Simulation and Modelling

Course Title: Simulation and Modelling **Credit: 3**
Course No: CSIT.314 **Number of period per week: 3+3**
Nature of the Course: Theory + Lab
Year: Third, Semester: Fifth
Level: B. Sc. CSIT

1. Course Introduction

A simulation is a computer model that mimics the operation of a real or proposed system. Simulation is a commonly-used and practical technique for modeling and analyzing the real world systems in order to make more effective decisions. This course is designed to teach students the processes, tools, and techniques for performing effective simulation analyses. In particular, the course focuses on the basic underlying principles of how simulations work, how to collect and analyze input data, how to build basic simulation models, how to verify and validate simulation models, and how to interpret (and perform statistical analyses of) simulation output.

2. Objectives

After Completing each student should be able:

- to design simulation models.
- to design simulation studies.
- to analyze simulation output.
- to collect and analyze input data.
- to incorporate knowledge from other disciplines in simulation studies.

3. Specific Objectives and Contents

Specific Objectives	Contents
• Understand Concepts of Simulation and Modeling • Identify Application areas and Importance of Simulation • Investigate Systems, System Types, and Simulation Steps	**Unit I: Basics of Simulation & Modeling (4 Hrs)** 1.1. Definition of Simulation, When is and is not Simulation Appropriate, Advantages and Disadvantages, Application Areas 1.2. System & System Environment, System Components, Discrete and Continuous Systems 1.3. Model of a System, Types of System Models, Discrete Event System Simulation, Steps in Simulation Study
• Exemplify Simulation of Systems	**Unit II: Simulation Examples and Principles (4 hr)** 2.1. Simulation of Queuing System: Single Channel

with hand • Use Even Scheduling to Simulate System Manually • Demonstrate Discrete Event Simulation	Queue & Call Center Problem, Simulation of Inventory System: New Dealers Problem, Order up to Level Inventory System 2.2. Concepts in Discrete Event Simulation, The Event Scheduling/Time Advance Algorithm, World Views, Manual Simulation Using Event Scheduling
• List and Exemplify Software's used in Simulation • Explore and use GPSS is Simulation Systems • Apply the Tool "ARENA" in System Simulation	**Unit III: Simulation Software (6 hr)** 3.1. Categories of Simulation Software, Selection of Simulation Software 3.2. Simulation in GPSS/H, GPSS Building Blocks, Single Server Queue Simulation in GPSS 3.3. Guided Tour Through ARENA, Simple Processing System, Modelling Basic Operations and Inputs, Introduction to Animation
• Explore and Understand Statistical Models Used in Simulation • Exemplify Discrete and Continuous Distributions • Understand Poisson Process and its Applications in Simulation • Understand Empirical Distribution of Discrete and Continuous Systems	**Unit IV: Statistical Models (6 hr)** 4.1. Review of Terminology and Concept, Useful Statistical Models 4.2. Discrete Distributions: Binomial, Geometric & Poisson Distribution, Continuous Distributions: Uniform, Exponential, Gamma, Normal, & Triangular Distribution 4.3. Poisson Process, Properties of Poisson Process, Non-stationary Poisson Process, Empirical Distributions
• Apply Queuing Models in Simulating Continuous Systems • Demonstrate Performance of Queuing Systems • Understand role of Differential Equations in Continuous System Simulation	**Unit V: Continuous System Simulation (5 hr)** 5.1. Characteristics of Queuing Systems, Types of Queues, Queuing Notation 5.2. Long-Run Measures of Performance of Queuing Systems, Markov Models 5.3. Differential and Partial Differential Equations in Simulating Continuous Systems
• Understand Concepts of Random and Pseudo Random Numbers • Implement Specified methods for Generating Random Numbers • Perform Tests for Identifying Degree of Randomness • Exemplify and Implement Random Variate Generation techniques	**Unit VI: Random Numbers (7 hr)** 6.1. Properties of Random Numbers, Generation of Pseudo-random Numbers 6.2. Random Number Generation Techniques: Linear Congruential Method, Combined Linear Congruential Generator, Random Number Streams 6.3. Test for Random Numbers: Frequency Tests, Uniformity Test, Test for Autocorrelation 6.4. Random Variate Generation: Inverses Transform Technique-Exponential, Uniform, Empirical Continuous & Discrete Distributions, Acceptance-Rejection Technique-Poisson Distribution, Non-stationary Poisson Process, Gamma Distribution

