University of Asia Pacific (UAP)
Department of Computer Science and Engineering (CSE)

Course Outline

Program:	Computer Science and Engineering (CSE)
Course Title:	Simulation and Modeling
Course Code:	CSE 405
Semester:	Spring-2018
Level:	4th Year 1st Semester
Credit Hour:	3.0
Name & Designation of Teacher:	**Dr. Md. Rajibul Islam (Assistant Professor),** Dr. Mohammad Shafiul Alam (Professor, EEE, DU)
Office/Room:	7th Floor, Teacher's Compound (Extended)
Consultation Hours:	**Thursday**, 9:30am − 10:50am (Section C)
E-mail:	**md.rajibul.islam@uap-bd.edu,** msalam@du.ac.bd
Mobile:	**01835022398,** 01726849575
Rationale:	Simulation and modeling and analysis is becoming important in every discipline as a method for improving or investigating process performance. It is a cost-effective method for evaluating the performance of resource allocation and alternative operating policies. It may also be used to evaluate the performance of capital equipment before investment. This course is not only important for computer science students but also engineering and management professionals will find the course useful.
Pre-requisite (if any)**:**	MTH 301: Statistics and Probability

Course Synopsis:

Introduction: Introduction to discrete-event system simulation, Simulation Examples, Simulation of Queueing Systems. Simulation of Inventory Systems, General Principles. Concepts in Discrete-Event Simulation. List Processing, Simulation Software. History of Simulation Software. Selection of Simulation Software. An Example Simulation, Practical Demonstration on Matlab/Simulink, Mathematical and statistical models, Queueing Models, Random-Number Generation, Random-Variate

Generation, Input Modeling, Verification and Validation of Simulation Models, Output Analysis for a Single Model, etc.

Course Objectives (CO):
The objectives of this course are to:

- Introduce students to the simulation and modeling techniques ; and
- Provide students with opportunities to develop basic simulation and modeling skills with respect to carrying out research projects using any simulation method on the computer.

Learning Outcomes (LO):
Upon successful completion of this course, the student will be able to:

(Knowledge based)

Problem formulation
• System definition
• Model translation
• Verification, validation
• Experimental design
• Analysis

(Skills)

- use the simulation software to:
- carry out simulation tasks;
- use graphs to present their results;
- write scripting languages to generate other reports.

Teaching-learning and Assessment Strategy: Lectures, assignments, quizzes, exams

Linkage of LO with Assessment Methods & their Weights:

LO	Assessment Method	(%)
1 – 3	Quiz	10
1 – 6	Class attendance	10
4,5,6	Assignment	10
1– 4	Midterm Exam	20
1 – 6	Final Exam	50

Minimum attendance: 70% class attendance is mandatory for a student in order to appear at the final examination.

Mapping of Course LO and Generic Skills:

Learning Outcome (LO) of the Course	Generic Skills* (Appendix-1)											
	1	2	3	4	5	6	7	8	9	10	11	12
Describe the ….	√											
Explain terms related to ..	√											

Understand and apply normalized concept of modeling and simulation process knowledge.		√	√	√								
Use different ….		√	√		√							
Analyze and enhance ….		√		√	√							
Design and develop ...			√	√	√				√	√		

Lecture Schedule

Lectures	**Topics to be discussed**	**Book Ref**	**Event**
Lec-1-2	INTRODUCTION TO DISCRETE-EVENT SYSTEM SIMULATION. 1. Introduction to Simulation. When Simulation Is the Appropriate Tool. When Simulation Is Not Appropriate. Advantages and Disadvantages of Simulation. Areas of Application. Systems and System Environment. Components of a System. Discrete and Continuous Systems. Model of a System. Types of Models. Discrete-Event System Simulation. Steps in a Simulation Study.	Chapter-1: *Discrete-Event System Simulation:* Banks, and Carson White Paper Introduction to Modeling and Simulation by Anu Maria	
Lec-3- 6	2. Simulation Examples. Simulation of Queueing Systems. Simulation of Inventory Systems. i. The Able-Baker Call Center Problem ii. The News Dealer's Problem iii. Order-Up-To-Level Inventory System iv. A Network Interface Card (NIC) v. A Reliability Problem vi. Random Normal Numbers vii. Lead-Time Demand viii. Project Simulation Other Examples of Simulation.	Chapter 2. Simulation Examples *Discrete-Event System Simulation:* Banks, and Carson Folder: simulation_examples-lec-3-6	Class Test-1 after 2 lectures (15 minutes) Assignment-1- Students will implement all example problems using any software and demonstrate in the class (10 marks)

Lec-7	3. General Principles. Concepts in Discrete-Event Simulation. List Processing.	Chapter 3 General Principles *Discrete-Event System Simulation:* Banks, and Carson	Class Test-2 after 6 lectures (15 minutes)
Lec- 8-9	4. Simulation Software. History of Simulation Software. Selection of Simulation Software. An Example Simulation. Simulation in C++. Simulation in GPSS. Simulation in CSIM. Simulation Packages. Experimentation and Statistical Analysis Tools. Trends in Simulation Software. Matlab/Simulink	Chapter 4 Simulation Software *Discrete-Event System Simulation:* Banks, and Carson	
Lec-10	Practical Demonstration on Matlab/Simulink		Assignment-2- Students will implement some example problems using Matlab/Simulink (10 marks)
Lec-11-12	MATHEMATICAL AND STATISTICAL MODELS. 5. Statistical Models in Simulation. Review of Terminology and Concepts. Useful Statistical Models. Discrete Distributions. Continuous Distributions. Poisson Process. Empirical Distributions.	Chapter 5 Statistical Models in Simulation *Discrete-Event System Simulation:* Banks, and Carson	Class Test-3 after 10 lectures (15 minutes)
Lec-13-14	Queueing Models. Characteristics of Queueing Systems. Queueing Notation. Long-Run Measures of Performance of Queueing Systems. Steady-State Behavior of Infinite-Population Markovian Models. Steady-State Behavior of Finite-Population Models. Networks of Queues	Cbapter 6 Queueing Models *Discrete-Event System Simulation:* Banks, and Carson	
Lec-15-16	RANDOM NUMBERS. 7. Random-Number Generation. Properties of Random Numbers. Generation of Pseudo-Random Numbers. Techniques for Generating Random Numbers. Tests for Random Numbers.	Chapter 7 Random-Number Generation *Discrete-Event System Simulation:* Banks, and Carson	Assignment-3- Students will implement some algorithms (10 marks)

