UNIVERSITY OF ARIZONA
DEPARTMENT OF CHEMICAL AND ENVIRONMENTAL ENGINEERING
CHEE 413 PROCESS CONTROL AND SIMULATION
SPRING, 20XX

Prerequisites:

ChEE 301A, 301B, 401A (unit operation laboratories), 402 (ODEs, PDEs, Laplace Transform) and 420 (chemical reaction engineering) and familiarity with MATLAB.

Course Description:

Theory of automatic control as applied to elementary chemical engineering processes. Use of continuous system simulation languages for study of practical control problems in the process industries.

Instructor:

Dr. Songtao Xie
Email: songtaoxie@email.arizona.edu
Office: Harshbarger 105B
Tel: 520-621-3155
Office Hours: TBD

Teaching Assistants: TBD

Office: TBD
Email: xxx@arizona.edu
Office Hours: TBD
Tel: 520-xxx-xxxx

TBD
Office: TBD
Email: xxx@arizona.edu
Office Hours: TBD
Tel: 575-xxx-xxxx

Course Objectives:

Upon completion of this course, students should be able to

1. Develop working knowledge of process control hardware such as valves, thermocouples, pumps, and microcontrollers.
2. Represent dynamic chemical and physical process by differential equations.
3. Solve systems of differential equations by Laplace transform and numerical methods.
4. Recast a dynamic system using a series of transfer function in a block diagram.
5. Tune a single loop PID controller.
6. Design and troubleshoot control loops based on stability criteria and empirical techniques.
7. Apply frequency analysis of dynamic processes.
8. Understand how process dynamics affect control.

Textbook:

Process Dynamics and Control, 3rd edition, Wiley (2010) by D. E. Seborg, T. Edgar, D. A. Mellichamp, F. J. Doyle, ISBN 978-0-470-12867-1.

Course Times:

Lecture	Days / Time TBD	Location TBD

Course Outline:

This class will cover the following chapters of the textbook:

1. Theoretical Models of Chemical Processes (chapter 2)
2. Laplace Transforms and Transfer Functional Models (chapter 3 & 4)
3. Dynamic behavior of first, second and higher order systems (chapter 5 & 6)
4. Introduction to process control (chapter 1 and 9)
5. Feedback controllers (chapter 8)
6. Dynamic behavior and stability of closed-loop control systems (chapter 11)
7. PID controller design, tuning, and troubleshooting (chapter 12)
8. Frequency Response Analysis and control system design (chapter 14)
9. Feedforward and Ratio Control (chapter 15)

Course Policies:

Successful performance in this class requires that you attend the class. Please contact with the Instructor or TA for unavoidable absences, such as medical conditions, interview trips and conference. All holidays or special events observed by organized religions will be honored for those students who show affiliation with that particular religion. The complete list of UA approved holidays is available at: http://registrar.arizona.edu/calendar-religious-holidays. Absences pre-approved by the UA Dean of Students (or Dean designee) will be honored.

To ensure an environment respectful of learning, telephone/electronic devices, or other communication technologies are strongly discouraged unless used for legitimate learning purpose, like searching for information related to the lecture.

Homework assignments are due at the beginning of class on the date specified on the problem set. No late homework will be accepted without prior permission from the instructor or TA. Group discussion on problem sets is encouraged, however, copy of someone else's work or solution manual is not allowed, and will result in a score of 0 for everyone involved.

Make-ups for midterm exams will be given only in the case of university-approved absence and documentable emergencies. All excuses must include adequate documentations. There will be no make-up for final exam. Students judged to have engaged in copying on an exam will receive score of 0 for that particular exam.

Course Website:

D2L websites for ChEE 413 and ChEE 401B

Course Grade:

Attendance 10%

Pre-lecture Quiz	10%
Homewoks	20%
Exam 1	20%
Exam 2	20%
Final Exam	20%
Total	100%

Grades will be based on a percentage of the total possible points:
A = 90-100; B = 80-89; C = 70-79; D = 60-69; E = 0-59

Final Exam:

The final exam will be conducted in the exam period of the semester. Students will complete this exam in 180 mins within a 48-hour window. The exam sheets and zoom videos will be submitted to the dropboxes on D2L for grading. Students could finish individual questions of the exam in different time of 48-hour window. However, the total amount of time should be limited to 180 mins.

Important Dates:

All dates and deadlines regrading registration, dropping, etc. can be found at http://www.registrar.arizona.edu/courses/dates-dealines.

Academic Integrity:

See http://deanofstudents.arizona.edu for the UA policies on academic integrity. This course encourages and requires collaboration. However, copying someone else's work or allowing someone else to copy your work is unacceptable and a clear violation of academic integrity. You should not copy homework solutions from any source whatsoever. Doing so only defeats the rational of the homework assignments. Exams must be individual effort of each student. You must not discuss the exams with anyone but the instructor. Any violation of the Academic Integrity code will not be tolerated and dealt with in as a severe manner as possible.

Accessibility and Accommodation:

It is the University's goal that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, please let me know immediately so that we can discuss options. You are also welcome to contact Disability Resources (520-621-3268) to establish reasonable accommodations.

SALT Center and Disability Resource Center:

Students who are able to use the services of the Strategic Alternatives Technology Center or may have other educational needs may see the instructor at any time to discuss accommodations for their needs. However, this should be done at least one week prior to the first exam to allow for preparations that may be needed. Students who are registered with the Disability Resource Center must submit appropriate documentation to the instructor if they are requesting reasonable accommodations (http://drc.arizona.edu/teach/syllbus-statement.html).

Threatening Behavior:
The University seeks to promote a safe environment where students and employees may participate in the educational process without compromising their health, safety, or welfare. The Arizona Board of Regents (ABOR) Student Code of Conduct, ABOR Policy 5-308, prohibits threats of physical harm to any member of the University community, including to one's self. The more detailed policy can be found at: http://policy.web.arizona/education-and-student-affairs/threatening-behavior-students.

