CHE 576 - Intermediate Process Control

Winter 2009

Syllabus

Instructor: Stevan Dubljevic

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Office hours: Mon.&Wed. 12.00-13.00pm

Course webpage:

Course Objective:

The main objective of this course is to provide students with advanced knowledge on computer based process control. Upon completion of this course, the students should be able to perform design, tuning and analysis of advanced computer control systems. Specifically, we will address the following objectives:

1. Development of discrete-time dynamic models
2. Analysis of discrete transfer functions
3. Design and tuning of digital computer controllers
4. Design of optimal linear quadratic controllers
5. Design of advanced model predictive controllers
6. Implementation of computer control systems on realistic processes.

- **Week 1 (Jan.6 -Jan.8)** : Introduction (course organization - syllabus); Introduction to discrete-time systems; Introduction to computer process control systems;

- **Week 2 (Jan.11 - Jan.15)** : Sampling and signal reconstruction; Conversion of continuous to discrete-time models; Finite difference method & exact discretization method

- **Week 3 (Jan.18 - Jan.22)** : Discrete-time response of dynamic systems; The backshift operator and transfer functions; Partial fraction expansion;

- **Week 4 (Jan.25 - Jan.29)** : Discrete-time response of transfer functions; Stability analysis; Final and initial value theorems;

- **Week 5 (Feb.1 - Feb.5)**: Physical realizability; Minimum phase and non-minimum phase; Development of closed-loop transfer functions;

- **Week 6 (Feb.8 - Feb.12)**: Continuous-time PID and conversion to discrete-time PID; State space representation of process models; Pole placement;

  ◇ Feb. 12: Midterm exam.

- **Week 7 (Feb.22 - Feb.26)** : Transformation between state space model and transfer function; Controllability; Observability;

- **Week 8 (Mar.1 - Mar.5)**: Optimal linear quadratic control; Control of inverse pendulum problem

- **Week 9 (Mar.8 - Mar.12)**: Direct synthesis of digital computer controllers; Perfect control; Effect of time delay and basic IMC; Role of filter and robust control;Controller ringing; Effect of non-minimum phase;

- **Week 10 (Mar.15 - Mar.19)** : Advanced multivariable model predictive control; Discrete convolution models; Matrix forms for predictive models; Unconstrained and constrained MPC

- **Week 11 (Mar.22 - Mar.28)** : Tuning and implementation issues Other advanced model predictive control systems

- **Final exam** :

Pre-requisites: CHE446 or equivalent
References:

1. B. Huang, CHE 576 Lecture Notes. Students registered to this course have access to the course notes.

2. B. Huang, and R. Kadali, Dynamic Modeling, Predictive Control, and Performance Monitoring, Springer-Verlag, 2008. University of Alberta students have free access to the e-book through UofA-Springer Link.

3. D.E. Seborg, T.F. Edgar and D.A. Mellichamp, Process Dynamics and Control, 2nd Ed. Wiley, 2003
4. B.A. Ogunnaike and W.H. Ray, Process Dynamics Modeling and Control, Oxford University Press, 1994
5. K.J. Astrom and B. Wittenmark, Computer Controlled Systems: Theory and Design, 3rd Ed, Prentice-Hall, 1997
6. G.C. Goodwin, S.F. Graebe, and M.E. Salgado, Control System Design, Prentice Hall, New Jersey, 2001

Grading

- Assignments 20%
- Labs 10%
- Midterm Exam 25%
- Final Exam 45%

The conversion of the percentage grade into a final grade will be performed using a combination of relative and absolute measures taking into account the quality of work submitted and University policy on the distribution of grades. Grades are unofficial until confirmed by Faculty Council or its representative. There will be no re-exam for the midterm. The weight for any deferred midterm exam will be carried to the final exam. Unless you have an acceptable excuse, there is a penalty on the late due assignments or lab reports according to the following rules:

- Late by 24 hours or less, the grade will be reduced by 25%
- Late by more than 24 hours, a zero grade will be assigned

Policy Regarding Calculators:
Only non-programmable calculators will be permitted during exams for this course. To see the list of approved non-programmable calculators, check the following website:
http://www.engineering.ualberta.ca/calculator.cfm
Plagiarism, Cheating, Misrepresentation of Facts and Participation in an Offense :

The University of Alberta is committed to the highest standards of academic integrity and honesty.

Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Code of Student Behavior (online at http://www.uofaweb.ualberta.ca/secretariat/) and avoid any behavior which could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University.

The following behaviours constitute academic misconduct in this course (in addition to those specified on the Code):

1. Looking at another students exam during a midterm or final.
2. Copying any part of an assignment or lab report from another student, or from an assignment or lab report from previous offerings for CHE576.
3. Permitting any other class member to copy any part of your assignment or project report.
4. Presenting laboratory data from any other student or former student of CHE576 as your own.
5. Using a programmable calculator in the exams.