

## Course Syllabus

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|----|---|--|
| 1  | <b>Course title</b>   | Advanced Methods in Modeling and Simulation  |
| 2  | <b>Course number</b>  | 1901755  |
| 3  | <b>Credit hours</b>   | 3  |
|    | <b>Contact hours theory</b>                                 | The whole semester   |
| 4  | <b>Prerequisites/Co-requisites</b>                          | Knowledge in probability, statistics and a programming language  |
| 5  | <b>Program title</b>  | Master in Computer Science   |
| 6  | <b>Program code</b>   | 017  |
| 7  | <b>Awarding institution</b>                                 | The University of Jordan   |
| 8  | <b>School</b>   | King Abdullah II School of Information Technology  |
| 9  | <b>Department</b>   | Computer Science   |
| 10 | <b>Level of course</b>                                      | Graduate   |
| 11 | <b>Year of study and semester (s)</b>                       | Second year / Second Semester  |
| 12 | <b>Final Qualification</b>                                  | Master   |
| 13 | <b>Other department (s) involved in teaching the course</b> | -  |
| 14 | <b>Language of Instruction</b>                              | English  |
| 15 | <b>Teaching methodology</b>                                 | <input type="checkbox"/> Blended <input checked="" type="checkbox"/> Online  |
| 16 | <b>Electronic platform(s)</b>                               | <input checked="" type="checkbox"/> Moodle <input checked="" type="checkbox"/> Microsoft Teams <input type="checkbox"/> Skype <input type="checkbox"/> Zoom<br><input checked="" type="checkbox"/> Others: Microsoft Forms |
| 17 | <b>Date of production/revision</b>                          | 22/2/2023  |

### 18 Course Coordinator:

Prof. Ahmad Sharieh  
 Office Numbers: KASIT Ground Floor Room: 105.  
 Office hours: Sunday, Tuesday: 12:30 -1:30; Monday : 10:00 – 11:00  
 Phone Number: Ext: 22591.  
 Email: sharieh@ju.edu.jo

### 19 Other instructors:

None

### 20 Course Description:

The following is the original course description:

“Advanced concepts of computer simulation; models for computer simulation; random numbers: Pseudorandom number generation and testing, Monte Carlo methods. distribution functions. Simulation modeling: discrete-event simulation, continuous simulation; verification and validation of simulation models: input analysis, output analysis. Queuing theory models; design codes, test and debug simulation programs. Sample applications.”

This course exploits students to advanced methods in modeling and simulation concepts of computer simulation. The topics include models for computer simulation; random numbers generating and testing methods; Monte Carlo methods and applications; distribution functions; Methods for variate numbers; Simulation modeling: discrete-event simulation, continuous simulation; verification and validation of simulation models (tracing, confidence intervals); input analysis, output analysis; Queuing theory models (single and multiple queues); design factors, test and debug simulation programs. Student will produce simulation projects and reports.

## **21 Course aims and outcomes:**

A- Aims:

**The Goal:**

The goal of this course is to enable the student to develop a simulation models for a real or predicted system; and apply the process of modeling and simulations method.

**Course Objectives:** Enable students to

1. Explain the methods of Modeling and Simulation in solving problems.
2. Utilize a software package and programming language to identify the key parameters of a model, estimate model outcomes, and utilize a computational tool, e.g., Arena or MATLAB to implement simulation project.
3. Describe and utilize functions to model empirical data, visualize empirical data and the fitting function using tool, e.g. Arena.
4. Analyze a system and explain the use of models and simulations for how models link the physical world, the virtual world and the science of prediction.
5. Discuss methods for reviewing models, their verification and validation, and assess the suitability and limits of the model to address the problem for which the model was designed.
6. Write and present the documents for the development and implementation of the model.

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

**A- Knowledge and Understanding:**

- A1) Understand the concepts of system, modeling and simulation and their types.
- A2) Understand the basic methods for generating random variables and variates.
- A3) Understand the principle of verification and validation and their techniques.

**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, and variate.
- B3) 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) Analyze modeling and simulation input and output data.
- C3) Develop a simulation to solve real world problems using programming language or tools

such as Arena or MATLAB.

**D- Transferable skills:**

- DI) Document the development and implementation of the model and present it in oral and written

## 22. Topic Outline and Schedule (SUMMER semester):

| Week  | Topic   | Teaching Methods*/platform                     | Evaluation Methods**   | References   |
|-------|---|--|--|--|
| 1+2+3 | <p>Topic 1<br/><b>Introduction:</b> Mathematical Modeling and Simulation, and applications.</p> <p>Topic 2<br/><b>Modeling and Simulation</b><br/><b>Project Steps:</b> Problem definition, Data Collection. Conceptual Modeling, Transferring, Validation &amp; Verification, implementation</p>                   | Synchronous lecturing/MOODLE                   | Discussion<br>In class questions   | Handout  |
| 4+5   | <p>Topics 3<br/><b>Discrete event simulation</b><br/>Inventory example, Red-Dead Sea example, Simulation by hand and Excel sheet</p>  | Synchronous lecturing, Reading/MOODLE          | <p>HW-Assignment 1: Manual Simulation</p> <p>2-Software-Assignment 2: Program Simulation</p> | Example .pdf (loaded on MOODLE)- Excel Sheet                 |
| 6     | <p>Topic 4:<br/><b>Arena:</b> facilities; basic elements of Arena, objects, modules, entities, storage objects (attributes, variables, and expressions), statistics collection, and output reporting.</p> <p>Statistics collection, and output reporting; and example with Animation, Input and Output Analyzer</p> | Synchronous lecturing, Developing model/MOODLE | Practice on Arena<br>Software-Assignment-3: Using-Arena-Mortgage                             | <p>Video on animation</p> <p>Lab-for-Arena.pdf: workshop</p> |

