Course Specification

(Postgraduate Programs)

Course Title:	**CS 727(0911727)**
Course Code:	**Advanced Modeling and Simulation**
Program:	**Master of Science in Computer Science**
Department:	**Computer Science**
College:	**Computer Sciences and Information technology**
Institution:	**King Faisal University**
Version:	*Course Specification Version Number*
Last Revision Date:	*Pick Revision Date.*

Table of Contents

A. General information about the course:

1. Course Identification:

1. Credit hours: 3(3-0-6)					
2. Course type					
A.	☐University	☐College	☐Department	☐Track	
B.	☐Required		☒ Elective		
3. Level/year at which this course is offered: Level 2, 3 or 4					
4. Course General Description:					
This course gives basic understanding on advanced modeling techniques used in dynamic systems, including continuous and discrete models. The course also provides knowledge on how to design and implement simulations for real-world complex systems and gain proficiency in using computational tools for modeling and simulation (e.g., MATLAB, Simulink, Python, AnyLogic, Arena). The course also teaches on applying optimization methods to improve simulation models thereby interpreting and analyzing simulation results to draw meaningful conclusions. Finally Communicate simulation results effectively, including data visualization techniques.					
5. Pre-requirements for this course (if any):					
None					
6. Pre-requirements for this course (if any):					
None					
7. Course Main Objective(s):					
This course covers advanced modeling and simulation techniques used in various fields such as engineering, science, economics, and social sciences. Topics include system dynamics, Monte Carlo simulation, agent-based modeling, discrete event simulation, optimization methods, and the use of advanced computational tools. The course emphasizes the development of models, analysis of system behavior, and effective use of simulation software.					

2. Teaching Mode: (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom		
2	E-learning		
3	Hybrid • Traditional classroom • E-learning	45	100%

No	Mode of Instruction	Contact Hours	Percentage
4	Distance learning		

3. Contact Hours: (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	45
2.	**Laboratory/Studio**	
3.	**Field**	
4.	**Tutorial**	
5.	**Others (specify)……**	
	Total	45

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods:

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	Ability to develop mathematical models for complex systems.	K3	Lectures	Assignment Quiz
1.2				
…				
2.0	**Skills**			
2.1	Critical thinking skills in analyzing simulation outputs and refining models.	S2,S3	Lectures	Midterm Final Exam Quiz Project
2.2	Ability to select and apply the appropriate simulation methodology for specific problems	S2, S3	Lectures	Midterm Final Exam Quiz Project
2.3	Critical thinking skills in analyzing simulation outputs and refining models.	S2, S3	Lectures	Midterm Final Exam Quiz Project
3.0	**Values, autonomy, and responsibility**			
3.1	Proficiency in solving real-world	V1	Project	Project Demo

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	problems through simulation tools..			
3.2	Ability to write reports and deliver presentations that effectively communicate simulation results.	V2	Project	Project report and presentation
...				

C. Course Content:

No	List of Topics	Contact Hours
1.	Introduction to Advanced Modeling and Simulation-Types of models: Continuous, Discrete, Hybrid-Overview of Simulation Tools and Techniques	3
2.	System Dynamics and Feedback Systems-Model development for dynamic systems-State-space representation and simulation-Analysis of stability and sensitivity	6
3	Monte Carlo Simulation- Random variables and stochastic processes-Monte Carlo techniques for solving problems-Variance reduction methods- Applications in finance, risk analysis, etc	6
4	Agent Based Modeling- Basics of agent-based models (ABMs)-Design and implementation of ABMs-Applications in social systems, ecology, and economics	6
5	Discrete event Simulation-Modeling systems with discrete ev-ents-Queuing theory and process modelling-Simulation of manufacturing systems, service systems, and logistics	6
6	Optimization Techniques in Simulation-Introduction to optimization-Linear and nonlinear optimization-Simulated annealing, genetic algorithms, and other heuristic methods-Optimization of simulation models	6

7	Advanced Computational Methods for Simulation- Numerical techniques and algorithms-High-performance computing in simulation-Parallel processing and distributed simulation Model Validation and Verification-Importance of model validation and verification-Techniques for verifying and validating simulation models-Sensitivity analysis and uncertainty quantification	6
8	Applications of Modeling and Simulation-Case studies in various industries (automotive, healthcare, energy, logistics, etc.)-Modeling and simulating complex real-world systems-Project work or research-based application	6
Total		**45**

D. Students Assessment Activities:

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Quiz**	**Week-5**	**10**
2.	**Mid Term**	**Week-12**	**25**
4	**Project**	**Week-15**	**25**
5	**Final exam**	**End Semester**	**40**

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.)

E. Learning Resources and Facilities:

1. References and Learning Resources:

Essential References	Banks, J., Carson, J. S., & Nelson, B. L. (2010). *Discrete-Event System Simulation* (5th ed.). Pearson Education.
Supportive References	Law, A. M. (2014). *Simulation Modeling and Analysis* (5th ed.). McGraw-Hill. Ross, S. M. (2014). *Introduction to Probability Models* (11th ed.). Academic Press. Bonabeau, E. (2002). *Agent-based modeling: Methods and techniques for simulating human systems*. Proceedings of the National Academy of Sciences, 99(suppl_3), 7280-7287.
Electronic Materials	
Other Learning Materials	

2. Educational and Research Facilities and Equipment Required:

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	Sufficient seats (typically 20) as per student registration required in the lecture
Technology equipment (Projector, smart board, software)	Sufficient computer terminals with required setup having the necessary software installed and configured for the students to complete assignments and projects. Data show is needed to demonstrate in the class
Other equipment (Depending on the nature of the specialty)	Not Required

F. Assessment of Course Quality:

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students	Indirect Assessment through Teaching Evaluation
Effectiveness of students' assessment	Faculty	Indirect assessment through Course Evaluation Survey
Quality of learning resources	Students	Indirect Assessment through Learning Resources Survey
The extent to which CLOs have been achieved	**Faculty**	Direct assessment through Rubrics analyses
Other		

Assessor (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval Data:

COUNCIL /COMMITTEE	
REFERENCE NO.	
DATE	