Kingdom of Saudi Arabia Ministry of Higher Education **Qassim University** College of Engineering		**المملكة العربية السعودية** وزارة التعليم العالي **جامعة القصيم** **كليه الهندسه**

Modeling and Simulation of Engineering Systems

College: Engineering

Department: Electrical, Civil and Mechanical

First: Course Definition

1- Course Code: GE 605

2- Units: 3 credit hrs

3- Semester:

4- Prerequisite:

5- Co-requisite:

6- Location

Second: Course Objectives

1- To enable the student to apply modern software packages to conduct analysis of real world data.
2- To enhance the student understanding of technical underpinning of modern computer simulation software.
3: To develop the student skills to apply the appropriate analytical technique to a wide variety of real world problems and data sets.
4: To enhance the student ability to summarize and present the analysis results in a clear and coherent manner.

Third: Course Description

1- Topics to be covered

Subject	Weeks	Units
1. Introduction 1.1. Definition of computer simulation 1.2. Importance of modeling and simulation 1.3. Modeling and simulation as complementary tasks 1.4. Computer simulation as an interdisciplinary tool 1.5. Examples of application in various fields of science,	1	3

technology and life		
2. General concepts of modeling 2.1. Continuous and discrete models and simulation 2.2. The model: components, descriptive variables and interaction rules 2.3. The concept of model state 2.4. Descriptive variables: input, state, output, model parameters, state transition and output functions 2.5. Experimental frames and simplified models 2.6. Model validation, verification and credibility 2.7. Classification of dynamic systems	2	6
3. Chronology of M&S methods and software development	1	3
4. Discrete simulation 4.1. Probability, distributions and random numbers generation (including chi-square test) 4.2. Simulation "Monte Carlo" 4.3. Object- and agent-oriented simulation. Model time, event messages and event queue 4.4. CSL 4.5. GPSS 4.6. PSM++ 4.7. The "Three phases" strategy in event simulation 4.8. Object-oriented simulation - ideas of Simula67	3	9
5. Continuous simulation 5.1. Analog machines 5.2. Possible continuous model representations: ODE, Signal Flow, Bond Graphs 5.3. Examples of continuous ODE models 5.3.1. Mass in movement 5.3.2. Car suspension 5.3.3. Stirred tank 5.4. Numerical methods for ODEs 5.5. Direct coding of a continuous simulation program 5.6. Exercise for ODE simulation : car suspension 5.7. Signal Flow Graphs (SGF) 5.7.1. Nodes and links, SFG and block diagrams 5.7.2. Examples: an automatic control system, an electric circuit 5.7.3. Eliminating equations and coding from the simulation task 5.7.4. Signal flow module of PSM++ - link types	3	9

5.7.5. Signal flow module of PSM++ - an exercise 5.8. Bond graphs 5.8.1. The bond and the related variables 5.8.2. Node and bond types, causality 5.8.3. Examples: application to mechanical systems 5.8.4. Exercises		
6. System Dynamics (SD) 6.1. System thinking. Definition of SD by Jay Forrester 6.2. Basic concepts 6.3. SD software tools 6.4. Examples: business dynamics, ecology	2	6
7. Advanced topics 7.1. Distributed simulation 7.2. High Level Architecture 7.3. Discrete Event Specification Formalism (DEVS) 7.4. Other possible tools: Differential Inclusions (DIs) in modeling and simulation 7.4.1. Advanced case study: Stock market simulation using DIs	2	6

2- Course components (Total hrs in the Semester): 42

Lectures	Exercises	Other
42	--	----

3- Intended Learning Outcomes of the Course (ILO's)

a. *Knowledge*

i) Description of the knowledge to be acquired:

- Importance of modeling and simulation, Continuous and discrete models, The model components, descriptive variables and interaction rules , The concept of model state, Experimental frames and simplified models, Classification of dynamic systems, random numbers generators, Monte Carlo simulation ,Object- and agent-oriented simulation, Signal Flow Graphs, Bond graphs, System Dynamics and System thinking.

ii) Teaching strategies to be used to develop that knowledge

- Class lectures.
- Students' presentations
- Assignments
- Case study Report (data collection, internet search, and reporting)

iii) Methods of assessment of knowledge acquired

- Exams.
- Quizzes.
- Homework assignments.
- Term projects.

