ChE522/ChE624: Advanced Process Dynamics and Control – Winter 2021

Administrative Information

Lectures: Classes will be posted online in the form of narrated Power Point presentations accompanied by non-narrated Power Point presentations and video files of the Power Point presentations.

Instructor: Prof. Hector Budman

Room: E6-3012

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Office hours: Monday 9:30-11:30 in Webex (https://uwaterloo.webex.com/meet/hbudman).

Course folder: UWLearn course site.

Calendar Description

Introduction to state space based control, computer control and multivariable control.

Detailed Description

At the conclusion of this course the students should be able to solve systems of ODE's by linear algebra techniques, formulate state feedback controllers and assess the observability and controllability of the states. For the purpose of computer control implementation and analysis students will learn the z-transform, analyzed closed loop stability of discrete systems and design discrete controllers based on z-transform based transfer functions. Then the student will learn concepts of multivariable control, stability of multivariable control strategies, determination of interaction in multivariable systems and decoupling strategies to deal with interactions.

References

Process Dynamics and Control by Seborg, Edgar and Mellichamp, Ed. Wiley, 3rd edition.

The following texts are also recommended:

- Chemical Process Control by G. Stephanopoulos, Ed. Prentice Hall.
- Linear Systems, Ed. Prentice Hall, 1980.
- Advanced Engineering Mathematics, E. Kreyszig, Ed. Wiley.

WEEK	LECTURE SESSION	TUTORIAL SESSION*
1	Why we need state space models for control? Homogeneous solution of	Homogeneous solution of systems of ODE's
2	Non-homogeneous solution of systems of ODE's, State feedback controllers	Example for particular solutions and Eigenvalue-placement method for designing state feedback
3	Observability and Controllability of states	Examples for observability and controllability
4	Introduction to discrete control: differences with respect to continuous systems, brief presentation of hardware necessary for discrete control implementation.	Used for lecture
5	Finite difference equations: solutions	Example on the effect of sampling interval on stability of finite difference equations and control
6	Choice of sampling interval, aliasing, Shannon theorem, Zero order hold to represent DAC converter, sampling operation to represent ADC converter.	Midterm
7		
8	Introduction to z transform	Examples for z transforms, transformation from z to s domain (Laplace domain)
9	Closed loop transfer functions using z-transforms	Examples
10	Direct synthesis and Internal model control for discrete systems using z transforms	Examples
11	Introduction to multivariable control, closed loop stability of multivariable systems	Examples
12	Relative Gain Array, finding best pairings between inputs and outputs, discussion on interaction, decouplers	Examples

***Note:** Tutorials and Lectures are interspersed according to need.

GRADING

Assignments: not graded but given every week and solutions posted a week later. Total of 8 assignments.

Mid-term (take home exam): 40%.

Final (take home exam): 60%

ACADEMIC INTEGRITY

You are expected to know what constitutes academic integrity, to avoid committing offences, and to take responsibility for your actions. For information on categories of offences and types of penalties, refer to Policy 71, Student Discipline, http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm

A student who believes that he/she has a ground to appeal a discipline decision should refer to Policy 72, Student Appeals, http://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm

A student who believes that a decision or action of a faculty member has been unfair or unreasonable should refer to Policy 70, Student Petitions and Grievances, http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm