



Course Specification of Modeling and Simulation

Course No (.....)

2020/2021

Head of Department	Vise Dean for Quality Assurance	Dean of the Faculty	Dean of Academic Development center and Quality
Dr. Ahmed Al-shalabi	Dr. Anwar Al-Shamiri	Dr. Nagi Al-Shibani	Assoc. Prof. Dr.Huda Al.Emad
			Rector of Sana'a University Prof. Dr. Qassim Mohammed Abbas



Course Specification of Modeling and Simulation

I. Course Identification and General Information:						
1	Course Title:	Modeling and Simulation				
2	Course Code & Number:					
3	Credit hours:	C.H				TOTAL
		Th.	Seminar	Pr	Tr.	
		2	-	2	-	3
4	Study level/ semester at which this course is offered:	Level 4 /1 st semester				
5	Pre –requisite (if any):	Software engineering				
6	Co –requisite (if any):	None				
7	Program (s) in which the course is offered:	Computer Science				
8	Language of teaching the course:	English/Arabic				
9	Study System	Term Based System				
10	Mode of delivery:	Full Time				
11	Location of teaching the course:	Faculty of Computer and Information Technology				
12	Prepared By:	Dr. Nabil Al shaweea				
13	Date of Approval					

Head of Department

Dr. Ahmed Al-shalabi

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II. Course Description:

This course provides an introduction to the field of modeling and simulation (M&S) from the perspective of M&S as an essential tool for systems engineering. The course presents an overview of the M&S discipline, the model/simulation development process, the types of models and simulations used in the various phases of the systems engineering life cycle, and the verification, validation, and accreditation of models and simulation. The strengths and limitations of M&S are explored with respect to the application of M&S use in systems engineering. Examples are given for several types of systems, including both military and civilian systems. Statistical methods used in applying M&S in systems engineering are explained. The Arena process modeling tool is used for some examples, an individual assignment, and a team-based project. Upon completion of the course, the student will be able to explain when M&S will provide meaningful support to a technical program, select the appropriate modeling techniques for a given task, plan the development of a model/simulation and the modeling of its input data, and analyze the results of its execution to support decisions at key milestones of a system's life cycle.

III. Course Intended learning outcomes (CILOs) of the course (maximum 8CILOs)

Referenced PILOs (Only write code number of referenced Program Intended learning outcomes)

a.1	Demonstrate knowledge of fundamental and advanced concepts of modeling and simulation, and its applications.	A1. A3.
a.2	Explain the principles, concepts, practical design of simulated systems, input modeling and random numbers generators.	A1. A2. A3.

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b.1	Analyze a reasoned argument to the solution of familiar and unfamiliar problems relevant to computer science	B1. B2
b.2	Distinguish appropriate theories, principles and concepts relevant to the modeling and simulation methods that are applicable to computer science	B2. B3
c.1	Employ mathematical foundations and concepts to generate and test random number variants and apply them to develop simulation models.	C1. C4
c.2	Design a model, analyze the output data produced by designed model, and test its validity, then apply simulation techniques to solve complex systems problems.	C2. C3, C6
d.1	Work effectively as an individual, and as part of a group to carry out problem description, formulation, and analysis.	D1
d.2	Write technical reports and deliverables effectively.	D2

(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
a1. Demonstrate knowledge of fundamental and advanced concepts of modeling and simulation, and its applications.	- Interaction lecture - Dialogue and discussion.	- Quizzes - Assessment - Midterm Exam
a2. Explain the principles, concepts, practical design of simulated systems, input modeling and random numbers generators.	-Brainstorming. -Problem Solving. -Labs	- Final Exam -Individual and group project work

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(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
b1. Analyze a reasoned argument to the solution of familiar and unfamiliar problems relevant to computer science& information technology.	- Interaction lectures - practical classes	- Assignment - Quizzes - lap
b2. Distinguish appropriate theories, principles and concepts relevant to the modeling and simulation methods that are applicable to computer science& information technology.	- discussion - brain storm -Labs	- Midterm Exam - Final Exam

(C)Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
c1. Employ mathematical foundations and concepts to generate and test random number variants and apply them to develop simulation models.	-Interaction lecture - Problem Solving	- Practical Exam and performance observation - Midterm Exam
c2.Design a model, analyze the output data produced by designed model, and test its validity, then apply simulation techniques to solve complex systems problems.	- Project-based learning -lap	- Final Exam - Individual and group project work

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(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
d1. Work effectively as an individual, and as part of a group to carry out problem description, formulation, and analysis.	<ul style="list-style-type: none"> -Group discussions - Problem Solving - Project-based learning 	<ul style="list-style-type: none"> - Projects evaluation - case study - presentation - assignments
d2 .Write reports and deliverables effectively.		

IV. Course Content:					
A – Theoretical Aspect:					
Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	contact hours
1	Introduction to Modeling and Simulation	a1, a2,	<ul style="list-style-type: none"> • Modeling and Simulation Process • Simulation of a Pure-pursuit Problem • System and its Model • Types of Models 	2	2

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			<ul style="list-style-type: none"> Simulation of an Inventory Problem Basic Nature of Simulation When to Simulate 		
2	Simulation of Continuous System (I)	a1, a2, b2	<ul style="list-style-type: none"> A chemical reactor Numerical integration Vs Continuous system simulation Selection of integration formulas 	1	2
3	Simulation of Continuous System (II)	a1,b2 c1, c2,d1	<ul style="list-style-type: none"> Simulation of a servo system Simulation of water reservoir system Analog Vs Digital Simulation 	1	2
4	Discrete System Simulation (I)	a1, b2, c1, c2,d1	<ul style="list-style-type: none"> Fixed time-step vs event-to-event model Simulating randomness Generation of random numbers 	1	2
5	Discrete System Simulation (II)	a2, b1, b2,, c1, c2,,d1	<ul style="list-style-type: none"> Generation of non-uniformly distributed random numbers Montecarlo Vs stochastic simulation 	1	2
6	Simulation of Queuing System	a2, b2, c1, c2,d1	<ul style="list-style-type: none"> Rudiments of queuing theory Simulation of single-server queue Simulation of two-server queue 	1	2
7	Simulation of a PERT Network	b2,c1,d1	<ul style="list-style-type: none"> Network model of a project PERT/CPM for Project Scheduling & Management Analysis of an activity network Program Evaluation Review Technique (PERT) Critical path computation Simulation of an activity network 	1	2

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8	Design and Evaluation of Simulation Experiments	b2, c1, c2,d1	<ul style="list-style-type: none"> Length of simulation runs Variance reduction techniques Experimental layout Validation Analysis for the Design of Simulation Experiments RBM Approximations 	2	4
9	Simulation Languages (I)	a2, b2, ,d2	<ul style="list-style-type: none"> Continuous and Discrete system simulation languages Continuous simulation languages 	1	2
10	Simulation Languages (II)	a2, b2, c1, d2	<ul style="list-style-type: none"> Block-structured continuous simulation languages GPSS (General Purpose Simulation System) General Purpose Simulation Packages Expression-based languages 	1	2
11	Seminar	All		2	4
Number of Weeks /and Units Per Semester				14	28

B - Practical Aspect: (if any)

Order	Tasks/ Experiments	Number of Weeks	contact hours	Learning Outcomes
1	-Review on Modeling and Simulation Process and types of Models -Example for some simulation sys	2	4	a1, a2
2	Discuss and explain for most language programming that support modeling and simulation,	1	2	b1,b2,c1

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	and mention all simulation languages such as GPSS, and arena.			
3	Implement hand simulation examples: Single Channel Queue, Storing Problem.	1	2	b2, c1, c2, d1
4	Implement hand simulation examples: Bakr and Ahmed for rapid service. Servo System.	1	2	b2, c1, c2, d1
5	Reemployment previous simulation examples by using EXCEL program.	2	4	b1, b2,c1, c2, d1
6	Mid Exam	1	2	a1,b1, b2,c1, c2, d1
7	Simulation Languages: Arena. Project bar, Basic Process Panel, and Navigate Panel.	1	2	c1, c2, d1,d2
8	Simulation Languages: Arena. Advance Process Panel, Blocks Panel, and Element Panel.	1	2	c1, c2.1, d1
9	Implement hand simulation examples: Single Channel Queue. Storing Problem. By using Arena.	2	4	b1, b2,c1, d1
10	Implement hand simulation examples: Bakr and Ahmed for rapid service. Servo System. By using Arena.	1	2	b1, b2, c1, d1

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11	Seminar	1	2	a1,a2,b1, b2, c1, d1
Number of Weeks /and Units Per Semester		14	28	

V. Teaching strategies of the course:

- Interactive Lectures
- Practical classes
- Project-based learning
- Problem solving
- seminars
- oral presentation
- Practical in computer (lab)

VI. Assignments:

No	Assignments	Aligned CIOs(symbols)	Week Due	Mark
1	Chapter 1 and 2 - Exercises	b2, c1, c2	4 th to 8 th	5
2	Chapter 3 and 4Exercises	b2,c1, c2	4 th to 12 th	5
3	Lab-reports	b2, c1, c2	2,4,8,10	10
Total				20

VII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning

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					Outcomes
1	Assignments	2 th , 4 th to 12 th	20	20%	b2, c1, c2
2	Mid-term exam (Lab)	7 th	5	5%	a1,b1, b2, c2
3	Mid-term exam (Theory)	7 th	10	10%	a1, a2, b1, b2, c2
4	Final exam (Lab)	14 th	5	5%	b2, c1, c2
5	Final exam (Theory)	16 th	60	70%	a1, a2, b1, b2, c1,c2,d1
	Total		100	100%	

VIII. Learning Resources:	
<ul style="list-style-type: none"> Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher). 	
1- Required Textbook(s) (maximum two).	
	1– Hector Guerrero, Dec 15 2018,- Excel Data Analysis: Modeling and Simulation Hardcover 2- Nancy B. Kelton, W. David, Sadowski, Randall P., Zupick , 2014, Simulation with Arena
2- Essential References.	
	النمذجة و Excel, SIMAN و Arena and General Purpose Simulation System و عدنان ماجد بري 1- المحاكاة باستخدام 2-Harry perros, 2009, Computer Simulation techniques: the definitive introduction, computer science department NC state university
3- Electronic Materials and Web Sites etc.	
	1- https://www.cs.nmt.edu/~jholten/ModelingAndSimulation/links.html

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2-1- https://casmodeling.springeropen.com/articles/10.1186/s40294-016-0015-x#Sec1
3- https://ep.jhu.edu/programs-and-courses/645.757-foundations-of-modeling-and-simulation-in-systems-engineering

IX. Course Policies:	
<p>Unless otherwise stated, the normal course administration policies and rules of the Faculty of Computer and Information Technology apply. For the policy, see: -----</p> <p>-----</p> <p>The University Regulations on academic misconduct will be strictly enforced. Please refer to -----</p>	
1	<p>Class Attendance: A student should attend not less than 75 % of total hours of the subject; otherwise he will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring a proof statement from university Clinic</p>
2	<p>Tardy: For late in attending the class, the student will be initially notified. If he repeated lateness in attending class, he will be considered as absent.</p>
3	<p>Exam Attendance/Punctuality: A student should attend the exam on time. He is Permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam.</p>
4	<p>Assignments & Project The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time.</p>
5	<p>Cheating: For cheating in exam, a student will be considered as fail. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty.</p>
6	<p>Plagiarism: Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proofed a plagiarism of a student, he will be disengaged from the Faculty. The final disengagement of the student</p>

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	from the Faculty should be confirmed from the Student Council Affair of the university.
7	<p>Other policies:</p> <ul style="list-style-type: none"> - Mobile phones are not allowed to use during a class lecture. It must be closed, otherwise the student will be asked to leave the lecture room - Mobile phones are not allowed in class during the examination. - Lecture notes and assignments my given directly to students using soft or hard copy

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Faculty of Computer & Information Technology

Department of Computer Science

Program of Computer Science

Course syllabus of Modeling and Simulation

Course No (.....)