b- Cognitive (Intellectual) Skills

i) Cognitive skills to be developed

- The ability to construct different types of models and validate them.
- The ability to choose and apply the suitable simulation method.
- The ability to choose and use the appropriate simulation package.
- The ability to analyze and interpret the output results.

ii) Teaching strategies to be used to develop these cognitive skills

- Class lectures.
- Case studies analysis.
- Assignments
- Term projects.

iii) Methods of assessment of students' cognitive skills

- Exams.
- Quizzes.
- Homework assignments
- Term projects.

c. Interpersonal Skills and Responsibility

i) Description of the interpersonal skills and capacity to carry responsibility to be developed

- Decision making based on engineering analysis.
- Communication skills.
- Team work.

ii) Teaching strategies to be used to develop these skills

- Reports.
- Term team projects.
- Presentations and seminars

iii) Methods of assessment of students' interpersonal skills and capacity to carry responsibility

- *Evaluation of the team* projects.
- Written reports.
- Students' seminars and presentations.

d. Communication, Information Technology and Numerical Skills

i) Description of the skills to be developed in this domain

- Computer programming.
- Numerical Modeling.
- Using simulation packages.
- Presentation and report writing.

ii) Teaching strategies to be used to develop these skills

- Case studies analysis.
- Computer lab sessions.
- Term projects.

iii) Methods of assessment of students numerical and communication skills

- Term projects.
- Homework assignments.
- Students' seminars and presentations.

e. Psychomotor (if applicable) & Other Non-cognitive Skills

i) Description of the psychomotor or other skills to be developed and the level of performance required

- NA

ii) Teaching strategies to be used to develop these skills-

- NA

iii) Methods of assessment of student's psychomotor skills

- NA

4- Student Assessment Schedule

Serial	*Assessment tool (test, group project, examination etc.)*	*Week due*	*Weight*

1	Term Project – 1	3rd	15 %
2	Mid Term Exam -1	7th	15 %
3	Term Project – 2	10th	15 %
4	Term Project – 3	13th	15 %
5	Final Exam	16th	40 %

5- Student Support

- Providing electronic library for references and scientific periodicals.
- Providing the necessary computer applications for the course.

6- Learning Resources

i) Essential Books (References

- Devendra k. Chaturvedi "Modeling and Simulation of systems using matlab and simulink", CRC press, London, 2010.

ii) Course Notes Course materials are uploaded on the College Web-Site (www.qec.edu.sa) to be available for the students.

iii) Recommended Books

1- R. M. Fujimoto, "Parallel and Distributed Simulation Systems", John Wiley, 2000.
2- J. Banks, J. Carson and B. Nelson, "Discrete-Event System Simulation", Prentice Hall, 1996.
3- A. Law and D. Kelton, "Simulation Modeling & Analysis", McGraw Hill Publishing Co., 1991
4- P. Fishwick, "Simulation Model Design and Execution: Building Digital Worlds", Prentice-Hall, 1995.

iv) Electronic Books & Web Sites:

- http://www.gogetpapers.com/Lectures/Introduction_to_Modeling_and_Simulation

v) Periodicals

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7- Course Evaluation and Improvement Processes

i) Strategies for Obtaining Student Feedback on Effectiveness of Teaching

- Students' Questionnaires,
- Observing the students opinions recorded in the college student site
- Appeal box
- Carrying out extensive questioners by a sample of the distinguished students just after the graduation from the college.-

ii) Other Strategies for Evaluation of Teaching by the Instructor or by the Department

- Instructor report
- Public faculty seminars.
- Periodical review of the teaching methods by both the department council and the education affairs vice dean.-

iii) Processes for Improvement of Teaching

- Assessment of students' work by external examiners.
- Analysis of students' evaluation of course and instructor.
- Seminars by industry professionals.
- Evaluation of the course outlines and student works by external staff member,
- Periodical contact with different engineering authorities and industries for evaluating and getting their feedback and suggestions concerning the course outlines.

iv) Processes for verifying standards of student achievement

- Check marking by an independent faculty member of a sample of student work.
- Periodic exchange and remarking of a sample of assignments/exams with a external evaluator.

v) Describe the planning arrangements for periodically reviewing course effectiveness and planning for improvement.

- Assessment and evaluation of the level of achieving the course outcomes through a continuous improvement process (part of a quality assurance system established by the university),
- Consequently, actions are to be taken to improve the course delivery when necessary.

- Review of the course objectives, outcomes and curriculum every 2 years.