• Investigate Distributions of Input Data • Simulating and Fitting the Models with Input Data • Exemplify Multivariate and Time-series Input Methods • Validate Input-Output by Using Confidence Interval Approach • Understand the Concepts of Model Calibration	**Unit VII: Input Modeling, Verification & Validation (8 hr)** 7.1. Data Collection, Identifying Distribution with Data, Parameter Estimations 7.2. Goodness-of-fit Tests: Chi-Square Test, Chi-Square Test with Equal Probabilities, p-values and Best Fits 7.3. Selecting Input Models without Data, Multi-Variate and Time-Series Input Models 7.4. Model Building, Verification, and Validation, Verification of Simulation Models, Calibration and Validation of Models
• Categorize Simulation Types on the Basis of Output Analysis • Understand Performance Measures for Output Analysis • Demonstrate Confidence Interval and Quantile Methods for Analyzing Outputs of Terminating Simulations • Exemplify Methods for Analyzing Outputs of Steady-State Simulations	**Unit VIII: Output Analysis (5 Hrs)** 8.1 Types of Simulation with respect to Output Analysis, Stochastic Nature of Output Data 8.2 Measures of Performance and their Estimation: Point Estimation, Confidence Interval Estimation 8.3 Output Analysis for Terminating Simulations: Confidence Interval with Specified Precision, Quantiles 8.4 Output Analysis for Steady-State Simulations: Bias Initialization, Error Estimation & Replication Method

Evaluation System

Undergraduate Programs							
External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**	**Practical**	**Weightage**	**Mark**
End semester examination	60	Assignments	20%	20	Practical Report copy	25%	20
(Details are given in the separate table at the end)		Quizzes	10%		Viva	25%	
		Attendance	20%		Practical Exam	50%	
		Internal Exams	50%				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

External evaluation

1. **End semester examination:**
   It is a written examination at the end of the semester. The questions will be asked covering all the units of the course. The question model, full marks, time and others will be as per the following grid.

2. **External Practical Evaluation:**
   After completing the end semester theoretical examination, practical examination will be held. External examiner will conduct the practical examination according to the above mentioned evaluation. There will be an internal examiner to assist the external examiner. Three hours time will be given for the practical examination. In this examination Students must demonstrate the knowledge of the subject matter.

   Full Marks: 100, Pass Marks: 45, Time: 3 hr

Nature of question	Total questions to be asked	Total questions to be answered	Total marks	Weight
Group A: multiple choice	20	20	20×1 = 20	60%
Group B: Short answer type questions	8	6	6×8 = 48	60%
Group C: Long answer type questions	3	2	2×16 =32	60%
			100	60%

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

Internal evaluation

Assignment: Each student must submit the assignment individually. The stipulated time for submission of the assignment will be seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of the course.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions.

Instructional Techniques: All topics are discussed with emphasis on real-world application. List of instructional techniques is as follows:

- Lecture and Discussion
- Group work and Individual work
- Assignments
- Presentation by Students
- Quizzes
- Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attend a formal exam/quiz/test, there won't be any provision for re-exam. Unless and until the student clears one semester he/she will not be allowed to study in the following semesters.

Laboratory Work

Student should practice laboratory exercises using simulation and modeling packages such as GPSS and ARENA. Besides this, students can also develop their own simulator by using general purpose high level programming language such C, C++ etc. The lab work should be practiced for minimum of 3 lab hours per week. It is highly recommended that a project work of simulation of some real world problem. A group of four or five students can work together. The project should be documented in a proper report structure in such a way that it will reflect the applications of the theories taught in the course.

Prescribed Texts

1. Banks, Carson, Nelson, and Nicol, "*Discrete-Event Simulation,*" Fourth Edition, 2005 Prentice Hall
2. W. David Kelton, Randall P. Sadowski and Nancy B. Swets, "*Simulation with Arena*" Fifth Edition, 2010 ,McGraw Hill

References

1. Geoffrey Gorden, "System Simulation", Second Edition, 1978, Prentice Hall of India
2. Thomas J. Schriber, "An Introduction to Simulation Using GPSS/H", 1991, Wiely Edition