Course E-Syllabus

1	**Course title**	Modeling and Simulation
2	**Course number**	1901353
3	**Credit hours**	3
	Contact hours (theory, practical)	(35 theory,10 Instructor–Monitoring and Student–Self practical)
4	**Prerequisites/corequisites**	Data Structures – 1901233
5	**Program title**	B.Sc. in Computer Science
6	**Program code**	01
7	**Awarding institution**	The University of Jordan
8	**School**	King Abdullah II School of Information Technology
9	**Department**	Computer Science
10	**Level of course**	Third year
11	**Year of study and semester (s)**	2020/2021 – Summer semester
12	**Final Qualification**	Bachelor
13	**Other department (s) involved in teaching the course**	-
14	**Language of Instruction**	English
15	**Teaching methodology**	☐Blended ☒Online
16	**Electronic platform(s)**	☒Moodle ☒Microsoft Teams ☐Skype ☐Zoom ☒Others: Microsoft Forms
17	**Date of production/revision**	10-2022/ 1-10-2022

18 Course Coordinator:

Prof. Ahmad Sharieh
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Office hours: Sunday, Tuesday: 1:00 -2:00; Monday : 12:00 – 1:00
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19 Other instructors:

None

٢٠ Course Description:

The course is an introduction to modeling and simulation. It includes the following topics: Fundamental concepts of computer simulation; Models for computer simulation; Random numbers: Pseudorandom number generation and testing, Monte Carlo methods; Introduction to distribution functions; Simulation modeling; Discrete-event simulation; Continuous simulation; Verification and Validation of simulation models; Input analysis; Output analysis; Queuing theory models; Design code; Test and Debug simulation programs; Sample of applications. There will be weekly practice in the lab.

٢١ Course aims and outcomes:

A– Aims:

The Goal:

The goal of this course is to enable the student to design, develop, implement, and analyze simulation models, and to have comprehensive of important aspects of simulation study including: modeling, simulation software, model verification and validation, random number generation and variates, and analysis of simulation experiment and applications.

Course Objectives: Enable students to

1. Explain the role of Modeling and Simulation in solving problems.
2. Utilize the Modeling Process to identify the key parameters of a model, estimate model outcomes, and utilize a computational tool, e.g., Arena or MATLAB to implement the mathematical representation of the model.
3. Construct difference-based computer models simulations.
4. Develop a simulation in a computational tool, e.g., Arena.
5. Describe and utilize functions to model empirical data, visualize empirical data and the fitting function using tool, e.g. Arena.
6. Identify different types of models and simulations, and explain the use of models and simulations for how models link the physical world, the virtual world and the science of prediction.
7. Assess computational models - Discuss methods for reviewing models, their verification and validation. Discuss the suitability and limits of the model to address the problem for which the model was designed.
8. Document the development and implementation of the model and present in oral and written form.

B– Intended Learning Outcomes (ILOs): Upon successful completion of this course students will be able to:

Intended Learning Outcomes(ILOs):

Successful completion of this course should enable a student to gain the following knowledge and skills:

A- Knowledge and Understanding:

Al) Understand the concepts of system, modeling and simulation.

A2) Identify different types of models and simulations including discrete-event and continuous simulation.

A3) Understand the basic methods for generating random variables and variates.

A4) Understand the principle of verification and validation and their techniques.

A5) Identify specific industry related examples of modeling and simulation

B- Cognitive and Intellectual skills:

B1) Design a model and simulation for a real system.

B2) Compare the different techniques for variable generation and distributing functions.

B3) Discuss the differences between the predictions of the model, the actual results and the relevance of these differences to the problem.

B4) Analyze the output data of a simulation for taken decision.

C- Subject specific skills:

C1) Model a system and develop a simulation for it.

C2) Convey the results of the simulation accurately, validate the model with data, and discuss the quality and sources of errors in the model.

C3) Analyze modeling and simulation input and output data.

C4) Develop a simulation to solve real world problems using programming language or tools such as Arena or MATLAB.

D- Transferable skills:

Dl) Document the development and implementation of the model and present it in oral and written form.

D2) Convey the need and importance, the cost effectiveness, and the time-effect of modeling and simulation.