Lec-17-18	8. Random-Variate Generation. Inverse Transform Technique. Direct Transformation for the Normal and Lognormal Distributions. Convolution Method. Acceptance-Rejection Technique.	Chapter 8 Random-Variate Generation *Discrete-Event System Simulation:* Banks, and Carson	
Lec-19-20	Input Modeling. Data Collection. Identifying the Distribution with Data. Parameter Estimation. Goodness-of-Fit Tests. Selecting Input Models without Data. Multivariate and Time-Series Input Models.	Chapter 9 Input Modeling *Discrete-Event System Simulation:* Banks, and Carson	
Lec-21-22	Verification and Validation of Simulation Models. Model Building, Verification, and Validation. Verification of Simulation Models. Calibration and Validation of Models.	Chapter 10 Verification and Validation of Simulation Models *Discrete-Event System Simulation:* Banks, and Carson	Class Test-4 after 20 lectures (15 minutes)
Lec-23-24	Output Analysis for a Single Model. Types of Simulations with Respect to Output Analysis. Stochastic Nature of Output Data. Measures of Performance and Their Estimation. Output Analysis for Terminating Simulations. Output Analysis for Steady-State Simulations.	Chapter 11 Output Analysis for a Single Model *Discrete-Event System Simulation:* Banks, and Carson	
Lec-25-26	Operational Laws and problems	Lecture note	

Required References:

Text Books

1. Banks, J., Carson, J. S., Nelson, B. L., & Nicol, D. M. (2013). *Discrete-Event System Simulation: Pearson New International Edition*. Pearson Higher Ed.
2. Law, Averill M., W. David Kelton, and W. David Kelton. *Simulation modeling and analysis*. Vol. 2. New York: McGraw-Hill, 1991.

Recommended References: Banks, J., Carson, J. S., Nelson, B. L., & Nicol, D. M. (2013). *Discrete-Event System Simulation: Pearson New International Edition*. Pearson Higher Ed.

Grading System: As per the approved grading scale of University of Asia Pacific (Appendix-2).

Student's responsibilities: Students must come to the class prepared for the course material covered in the previous class (es).
They must submit their assignments on time.

No late or partial assignments will be acceptable. There will be no make-up quizzes/class tests.

Appendix-1: Generic Skills

No.	Generic Skills
1.	**Engineering Knowledge**
2.	**Problem Analysis**
3.	**Design/Development of Solutions**
4.	**Investigation**
5.	**Modern Tool Usage**
6.	**The Engineer and Society**
7.	**Environment and Sustainability**
8.	**Ethics**
9.	**Communication**
10.	**Individual and Team Work**
11.	**Life Long Learning**
12.	**Project Management and Finance**

Generic Skills (Detailed):

1. **Engineering Knowledge (T)** -Apply knowledge of mathematics, sciences, engineering fundamentals and manufacturing engineering to the solution of complex engineering problems;
2. **Problem Analysis (T)** – Identify, formulate, research relevant literature and analyze complex engineering problems, and reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences;
3. **Design/Development of Solutions (A)** –Design solutions, exhibiting innovativeness, for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, economical, ethical, environmental and sustainability issues.
4. **Investigation (D)** Conduct investigation into complex problems, displaying creativeness, using research-based knowledge, and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions;
5. **Modern Tool Usage (A & D)** -Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations;
6. **The Engineer and Society (ESSE)** -Apply reasoning based on contextual knowledge to assess societal, health, safety, legal, cultural, contemporary issues, and the consequent responsibilities relevant to professional engineering practices.
7. **Environment and Sustainability (ESSE)** -Understand the impact of professional engineering solutions in societal, global, and environmental contexts and demonstrate knowledge of and need for sustainable development;
8. **Ethics (ESSE)** –Apply professional ethics with Islamic values and commit to responsibilities and norms of professional engineering code of practices.
9. **Communication (S)** -Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions;

10. **Individual and Team Work (S)** -Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
11. **Life Long Learning (S)** -Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
12. **Project Management and Finance (S)** -Demonstrate knowledge and understanding of engineering management and financial principles and apply these to one's own work, as a member and/or leader in a team, to manage projects in multidisciplinary settings, and identify opportunities of entrepreneurship.

Appendix-2: Grading Policy

Numeric Grade	Letter Grade	Grade Point
80% and above	A+	4.00
75% to less than 80%	A	3.75
70% to less than 75%	A-	3.50
65% to less than 70%	B+	3.25
60% to less than 65%	B	3.00
55% to less than 60%	B-	2.75
50% to less than 55%	C+	2.50
45% to less than 50%	C	2.25
40% to less than 45%	D	2.00
Less than 40%	F	0.00

Prepared by:	Checked by:	Approved by: (Head of the Detp.)
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