Digital Process Control Design

ENGG\*4280

Winter Semester 2011

# 1 Instructor

Dr. Julie Vale. THRN 2333, 519-824-4120 ext. 54863, jvale@uoguelph.ca

# 2 Teaching assistant

Tom Hummel - thummel@uoguelph.ca

# 3 Laboratory technician

Hong Ma - hongma@uoguelph.ca

# 4 Meetings

**Lectures:** Tuesdays and Thursdays, 8:30 to 9:50, MACK 234

**Laboratories:** THRN 2196

Monday, 16:30-17:20 and Wednesday, 11:30-12:20

Thursday 13:30-14:20 and Friday 10:30-11:20

Thursday 14:30-15:20 and Friday 11:30-12:20

**Midterm:** *Tentatively* scheduled for Thursday Feb. 16th 8:30-9:50

**Final exam:** April 10,19:00-21:00.

# 5 Materials

**Textbook:** No text has been specified as the material comes from a wide variety of sources. The chapter that Dr. Gord Hayward wrote for "Computerized Control Systems in the Food Industry" (G.S. Mittal, ed.) is a review of some of the material in ENGG 3410 as well as this course.

**Web**: The course will have a web page on courselink.uoguelph.ca (I am still waiting for access)

# 6 Prerequisites

**Topics:** Success in this course requires the fundamentals of engineering mathematics for linear time-invariant systems (linear algebra, differential equations, Laplace transform), discrete time mathematics (difference equations, z-transform), and basic controls tools and approaches (PID, root locus, Bode plot etc.).

**Courses:** As stated in the Undergraduate Calendar.

# 7 Calendar Description

Design, analysis, synthesis, and simulation of process control and automation systems. Automation hardware, process compensation techniques and PID controllers, design and dynamics of final control elements, computer control and the microprocessor.

# 8 Learning objectives

By the end of this course you should be able to

1. Analyze a hybrid control system
2. Use multiple techniques to design a digital controller that achieves given specifications for a continuous time plant
3. Implement a digital controller (including interfaces) in a laboratory setting
4. Compare and contrast different controllers in the context of performance, robustness, and stability
5. Write a clear and comprehensive engineering report

# 9 Evaluation

Lab Progress Report 15%

Final Lab Report 25%

Midterm 10%

Final Exam 50%

The laboratory reports will be graded for both their technical content and for their grammar and writing style.

# 10 Approach

**Lectures** concentrate on theory while the **lab** concentrates on application and realisation of that theory. **Assignments** will provide practice and reinforcement of the theoretical components and will not be graded.

**Laboratory:**

Rather than a series of short experiments, the laboratory will consist of a controller design project. The lab periods will consist of group work and informal consultation with the lab assistant, where progress and problems may be discussed. The work is to be performed in groups of two and can be scheduled at other times in consultation with Hong Ma, the lab technician in charge of the lab. Two reports are required. The lab progress reports (group reports) will be due on February 17 and individual final lab reports on March 30.

**There are no makeup reports and late submissions are not accepted for marking.**

The **midterm** and the **final exam** (comprehensive) are used to determine the extent to which you have achieved the theoretical course learning objectives. The use of notes, books, programmable calculators, or other aids is not permitted at exams. Any student not taking an exam receives a grade of zero for that exam. In case you have a legitimate reason for missing an exam session, I may consider an accommodation upon presentation of a written request and suitable documentation before the time of the exam.

# 11 Obtaining help

You can obtain help from me during my office hours (posted on the course web page) and after lectures, from the teaching assistant during his office hours and in the lab, and from the laboratory technician during the laboratory time slots.

Please contact us if you need help or you have fallen behind in your work. We are willing to put in as much effort to help you as you are willing to put in to help yourself. We are happy to work with you on difficult concepts and hear your suggestions for improving the course. If you are busy during our office hours, then email us with some days and times you are free, and we will set an appointment that works for both you and us.

If you are ill, call the Student Health Services or a medical doctor. If you have emotional, family, or living environment problems that affect your ability to study, visit the Counselling Services or your academic advisor. If you have a disability or a temporary disability, refer to the Centre for Students with Disabilities and you are welcome to discuss with us your specific learning needs at the earliest possible time. I have made every effort to avoid conflicts with religious obligations. If there is a discrepancy, please contact me as soon as possible.

# 12 Scholastic integrity

The value of an academic degree depends on the integrity of the work done to earn that degree. It is imperative that you keep a high level of honour in your work. The policies on scholastic dishonesty reported in the Undergraduate Calendar will be enforced.

Academic misconduct, such as plagiarism, is a serious offence at the University of Guelph. Please consult the Undergraduate Calendar 2010-2011 and School of Engineering programs guide, for offences, penalties and procedures relating to academic misconduct.

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

I recommend that you review the tutorial on academicintegrity.uoguelph.ca and that you discuss any questions that you may have with me or the teaching assistants.

# 13 Communication

Communication is through announcements in class. Some information will be posted on the course web page or sent via email messages to your University address. It is your responsibility to keep yourself informed.

# 14 Copyright

The instructor reserves the right to all materials made available for this course and all interpretations presented in class, which may not be reproduced or transmitted to others without the written consent of the instructor. The electronic recording of classes is only allowed with prior consent of the instructor and solely for the use of the authorized student.

# 15 Disclaimer

I reserve the right to change any or all of the above in the event of appropriate circumstances, subject to the University of Guelph academic regulations.

# 16 Topics

Please note that these topics are subject to change as needed. The order that the material is presented in may be adjusted to accommodate the lab.

**Review of ENGG 3410:** Laplace transform, control topologies, continuous time (CT) specifications

**Review of discrete time mathematics:** Difference Equations, z-transforms

**System identification:** Modeling, second order systems, response characterization

**CT Design methods:** Cascade control, feed forward control, PID, pole placement, Lead-Lag

**Emulation:** CT <=> discrete time (DT) transformations, analysis, stability issues

**Direct Design:** DT performance specs, stability, controllers, analysis

**Multivariable Control Systems:** Decoupling, state variables, state space

If time allows, we will also (briefly) look at **Sampled Data Systems** (how to achieve good inter-sample performance!)