|     |   |  |   |   |
|-----|---|--|---|---|
| 8+9 | <p>Topic 5:<br/> <b>Probability and Statistics:</b><br/> Discrete Distribution probability and Continuous Distributed Probability<br/> Random Variate<br/> Method of finding random variate numbers</p> | Synchronous lecturing, Reading/MOODLE  | <p>HW-Assignment 4: f, F, inverse-random variate</p> <p><b>Midterm Exam</b></p> | <p>Probability -Dist.ppt<br/> Variate-generation.pdf</p> <p>Handout</p> |
| 10  | <p>Topic 6: Validation &amp; Verification</p> <p>Validation &amp; Calibration<br/> Statistics Methods: T-test and Confidence Interval, Error Types</p>  | Synchronous lecturing, Reading/MOODLE  | <p>HW-Assignment 5: Testing and Validation-Confidence Int.</p>                  | Handout   |
| 11  | <p>Topic 7<br/> <b>Monte Carlo:</b> Steps and Applications</p>  | Synchronous lecturing, Reading /MOODLE | <p>Software-Assignment 6: Computing value by Monte Carlo</p>                    | Handout   |
| 12  | <p>Topic 8<br/> <b>Queuing Theory:</b> Single queue, model types, multiple queues</p>   | Synchronous lecturing, Reading /MOODLE | <p>Assignment 7: on queues</p>  | <p>Queuing Theory (on MOODLE):V-on-queuing-theory-Examples</p>          |

|       |  |  |            |         |  |
|-------|--|--|------------|---------|--|
| 13    | <b>Topic 9:<br/>Design factoring Scenarios:</b><br>manufacturing example | Synchronous lecturing,<br>Reading/MOODLE | Discussion | Handout |  |
| 14+15 | <b>Demo + Presentation+<br/>Report</b>                                   | Synchronous                              | Discussion |         |  |
| 16    | <b>Final Exam</b>  |  |            |         |  |

- \* Teaching methods include: Synchronous lecturing/meeting; lecturing/Reading
- \*\* Evaluation methods include: Homework, Quiz, Exam, lab, quiz, project,...etc.

### 23 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+3             | 2             | MOODLE                           |
| Software-Assignment 2     | 3           | 1+2+3             | 3             | MOODLE                           |
| Software-Assignment-3     | 3           | 4                 | 4             | MOODLE                           |
| <b>Midterm Exam</b>       | <b>20</b>   | <b>1-5</b>        | <b>7</b>      | <b>Essay</b>                     |
| HW-Assignment 4           | 3           | 4                 | 9             | MOODLE                           |
| HW-Assignment 5           | 3           | 6                 | 11            | MOODLE                           |
| Software Assignment 6     | 3           | 7                 | 12            | MOODLE                           |
| HW-Assignment 7           | 3           | 8                 | 14            | MOODLE                           |
| <b>Demo+ Presentation</b> | <b>20</b>   |                   |               |                                  |
| <b>Final Exam</b>         | <b>40</b>   | <b>All Topics</b> | <b>15-16</b>  | <b>Microsoft Teams and Forms</b> |
| <b>Total</b>              | <b>100%</b> |                   |               |                                  |

**24 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,

**25 Course Policies:**

Please follow The University of Jordan regulations regarding the following policies, more information is at [www.ju.edu.jo](http://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.

|       |    |       |    |        |    |       |   |
|-------|----|-------|----|--------|----|-------|---|
| 0-49  | F  | 50-54 | C- | 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

**26 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](http://www.mhhe.com/engcs/industrial/lawkelton)
- 2- System Design, Modeling, and Simulation using Ptolemy II First Edition, Version 1.02 ISBN: 978-1-304-42106-7 Please cite this book as: Claudius Ptolemaeus, Editor, , Ptolemy.org, 2014. <http://ptolemy.org/systems>
- 3- Tayfur Altiok and Benjamin Melamed, Simulation Modeling and Analysis with Arena, edition 2007/ or the latest.
- 4- 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.
- 5- Theory of Modeling and Simulation Discrete Event and Iterative System Computational Foundations, Third Edition Bernard P. Zeigler University of Arizona Tucson, USA Alexandre Muzy CNRS, I3S United Kingdom Copyright © 2019 Elsevier Inc.

B- Recommended books, materials, and media:

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

## 27 Additional information:

N/A

Name of Course Coordinator: Prof. Ahmad Sharieh Signature: *Ahmad Sharieh* Date: 27/2/2023

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

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

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

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