters. Respondents were classified by gender (male or female) and by voting preference (BJP, Congress and AAP). Results are shown below:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Programing language Preferences | | | Row total |
| BJP | Congress | AAP |
| Male | 200 | 150 | 50 | 400 |
| Female | 250 | 300 | 50 | 600 |
| Column total | 450 | 450 | 100 | 1000 |

Design and implement a Java program to conduct chi-square test with level of significance and determine if there is a gender gap. Identify whether the men’s preferences differ significantly from the women's preferences.

1. Algorithms
2. Presentation of Results
3. Analysis and Discussions
4. Conclusions

# Laboratory 8: Simulation of a single server Single queue (M/M/1)

1. Introduction and Purpose of Experiment
2. Aim and Objectives
3. Experimental Procedure

Design and implement a Java program to simulation of Single Server Single Queue System and create Java simulation class hierarchy by implementing sub-class of the given thread class to simulate simple M/M/1 queue.

Structure of model should include:

a. Time Based Entity Generator

b. Exponential Inter arrival Time and Service time Distribution subsystem.

c. FIFO Queue

d. Single Server

Consider the following Input values

i. Mean inter arrival time of request = 4.5 mins

ii. Mean service time = 3.5 mins

iii. Sigma = 0.6

iv. Total request = 1000

v. Long seed = 123567

Determine the following

i. Server utilization

ii. Maximum line length

iii. Average response time

iv. Number of requests spend minimum four minutes in the system

v. Simulation run length in minutes

vi. Number of departures

1. Algorithms
2. Presentation of Results
3. Analysis and Discussions
4. Conclusions