DEPARTMENT OF CHEMICAL ENGINEERING

Mission Statement of the Undergraduate Chemical Engineering Programs

The mission of the undergraduate programs in the Department of Chemical Engineering is to equip students with high quality education, fundamentals of chemical engineering, interdisciplinary knowledge, industrial experience, awareness of local industry needs, and skills in lifetime learning, communication and leadership.

Chemical Engineering Undergraduate Program Objectives

The objectives of the undergraduate programs in the Department of Chemical Engineering are to:

1. Provide students with the basic mathematical, scientific and engineering principles needed for solving problems in operation, evaluation and design of chemical processes.
2. Enhance students' skills related to experimentation, teamwork, open-ended problem solving, critical thinking and life-long learning.
3. Develop students' communication skills, English and Arabic, and awareness of professional ethics and safety practices.
4. Provide students with an understanding of environmental, societal, and economic aspects of the profession.
5. Provide opportunity for students to practice academic principles in industry.

Chemical Engineering Undergraduate Program Outcomes

As the outcomes of the undergraduate programs in the Department of Chemical Engineering, the students at the time of graduation are expected to:

1. Apply knowledge of mathematics, science, and engineering principles in solving chemical engineering problems [1]* (a, e)&.
2. Engage in adopting and developing new technology [1, 2] (i, k).
3. Design and evaluate chemical processes [1, 2, 3, 4] (c).
4. Conduct chemical engineering experiments and analyze and interpret plant data [1, 2] (b).
5. Function and work with others in multidisciplinary teams [2, 3] (d).
6. Communicate effectively both in English and Arabic [3] (g).
7. Apply modern simulation software [1, 2] (k).
8. Function professionally and behave ethically [3] (f).
9. Recognize environmental and societal impact of engineering decisions [4] (h).
10. Apply safety rules in the work place [3] (h).
11. Recognize contemporary issues related to the profession [4] (j).
12. Acquire industrial practice through two and six months training for science and applied programs, respectively [5] (k).

* The numbers in [ ] reference the corresponding objectives.
& The letters in ( ) reference ABET2000 outcomes a-k.

CHE 401 Process Dynamics and Control

Spring Term – 072

Instructor:	**Dr. Naim M. Faqir**
Lectures:	**SMW 11-11:50 a.m**
Office:	**4-237**
Office Hours:	**10:00 to 10:50 AM, SMW**
Tel:	**1671**
Email:	**faqir@kfupm.edu.sa**

Textbook: Process Dynamics & Control, by Dale E. Seborg, Thomas F. Edgar, and Duncan A. Mellichamp, Wiley, New York (2004), 2nd Edition

Ref. Books: Principles and Practice of Automatic Process Control, by C.A. Smith and A.B. Corripio, Wiley (1985)

Chemical Process Control, by G. Stephanopolous Prentice Hall, New Jersey (1984)

Process Dynamics, Modeling and Control, Babatunde A. Ogunnaike and W. Harmon Ray, Oxford University Press, New York, 1994

Process Control, 2nd, ed., Thomas E. Marlin, McGraw-Hill, USA, 2000

Prerequisite: SE 301 Numerical Methods, CHE 306 Equilibrium Separations
Corequisite: CHE 402 – Reactor Design

Course Objectives

Objectives

1. Provide students with the basic mathematical [mainly Laplace transforms] and engineering concepts of dynamics and control of systems.
2. Provide students with the modeling skills necessary to model 1st, 2nd and general order linear systems, and non-linear systems. Provide students with the tools required for linearizing non-linear systems.
3. Provide students with the concepts of modes of control, stability analysis, frequency response analysis and BODE diagrams.
4. Provide students with the skills necessary to design, analyze, simulate and tune contol systems.
5. Provide students with the concepts of the control toolbox and SIMULINK in MATLAB.
6. Enhance students' skills related to simulation, open-ended problem solving, critical thinking and life-long learning.
7. Develop students'awareness of professional ethics and safety practices.
8. Provide students with an understanding of environmental, societal, and economic aspects of the profession.