٢٢. Topic Outline and Schedule (SUMMER semester):

Week	Lecture	Topic	Teaching Methods*/platform	Evaluation Methods**	References
1+2+3	1.1	**Topic 1** **Introduction:** computer Modeling and Simulation, and applications.	Synchronous lecturing/meeting	In class questions	Presentation Week1.ppt (loaded on MOODLE) Ch1 Ref.1
	2.2	**Topic 2** **Modeling and Simulation Project Steps:** Problem definition, Data Collection.	Synchronous lecturing/meeting		
	2.3	Conceptual Modeling,	Synchronous lecturing/meeting		
	2.4	Transferring, Validation & Verification	Asynchronous lecturing/meeting		
	3.5	Implementation	Synchronous lecturing/meeting		
4+5	3.1	**Topics 3** Discrete event simulation (DES), state, events, simulation clock, and event list.	Synchronous lecturing/meeting	HW-Assignment 1: Manual Simulation of a single server single queue Software-Assignment 1: Program Simulation of a single server single queue	Ch2 Ref. 1 Discrete-event-Manual-Simulation .xls Barber- Sim-Example .pdf (loaded on MOODLE)- Excel Sheet
	4.2	Barber Shop Example	Synchronous lecturing/meeting		
	4.3	Flowchart of Single Server Single queue	Asynchronous lecturing/meeting		
	4.4	Single Server-Single Queue program 1	Synchronous lecturing/meeting		
	5.5	Single Server-Single Queue program 2	Asynchronous lecturing/meeting		
6	6.1	**Topic 3** **Arena:** Introduce to Arena basics and its facilities; basic elements of Arena,	Synchronous lecturing/meeting	Practice on Arena	Ch 2: From Ref(2) + Ch3 Ref (1). Lab-for-Arena.pdf
	6.2	Graphical screen objects, modules, entities, storage objects (attributes, variables, and expressions),	Synchronous lecturing/meeting		

		statistics collection, and output reporting; and examples.		Software-Assignment-2: Using-Arena-Mortgage	Mortgage-Example.pdf
	7.3	Statistics collection, and output reporting; and examples	Asynchronous lecturing/meeting		
	7.4	Mortgage Example	Asynchronous lecturing/meeting		
	7.5	Mortgage with Animation	Asynchronous lecturing/meeting		
8+9	8.1	**Topic 4:** **Probability and Statistics**: information on the elements of probability, statistics, and stochastic processes that is relevant to simulation modeling.	Synchronous lecturing/meeting	Midterm Exam	Ch 4 from Ref. 1 Probability -Dist.ppt
	8.2	Discrete Distribution probability	Synchronous lecturing/meeting		
	9.3	Continuous Distributed Probability	Asynchronous lecturing/meeting	HW-Assignment 2: f, F, inverse-random varaite	Variate-generation .pdf Ch 7 & 8 from Ref 1
	9.4	Random Variate	Asynchronous lecturing/meeting		
	9.5	Inverse Method	Asynchronous lecturing/meeting		
10+11	10.1	**Topic 5: Validation & Verification**	Synchronous lecturing/meeting	HW-Assignment 3: Validation-Confidence Int.	Ch 5 Ref 1
	10.2	Validation & Calibration	Synchronous lecturing/meeting		
	11.3	Statistics Methods: T-test and Confidence Interval	Asynchronous lecturing/meeting		
	11.4	Error Types	Synchronous lecturing/meeting		
	11.5	Monte Carlo	Asynchronous lecturing/meeting		Monte -Carlo – example.pdf (On MOODLE)

