PROCESS CONTROL AND DYNAMICS
ChE 4198

Course Outline

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Department of Chemical Engineering
Louisiana State University

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Lectures

Day	Time	Location
Monday	11:30 to 12:20	Room 1221 PFT
Wednesday	11:30 to 12:20	Room 1221 PFT
Friday	1130 to 12:20	Room 1221 PFT

Course Outline

CHE 4198: Process Dynamic & Control

Welcome & Course Description

We welcome you to the core course "Process Control and Dynamics" and hope it develops your interest in process control and systems dynamics. We hope you will also develop an appreciation for the importance of the knowledge imparted in this course to the chemical and biomedical industries.

Course Aims/Goals

This course follows on from your learning in previous years. This unit aims at furthering your knowledge by extending your skills in process systems control. This unit will also enable you to develop a systematic approach to process modeling, control design and controller development and analysis. Furthermore, Process Control and Dynamics aims:

- To develop an appreciation for the importance of process models in a chemical plant/process, to see the significance of this in real life and to relate the theory learnt to practice.
- To develop an appreciation for the importance of process control in a chemical plant/process, to see the significance of this in real life and to relate the theory learnt to practice.
- To appreciate the importance of process models in the development of control theory and practice.
- To develop technical report writing skills with the ability of professionally presenting solutions to engineering problems.
- To integrate to this course knowledge and skills acquired in other course such as Fluid Mechanics, Thermodynamics, Transport Phenomena, and Unit Operations,
- To develop adequate knowledge and preparation to progress to subsequent courses including Chemical Engineering Design.

Learning Commitments and Contact

- It is expected that you will have Internet access, since this course uses internet sites for transmission and retrieval of course information. The main course site is accessible through Moodle. You can login using your LSU network student username and a password that will be provided to you at the commencement of the course.
- You are encouraged to familiarize yourself with this website and be acquainted with its various menus, as this will represent a major point of contact between you and the teaching staff.
- At the course website, you will have access to the lecture notes, tutorial question sheets and solutions, as well as other relevant resources such as assignments and handouts. You will also be able to check your records and progress.
- You are required to check the on-line message board on a daily basis, as this board will act as the general point of contact. You also have the opportunity to post your own messages to your peers and teaching staff.
- Email will also be used as the main method of contact. You are required to check that you have provided the correct email address.
- You are also encouraged to be familiar with the Department of Chemical Engineering site http://www.che.lsu.edu.
- There will be three contact periods per week. Refer to timetable on front page of this document.

- You are expected to access the weekly lecture notes and familiarize yourself with their contents prior to the lecture hour.

Learning Situations

This course uses a variety of teaching and learning activities. These activities consist of lectures, tutorials, assignments and paper examinations.

The lectures are highly interactive and you are encouraged to participate in them by making comments and raising questions. You are encouraged to download the relevant lecture files prior to meeting at lectures, as this preparatory work is essential in the construction of your knowledge in process control.

The tutorials complement the theory and applications presented in the lectures and represent a key component for realizing the aims of the course. When scheduled, a new tutorial will be uploaded and you are highly encouraged to attempt this prior to attending the tutorial session. This will promote discussion and interaction during the tutorial deepening your learning.

There will be five assignments as part of the assessment of this subject. They will be spaced out across the semester (see schedule below). All assignments will be conducted individually. As these problems resemble real life situations, you are highly encouraged to participate, as your work skills will be enhanced.

There will be a semester project. The semester project will be conducted in groups. You will treat your group as an engineering team that will work together to solve the required problem. You will be allocated to a group and each group will have a leader. The group leader will be responsible for organizing meetings for the group and liaising with the lecturer/tutor on behalf of the group and importantly will be responsible for submitting, on-line, his/her group's assignment.

Two midterms and the final exam will be part of the assessment. It is aimed to allow you to reflect on your learning and to gauge your performance in the course. You are highly encouraged to treat and use these as learning situations rather than examination exercises.

Student Learning Outcomes

By the end of this course, students should be able:

- To understand the role of modeling in Process Engineering and specifically in process control.
- To understand the differences between various model types and uses.
- To understand and be able to develop, using a systematic approach, models of various chemical engineering processes.
- To relate to control concepts and terminology.
- To understand the role of process control in process systems engineering.
- To understand the differences between various conventional controller types and to understand the consequences arising from their implementation.
- To understand and be able to design and tune conventional process controllers using a systematic approach.
- To be able to use modern software tools (C-Station, Matlab and Simulink) for process control analysis and design.
- To achieve a good understanding of feedback control design, analysis and tuning.
- To see links between this course and other Chemical Engineering courses.

Continuous assessment

Task No.	Component	Due Date	Weight
1.	Assignment 1	31 January	3 %
2.	Assignment 2	14 February	3 %
3.	1st Midterm Examination	19 February	20 %
4.	Assignment 3	2 March	3 %
	Project: Preliminary Report	9 March	5%
5.	Assignment 4	16 March	3%
6.	2nd Midterm Examination	20 March	20%
7.	Assignment 5	22 April	3%
	Project: Final Report	27 April	10%
8.	Final Examination	6 May 7:30 to 9:30 AM	30 %
Total			100 %

The five assignments will be conducted individually. Each assignment will be given a mark out of 100. The semester project will be conducted in groups and will have two reports (preliminary and final).