Outcomes

Upon successful completion of this course, you will be able to:

1. Apply knowledge of mathematics [Linearization, Laplace Transforms and Frequency Response] to model and solve models describing dynamics of chemical processes. [1,2].

2. Model unsteady state chemical processes [1,2]
3. Develop block diagram description of processes and control loops [1,2]
4. Design and evaluate control systems [3, 4,5].
5. Apply simulation software (SIMULINK) to to design control loops [5,6]
6. Function professionally and behave ethically [7].
7. Evaluate stability of control loops [1,2].

Examination

Schedule:	**1st Major** Examination	Wensday, **2nd April** 2008
	2nd Major Examination	Wensday, **21st May** 2008

Attendance: Attendance will be regularly taken and the university regulations will be strictly enforced. To encourage lecture attendance, a marks bonus system will be adopted as follows:

No. Abscences	Bonus Marks
0-1	+3
2-3	+2
4-5	+1
>5	0

Grading System:

Two Major Examinations	50%
Homeworks (7 to 9 assignments)	8%
Quizes & Class Participations	7%
Final Examination	35%
Total:	100%

Assignments: There will be one assignment (homework or computer) every week except examination weeks.

Course Outline	**Lectures**
Introduction	1
Introduction to Process Control - Chapter 1	1
Mathematical Modelling of Chemical Processes - Secs. 2-1 to 2-4.6	3
Omit pps. 36 to 43	
Laplace Transforms - Secs. 3-1 to 3-4	4
Students study example 3-5	
Transfer Function and State Space models	
Trans Function Sec. 4-1 to 4-3	
State Space Analysis Sec 4.4	3
Omit Example 4-7	
Dynamic Behaviour of 1st and 2nd Order Systems.	

5-1 Standard Process Inputs 2
5-2 Response of 1st Order Systems
5.3 Response of Integrating Processes
5-4 Response of 2nd Order Systems 2

SIMULINK –Laboratory Computer Class **1**

FIRST MAJOR

Dynamic Response Characteristics of More Complicated Systems

6-1 Poles and Zero's and their effect on System Response 1
Lead-Lag element
6-2 Time Delays 1
6-3 Approximation of Higher Order System
6-4 Interacting and Noninteracting System 1
May Omit 6-5 to 6-7

Development of Empirical Dynamic Models from Step Response Data

7-1 Model Development using Linear Regression 2
7-2 Fitting 1st and 2nd Order models using step test

Feedback Controllers:

8-2 Controllers - Proportional Control
Integral Control
Derivative Control 2
8.3 Reset Windup
Reverse or Direct Action
8.4 on-off control
8.5 Typical Response of Feedback Control Systems
Digital Versions of PID controller Omitted

Control System Instrumentation Chapter 9 1
Standard Instrumentation Symbols Levels 2
Transmitters
Final Control Elements
Sizing Control Values

Overview of Control System Design New Chapter

10-1 10-5 Selection of Controlled, Manipulated and Measured variables 1L

Dynamic Behavior and Stability of Closed-Loop Control systems
11.1Block Diagram Representation 1L
11-2 Closed Loop Transfer Functions 1L
11-3 Closed Loop Responses of Simple Control Systems 1L
11-4 General Stability Criterion 1L
Routh Stability Criterion 1L
Direct Substitution Method 1L
Omit 11-5

SECOND MAJOR

PID Controller Design, Tuning and Troubleshooting

12-1 Performance Criteria

12-2 Model based Design Methods	
12-3 Controller Tuning relations	2L
12.5 On-Line Controller Tuning	
12.6 Guidelines for Common Control Loops	
12.7 Troubleshooting Control Loops	1L

Frequency Response Analysis

13-1/2 Sinusoidal Forcing	
13-3 Bode Diagrams	2L
13-4 Frequency Response Characteristics of Feedback Controller	1L
13-5 Nyquist Diagrams	1L

Controller Design Using Frequency Response Criteria

14-2 Bode Stability Criteria	1L
14-3 Nyquist Stability Criterion	
14-4 Gain and Phase Margins	1L
14-5 Closed Loop Frequency Response	1L