Extracurricular Activities: none

Changes to the syllabus:
The information contained in the course syllabus may be subject to change with reasonable advanced notice as deemed appropriate by the instructor.

ChEE 413 Spring 20XX Class Schedule (subject to change - check D2L for updates)

Week	Date	Day	Lec #	Reading Assigned	Homework Due	Pre Class Activities	Topic
1	**xxxx**	**x**	1	Ch.3 (p. 40 – p. 45)			Laplace Transform
	xxxx	**x**	2	Ch.3 (p.45 – p.49)	HW 1	Pre-Quiz 1	Partial Fraction Expansion
2	**xxxx**	**x**	3	**MLK Holiday**			
	xxxx	**x**	4	Ch.3 (p.49 – p.54)			Laplace Transform Properties
	xxxx	**x**	5	Ch.2 (p.14 – p.21)	HW 2	Pre-Quiz 2	Conservation Laws
3	**xxxx**	**x**	6	Ch.2 (p.21 – p.26)			Dynamic Models I
	xxxx	**x**	7	Ch.2 (p.26 – p. 33)			Dynamics Models II
	xxxx	**x**	8	Ch.4 (p.59 – p.62)	HW 3	Pre-Quiz 3	Transfer Function
4	**xxxx**	**x**	9	Ch.4 (p.62 – p.65)			Transfer Function Properties
	xxxx	**x**	10	Ch.4 (p.65 – p. 69)			Linearization
	xxxx	**x**	11	Ch.5 (p.73 – p.76)	HW 4	Pre-Quiz 4	Standard Process Inputs
5	**xxxx**	**x**	12	Ch.5 (p.76 – p.79)			First Order Process Response
	xxxx	**x**	13	Ch.5 (p.81 – p.86)			Second Order Process Response
	xxxx	**x**	14		Test 1		
6	**xxxx**	**x**	15	Ch.6 (p.92 – p.96)			Poles and Zeros

	xxxx	**x**	16	Ch.6 (p.96 – p.102)			Approximation of Higher-Order Transfer Function
	xxxx	**x**	17	Ch.6 (p.103 – p.107)	HW 5	Pre-Quiz 5	State Space Models
7	**xxxx**	**x**	18	Ch.7 (p.119 – p. 123)			Fitting First and Second Order Models
	xxxx	**x**	19	Ch.7 (p.125 – p.129)			Discrete-Time Dynamic Models
	xxxx	**x**	20	Ch.1 (p.1 – p. 7)	HW 6	Pre-Quiz 6	Introduction to Process Control
8	**xxxx**	**x**	21	Ch.9 (p.150 – p.156)			Sensors, Transmitters and Transducers
	xxxx	**x**	22	Ch.9 (p.156 – p.162)			Final Control Element
	xxxx	**x**	23	Ch.13 (p.237 – p.243)	HW 7	Pre-Quiz 7	Control Strategies
9	**xxxx-xxxx Spring Break**						
10	**xxxx**	**x**	24	Ch.8 (p.134 – p.141)			Basic Control Modes
	xxxx	**x**	25	Ch.8 (p.141 – p.145)			PID Controllers
	xxxx	**x**	26		HW 8	Pre-Quiz 8	
11	**xxxx**	**x**	27	Ch.11 (p.183 – p.189)			Closed-Loop Transfer Functions
	xxxx	**x**	28	Ch.11 (p.189 – p.194)			Closed-Loop Response
	xxxx	**x**	29		Test 2		
12	**xxxx**	**x**	30	Ch.11 (p.194 – p.200)			Stability of Closed-Loop Control Systems
	xxxx	**x**	31	Ch.11 (p.200 – p.202)			Root Locus Diagram
	xxxx	**x**	32	Ch.12 (p.210 – p.217)	HW 9	Pre-Quiz 9	Model Based Design Methods
13	**xxxx**	**x**	33	Ch.12 (p.217 – p.222)			Controller Tuning Relations

	xxxx	**x**	34	Ch.12 (p.222 – p.228)			On-Line Controller Tuning
	xxxx	**x**	35	Ch.12 (p.228 – p.231)	HW 10	Pre-Quiz 10	Troubleshooting
14	**xxxx**	**x**	36	Ch.14 (p.251- p.253)			Sinusoidal Forcing of First Order Process
	xxxx	**x**	37	Ch.14 (p.253 – p.254)			Sinusoidal Forcing of n-th Order Process
	xxxx	**x**	38	Ch.14 (p.254 – p.258)	HW 11	Pre-Quiz 11	Bode Diagram
15	**xxxx**	**x**	39	Ch.14 (p.258 – p.263)			Nyquist Diagram
	xxxx	**x**	40	Ch.14 (p.263 – p.266)			Bode Stability Criterion
	xxxx	**x**	41	Ch.14 (p.266 – p.268)	HW 12	Pre-Quiz 12	Gain and Phase Margins
16	**xxxx**	**x**	42	Ch.15 (p.273 – p.277)			Feedforward/Ratio Control
	xxxx	**x**	43	Ch.15 (p.277 – p.279)			Feedforward Controller Design Based on Steady State Models
	xxxx	**x**	44	Ch.15 (p.279 – p.283)	HW 13	Pre-Quiz 13	Feedforward Controller Design Based on Dynamic Models
17	**xxxx**	**x**	45	Ch.15 (p.283 – p.285)			Feedforward Controller Tuning
	xxxx	**x**	46	Ch.15 (p.289 – p.294)			Cascade Control
	xxxx				Final Exam		

All homework is due on the days listed above unless otherwise designated on a specific problem handout.