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I. - Information about Faculty Member Responsible for the Course:							
Name of Faculty Member		Office Hours					
Location Telephone No.		SAT	SUN	MON	TUE	WED	THU
E-mail							

II. Course Identification and General Information:						
1-	Course Title:	Modeling and simulation				
2-	Course Number & Code:					
3-	Credit hours:	C.H				Total
		Th.	Seminar	Pr.	F. Tr.	
		2	-	2	-	3
4-	Study level/year at which this course is offered:	CS Level 4 /1 st semester				
5-	Pre –requisite (if any):	Software engineering -				
6-	Co –requisite (if any):	None				
7-	Program (s) in which the course is offered	Computer Science				
8-	Language of teaching the course:	English/Arabic				
9-	System of Study:	Term Based System				
10-	Mode of delivery:	Full Time				

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11-	Location of teaching the course:	Faculty of Computer and Information Technology
III. Course Description:		
<p>This course provides an introduction to the field of modeling and simulation (M&S) from the perspective of M&S as an essential tool for systems engineering. The course presents an overview of the M&S discipline, the model/simulation development process, the types of models and simulations used in the various phases of the systems engineering life cycle, and the verification, validation, and accreditation of models and simulation. The strengths and limitations of M&S are explored with respect to the application of M&S use in systems engineering. Examples are given for several types of systems, including both military and civilian systems. Statistical methods used in applying M&S in systems engineering are explained. The Arena process modeling tool is used for some examples, an individual assignment, and a team-based project. Upon completion of the course, the student will be able to explain when M&S will provide meaningful support to a technical program, select the appropriate modeling techniques for a given task, plan the development of a model/simulation and the modeling of its input data, and analyze the results of its execution to support decisions at key milestones of a system's life cycle.</p>		

IV. Intended learning outcomes (ILOs) of the course:
Brief summary of the knowledge or skill the course is intended to develop:
<p>a.1 Demonstrate knowledge of fundamental and advanced concepts of modeling and simulation, and its applications.</p> <p>a.2 Explain the principles, concepts, practical design of simulated systems, input modeling and random numbers generators.</p> <p>b.1 Analyze a reasoned argument to the solution of familiar and unfamiliar problems relevant to computer science & information technology.</p> <p>b.2 Distinguish appropriate theories, principles and concepts relevant to the modeling and simulation methods that are applicable to computer science & information technology.</p> <p>c.1 Employ mathematical foundations and concepts to generate and test random number variants and apply them to develop simulation models.</p> <p>c.2. Design a model, analyze the output data produced by designed model, and test its validity, then apply simulation techniques to solve complex systems problems.</p>

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d.1 Work effectively as an individual, and as part of a group to carry out problem description, formulation, and analysis.

d.2 Write technical reports and deliverables effectively.

V. Course Content:			
Distribution of Semester Weekly Plan of Course Topics/Items and Activities.			
A – Theoretical Aspect:			
Order	Topics List	Week Due	Contact Hours
1	Introduction to Modeling and Simulation	1 st	4
2	Simulation of Continuous System (I)	3 th	2
3	Simulation of Continuous System (II)	4 th	2
4	Discrete System Simulation (I)	5 th	2
5	Discrete System Simulation (II)	6 th	2
6	Mid-Term Exam	7 th	2
7	Simulation of Queuing System	8 th	2
8	Simulation of a PERT Network	9 th	4
9	Design and Evaluation of Simulation Experiments	11 th	2
10	Simulation Languages (I)	12 th	2
11	Simulation Languages (II)	14 th	4

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12	Seminar	15 th	2
13	Final exam	16 th	2
Number of Weeks /and Units Per Semester		16	32

B– Practical Aspect: (if any)			
Order	Topics List	Week Due	Contact Hours
1	-Review on Modeling and Simulation Process and types of Models -Example for some simulation sys -	1 st	4
2	Discuss and explain for most language programming that support modeling and simulation, and mention all simulation languages such as GPSS, and arena. simulation, and mention all simulation languages such as GPSS, and arena.	3 rd	2
3	Implement hand simulation examples: Single Channel Queue, Storing Problem.	4 th	2
4	Implement hand simulation examples: Bakr and Ahmed for rapid service. Servo System.	5 th	2

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5	Reemployment previous simulation examples by using EXCEL program.	6 th	4
6	Mid Exam	8 th	2
7	Simulation Languages: Arena. Project bar, Basic Process Panel, and Navigate Panel.	9 th	2
8	Simulation Languages: Arena. Advance Process Panel, Blocks Panel, and Element Panel.	10 th	2
9	Implement hand simulation examples: Single Channel Queue. Storing Problem. By using Arena.	11 th	4
10	Implement hand simulation examples: Bakr and Ahmed for rapid service. Servo System. By using Arena.	13 th	2
11	Seminar	14 th	2
12	Final Exam	15 th	2
Number of Weeks /and Units Per Semester		15	30