12	12.1	**Topic 6** **Arena Advanced Process**	Synchronous lecturing/meeting	Software-Assignment 3: Computing value by Monte Carlo .	Video on Parking Lot
	12.2	Parking Lot example	Synchronous lecturing/meeting		
	12.3		Asynchronous lecturing/meeting		
13+14	13.1	**Topic 7** Arena Input Analyzer	Synchronous lecturing/meeting	*Software – Assignment 4: Restaurant* *Input-Analyzer-Example*	*Use-Input-Analyzer* Input-Analyzer-Example (on MOODLE)
	13.2	Input Analysis	Asynchronous lecturing/meeting		
	14.3	Output Analysis	Synchronous lecturing/meeting		
	14.4	Arena: Curve fit			
15+16	15.1	**Topic 8** **Queuing Theory**	Synchronous lecturing/meeting	Hw-Assignment 4: single-server-single queue All Topics	Queuing Theory (on MOODLE):V-on-queuing-theory-Examples Summary and Revision
	15.2	Examples	Asynchronous lecturing/meeting		
	15.3	Review	synchronous lecturing/meeting		
	16.4	Final			

- Teaching methods include: Synchronous lecturing/meeting; Asynchronous lecturing/meeting
- Evaluation methods include: Homework, Quiz, Exam, pre-lab quiz…etc

٢٣ Evaluation Methods:

Opportunities to demonstrate achievement of the ILOs are provided through the following assessment methods and requirements:

Evaluation Activity	Mark	Topic(s)	Period (Week)	Platform
HW-Assignment 1	3	1+2	2	MOODLE
Software-Assignment 1	4	2	3	MOODLE
Software-Assignment-2	3	3	4	MOODLE
Midterm Exam	25	1-3	7	Teams Forms
HW-Assignment 2	3	4	9	MOODLE
HW-Assignment 3	3	5	11	MOODLE

Software-Assignment 3	3	6	12	MOODLE
Software Assignment 4	3	6+7	13	MOODLE
HW-Assignment 4	3	8	14	MOODLE
Final Exam	50	All Topics	15-16	Microsoft Teams and Forms

٢٤ Course Requirements (e.g: students should have a computer, internet connection, webcam, account on a specific software/platform…etc):

- Computer
- Internet connection
- Account on MS Teams, Moodle, Microsoft Forms
- Software Package such as ARENA, MATLAB
- A programming Language such C, C++, Java,

٢٥ Course Policies:

Please follow The University of Jordan regulations regarding the following policies, more information is at www.ju.edu.jo

A- Attendance policies:

B- Absences from exams and submitting assignments on time:

C- Health and safety procedures:

D- Honesty policy regarding cheating, plagiarism, misbehavior: In addition, if any work is proved to be copied or cheated, a task will be given zero.

E- Grading policy: Grading policy + Weighting (i.e. weight assigned to exams as well as other student work):

20% Two Tests (each 10%)
15% Homework assignments
15% Software assignments (Program and Package)
50% (Writing (Essay & Problem Solving questions, and multiple choices: Final Exam)

Tentative General scale is

Satisfactory completion of this subject requires a 50% pass in the end-of-semester examination and scales as follows.

0-39	F	40-44	D-	45-49	D	50-54	D+	55-59	C-
60-64	C	65-69	C+	70-74	B-	75-79	B		
80-84	B+	85-89	A-	90-100	A				

The grade may be given based on the average of all marks out of 100%.

F- Available university services that support achievement in the course: Labs + lab Technicians

٢٦ References:

A- Required book(s), assigned reading and audio-visuals:

A- Required book (s), assigned reading and audio-visuals:

Required book (s)-Text Book: assigned reading and audio-visuals:

1- Simulation Modeling and Analysis , 5/e, by Averil M Law and W. David Kelton, McGraw Hill, 2015. www.mhhe.com/engcs/industrial/lawkelton

2- Tayfur Altiok and Benjamin Melamed, Simulation Modeling and Analysis with Arena, edition 2007/ or the latest.

3- Video and audio are; and presentation slides are uploaded on MOODLE on the elarnig.ju.edu.jo. Each starts with V-XXX, where XXX is the name of the topic.

B- Recommended books, materials, and media:

http://www2.mansfield.edu/mathematics/program-course-goals-objectives-and-outcomes/index.cfm

٢٧ Additional information:

N/A

Name of Course Coordinator: Prof. Ahmad Sharieh Signature: *Ahmad Sharieh* Date: 1/10/2022

Head of Curriculum Committee/Department: ---------- Signature: ----------

Head of Department: ---------- Signature: ----------

Head of Curriculum Committee/Faculty: ---------- Signature: ----------

Dean: ----------Signature: ----------