Two mid-semester examinations will be your point of reflection on your learning. You will diagnose your weaknesses and strengths and analyze your learning outcomes. To achieve as high a mark as possible will only be possible by deep understanding of the concepts presented in the lectures, and this examination will be structured to test understanding and not simple rote learning. As a consequence you are highly encouraged to engage in the subject matter.

The final semester examination will test understanding in a collective manner.

You will receive a summative mark for each assessment task with a final mark for the course being a total of all your individual task marks.

Policy on report submissions

- Plagiarism will not be tolerated. Those caught will automatically receive zero marks and further action may be taken.
- Only electronic submissions will be accepted.
- Reports are to adhere to the report expectations instructions given to you during the semester.

Course Program

The following table represents a road map for lectures and assessment tasks throughout the semester. Please note that there will be an attempt to adhere to this schedule as closely as possible but changes could occur during the semester, so the onus is on you to keep checking the announcement section of course website for continuous updates.

Program for lectures and assessment for ChE 4198 course for fall semester 2020

Week	Beginning	Topic	Description
1	13-Jan	Introduction to process control	• Introduction and course administration • Why is control necessary? • Objectives and benefits • General concepts and definitions • The control design problem • Steps to follow in the design of a control system • Why is process modeling necessary?
2	20 Jan	Modeling and Dynamics	• Why is process modeling necessary? • Modeling application areas • Goal of modeling • Types of models • Dynamic lumped parameter models
3	27-Jan	Modeling and Dynamics	• Modeling principles • Conservation laws and constitutive relations • Model analysis: degrees of freedom • Role of process simulators • Approximation of dynamic models: Linearization • State-space models **ASSIGNMENT 1 DUE 31-JAN**
4	03-Feb	Working with Matlab-Simulink	• Introduction to Matlab/Simulink • Model development and solution in Simulink
5	10-Feb	Modeling for Control	• Solution of dynamic models • Laplace transforms • Modeling for control • Transfer functions • Input output models • Introduction to Matlab/Simulink **ASSIGNMENT 2 DUE 14-FEB**
6	17-Beb	Empirical Modeling Working with C-Station	• Development of empirical models • Process reaction curve • FPTD Models • Introduction to C-Station • Understanding process dynamics through experiments **1ST MIDTERM EXAMINATION 19-FEB**

7	24-Feb	Stability analysis of Dynamic Systems	• Stability of Linear Systems • Input-Output Stability • Methods for stability analysis • Routh's Method • Root-Locus Method
8	02-March	Dynamics performance	• Analysis of dynamic systems • First Order Processes • Second order Processes • Multi-capacity Processes **ASSIGNMENT 3 DUE 02-MARCH**
9	09-March		• Additional elements on systems dynamics • Effect of Zeros • Effect of Time Delay • Lead-lag processes **PROJECT: PRELIMMINARY REPORT DUE 14 OCT**
10	16-March	Basic elements of feedback control	• Introduction to feedback control • Feedback Control problem • Elements of a feedback loop • Control Law **ASSIGNMENT 4 DUE 16-MARCH** **2ND. MIDTERM EXAMINATION 20-MARCH**
11	23-March		**Spring Break**
	30-March	Stability analysis of closed-loop systems	• Closed-loop Transfer Function • Closed-loop Performance • Closed-loop Stability • Methods for stability analysis • Routh's Method • Root-Locus Method • Frequency response analysis
12	06-April	Feedback control design	• Control Tuning methods • Open Loop Tuning (Cohen-Coon) Method • Closed-Loop Tuning (Ziegler-Nichols) Method • Examples
13	13-April	Feedback control design	• Model-based approaches • Practical Issues in Controller Design • Comparison of methods • Examples
14	20-April	Advanced Control Strategies	• More advanced control strategies • Cascade Control • Ratio Control • Split-Range Control • Override Control

15	20-April	Review **ASSIGNMENT 5 DUE 22-APRIL** **PROJECT: FINAL REPORT DUE 27 APRIL**
16	May	Final Exam – 7:30 AM to 9:30 AM Wednesday, May 6th, 2020

Course References

The following is the text book prescribed for this course:

- J.A. Romagnoli and A. Palazoglu, (2012), *Introduction to Process Control*, 2nd. Edition, CRC Press.

There are a number of other text books available on the subject who could be sought, but the following texts are recommended:

- George Stephanopolous (1983), *Chemical Process Control: An Introduction to theory and practice*, Prentice Hall Int. Series.
- D. E. Seborg, T. F. Edgar and D. A. Millichamp (1989), *Process Dynamics and Control*, Wiley.
- B. A. Ogunnaike and W. H. Ray (1994). *Process Dynamics Modeling and Control*, Oxford University Press.

Staff Contact Information

Lecturers	Prof. Jose A. Romagnoli Email: jose@lsu.edu **Location:** PFT Room 3315N Prof. Chris Arges carges@lsu.edu Location: PFT Room 3315S
TAs	Luis A Briceno-Mena: lbrice1@lsu.edu **Location:** PFT Room 2125