VI. Teaching strategies of the course:	
▪ Interactive Lectures	
▪ Practical classes	
▪ Project-based learning	
▪ Problem solving	
▪ seminars	
▪ oral presentation	
▪ Practical in computer (lab)	

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VII. Assignments:			
No	Assignments	Week Due	Mark
1	Chapter 1 and 2 - Exercises	4 th to 8 th	5
2	Chapter 3 and 4 Exercises	4 th to 12 th	5
3	Lab-reports	2 nd , 4 th , 8 th , 10 th	10
Tota Total			20

VIII. Schedule of Assessment Tasks for Students During the Semester:				
Assessment	Type of Assessment Tasks	Week Due	Mark	Proportion of Final Assessment
1	Assignments	2 th , 4 th to 12 th	20%	b2, c1, c2
2	Mid-term exam (Lab)	8 th	5%	a1, b1, b2, c2
3	Mid-term exam (Theory)	7 th	10%	a1, a2, b1, b2, c2
4	Final exam (Lab)	15 th	5%	b2, c1, c2
5	Final exam (Theory)	16 th	70%	a1, a2, b1, b2, c1, c2, d1
		100	100%	

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IX. Learning Resources:	
<ul style="list-style-type: none"> • Written in the following order: (Author – Year of publication – Title – Edition – Place of publication – Publisher). 	
1- Required Textbook(s) (maximum two).	
<p>1– Hector Guerrero, Dec 15 2018,- Excel Data Analysis: Modeling and Simulation Hardcover</p> <p>2- Nancy B. Kelton, W. David, Sadowski, Randall P., Zupick , 2014, Simulation with Arena</p>	
2- Essential References.	
<p>النمذجة و Excel, SIMAN و Arena and General Purpose Simulation System , عدنان ماجد بري 1- المحاكاة باستخدام</p> <p>2- Harry perros, 2009, Computer Simulation techniques: the definitive introduction, computer science department NC state university</p>	
3- Electronic Materials and Web Sites etc.	
<p>1-https://www.cs.nmt.edu/~jholten/ModelingAndSimulation/links.html</p> <p>2-1-https://casmodeling.springeropen.com/articles/10.1186/s40294-016-0015-x#Sec1</p> <p>3-https://ep.jhu.edu/programs-and-courses/645.757-foundations-of-modeling-and-simulation-in-systems-engineering</p>	

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1	<p>Class Attendance:</p> <p>A student should attend not less than 75 % of total hours of the subject; otherwise he will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring a proof statement from university Clinic</p>
2	<p>Tardy:</p> <p>For late in attending the class, the student will be initially notified. If he repeated lateness in attending class, he will be considered as absent.</p>

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3	<p>Exam Attendance/Punctuality: A student should attend the exam on time. He is Permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam.</p>
4	<p>Assignments & Project The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time.</p>
5	<p>Cheating: For cheating in exam, a student will be considered as fail. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty.</p>
6	<p>Plagiarism: Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proofed a plagiarism of a student, he will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university.</p>
7	<p>Other policies:</p> <ul style="list-style-type: none"> - Mobile phones are not allowed to use during a class lecture. It must be closed, otherwise the student will be asked to leave the lecture room - Mobile phones are not allowed in class during the examination. - Lecture notes and assignments my given directly to students using soft or hard copy

Head of Department	Vise Dean for Quality Assurance	Dean of the Faculty	Dean of Academic Development center and Quality
Dr. Ahmed Al-shalabi	Dr. Anwar Al-Shamiri	Dr. Nagi Al-Shibani	Assoc. Prof. Dr.Huda Al.Emad

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اللجنة الإشرافية			
م.م	الاسم	الصفة	التوقيع
١	أ.م.د. عبد الماجد الخليدي	نائب عميد الكلية للشؤون الأكاديمية	
٢	أ.م.د. احمد مجاهد	نائب عميد مركز التطوير الأكاديمي وضمان الجودة	
٣	د. حسين الأشول	ممثل المركز في الكلية	
٤	أ.د. إبراهيم المطاع	نائب رئيس الجامعة للشؤون الأكاديمية	

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