Pokhara University
Faculty of Science and Technology

Course No.: CMP 338
Course title: **Simulation and Modeling**
Nature of the course: Theory and Practical

Level: Bachelor

Full marks: 100
Pass marks: 45
Time per period: 1 hour
Total periods: 45
Program: BE

1. Course Description

This course covers the various concepts system simulation. This course emphasizes on fundamental concept, principles and properties of continuous system and discrete system. It covers examples, solutions and programming language regarding continuous and discrete system. It also covers probability concepts and random number generation technique and testing. Output generated from the process is analyzed.

2. General Objective

The main objectives of the course are

- To provide basic knowledge of various systems.
- To study continuous and discrete system.
- To get the concept of probability concept and random numbers.

3. Methods of Instruction

3.1.General instructional Techniques: Lecture, discussion, readings.
3.2.Specific instructional Techniques: Lab works, Project works

4. Contents in Detail

Specific Objectives	Contents
• Familiarize and compare the various concept of system and its environment. • To explain why simulations are used in systems analysis and design, emphasizing their role in modeling complex systems.	**Unit 1 : Introduction to simulation and modeling (4 hrs)** 1.1System and its concept 1.2System Environment 1.3Types of System (continuous and discrete, static and dynamic, stochastic and deterministic) 1.4Steps of Simulation 1.5Advantage, disadvantage and application of simulation 1.6System Modeling and types of models 1.7Principles of Modeling 1.8Verification and validation of model

• To introduce simulation techniques such Monte Carlo simulation. • To provide knowledge on how to create accurate models that represent real-world systems.	**Unit 2 : System Simulation(8 hrs)** 2.1Monte Carlo Method 2.1.1 Problems regarding Monte Carlo method 2.2 Comparison of simulation and analytic solution 2.3 System simulation and its types 2.4 Real time simulation 2.5 Lag Models (Distributed lag Model, Cobweb Model) 2.6 Queuing system and its characteristics and notation 2.7 Single server queuing model 2.7.1 Arrival routine 2.7.2 Departure routine 2.7.3 Performance measure of SSQM 2.8 Time advance mechanism (next event oriented and fixed increment oriented)
• To represent continuous system using differential equations and other mathematical tools. • To analyze system dynamics, understand their stability, and predict future behavior. • To solve and implement continuous system using analog method and programming language.	**Unit 3 : Continuous System(8 hrs)** 3.1 Introduction to continuous system 3.2 Representation of continuous system using differential equation 3.3 Linear and nonlinear differential equations and its examples 3.4 Analog Computer (Components and examples) 3.5 Digital Analog Simulators 3.6 Hybrid Computers 3.7 CSSLs, CSMP III 3.7.1 Structural Statement 3.7.2 Data Statements 3.7.3 Control Statements 3.8 Feedback System with example 3.9 Interactive System
• For understanding and modeling processes where changes occur at distinct, separate points in time or involve discrete states. • To gather statistics white studying discrete system.	**Unit 4 : Discrete System(7 hrs)** 4.1 Introduction to discrete system 4.2 Components of discrete system 4.3 Representation of Time 4.4 Examples for discrete system 4.4.1Telephone call system as lost call and delayed call system 4.4.2 Bank Queue System 4.5 Simulation Programming Task 4.6 Steps of simulation programming task 4.7 Gathering Statistics 4.7.1 Counters and Summary Measures 4.7.2 Measuring Utilization and Occupancy 4.7.2 Recording Distribution and Summary Measures 4.8 Discrete System Simulation Languages

• To understand probability distributions and random variables, which can accurately represent random phenomena in simulations. • To generate random numbers using various generators and test their independence and uniformity property.	**Unit 5 : Probability Concept and Random Numbers(7 hrs)** 5.1 Stochastic System 5.2 Discrete and continuous probability function 5.3 Random numbers versus pseudo random numbers 5.4 Properties of random numbers 5.5 Random number generation Techniques 5.5.1 Linear Congruential Generator 5.5.2 Mixed Generator 5.5.3 Additive and Incremental Generator 5.6 Test for randomness 5.6.1 Uniformity Test - KS Test - Chi Square Test 5.6.2 Independence Test - Run Test (above and below, up and down, length of Runs - Test for Auto correlation - Gap Test - Poker Test
• To test different scenarios, identifying potential issues, and optimizing performance without the risks and costs associated with real-world trials.	**Unit 6 : Discrete System Languages (6 hrs)** 6.1 Simulation using GPSS 6.1.1 GPSS problems 6.2 Simulation using SIMSCRIPT 6.2.1 Organization of SIMSCRIPT 6.2.2 Programs of SIMSCRIPT 6.3 Other discrete simulation Languages
• To interpret, understand, and make decisions based on the results generated by a simulation model. • To validate the simulation results, optimizing system performance, and providing actionable insights.	**Unit 7 : Output Analysis Method(5 hrs)** 7.1 Nature of Problem 7.2 Estimation Method 7.3 Simulation Run Statistics 7.4 Replication of Runs 7.5 Elimination of Initial Bias

5. Laboratory work: (30 hrs)

1. Representing ohm's law and verifying its VI characteristics.
2. Generating value of pi using Monte Carlo method and check its accuracy level
3. Implementing various models in simulation

4. Generating random numbers and their testing
5. Implementing GPSS programs
6. Examples of continuous and discrete system
7. Develop a small project to simulate any mathematical model

6. List of Tutorials:

The various tutorial activities that suit this course should cover all the content of this course to give student a space to engage more actively with the course content in the presence of instructor. Students should submit tutorials as assignments or class works to the instructor for evaluation. The following tutorial activities of 15 hours should be conducted to cover all the content of course:

A. Discussion-based Tutorials: (6 hrs)
   1. Explain the concepts of system modeling, abstraction, and the simulation life cycle.
   2. Example of different models that can be simulated.
   3. Analyzing the output obtained from simulation.
   4. Continuous and discrete system example.

B. Problem solving-based Tutorials: (9 hrs)

   1. Examples using Monte Carlo simulation technique.

   2. Example questions for distributed lag model and cobweb model.

   3. Numerical to generate random numbers.

   4. Testing random number properties using various techniques.

7. Evaluation system and Students' Responsibilities

Internal Evaluation

In addition to the formal exam(s), the internal evaluation of a student may consist of quizzes, assignments, lab reports, projects, class participation, etc. The tabular presentation of the internal evaluation is as follows.

External Evaluation	**Marks**	**Internal Evaluation**	**Weight**	**Marks**
Semester-End examination	50	Assignments	12%	
		Attendance	6%	
		Unit test	14%	
		Assessment	28%	
		Practical	40%	
Total External	50	Total Internal	100%	50

Full Marks 50+50 = 100

Student Responsibilities:

Each student must secure at least 45% marks in internal evaluation with 80% attendance in the class in order to appear in the Semester-End Examination. Failing to get such score will be given NOT QUALIFIED (NQ) and the student will not be eligible to appear the Semester-End Examination. 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 the period. If a student fails to attend a formal exam, test, etc. there won't be any provision for re-exam.

8. Prescribed Books and References

Text Book

1. G Gorden, **System Simulation**, Prentice Hall of India.
2. Jerry Banks, John S. Carson II, Barry L Nelson, David M. Nicol, **Discrete Event System Simulation,**

Reference Books

1. "Simulation Modeling and Analysis" by Averill M. Law and W. David Kelton
2. "System Simulation with Digital Computer" by N. W. McCormick
3. "Simulation and the Monte Carlo Method" by Reuven Y. Rubinstein and Dirk P. Kroese