CHME 4961/6650	Professor B. W. Bequette
Fall 1999	30 August 1999

Advanced Process Control

Days and Room

Tu-Th 2:00 -3:50 pm Control Engineering Studio – JEC 4304

Office Hours and email addresses

		Time and Location	
Instructor:	Professor B.W. Bequette (bequeb)	Tu 1-2 Th 1-2	133 Ri 133 Ri
Teaching Assistant:	Brian Aufderheide (aufdeb)	TBA	202B Ri

It is generally easier to use email for contact outside of office or class hours (particularly at night). Please send an email in advance of dropping by outside of office hours, to make certain the instructor is available. A WebCT bulletin board will be used to answer commonly asked questions and distribute course materials.

Required Background

It is assumed that the students have had an introductory course in process control. Any standard process control textbook can be used for the background reference material for this course.

Course Objective

The purpose of this course is to provide an advanced treatment of the theory and practice of chemical process modeling and control, for advanced undergraduate and first-year graduate students. An emphasis of this course is on model-based control system design and implementation. The SIMULINK simulation package (based on MATLAB) will be used for dynamic process simulation and control system development. Most of the homework assignments will require the use of MATLAB/SIMULINK.

The course is taught in a *studio format*, combining lectures, computer-based simulations and bench-top experiments in a single classroom.

Notice that the graduate section (6650) is being taught simultaneously with the undergraduate section (4961). Graduate students will be expected to explore topics in more depth, particularly on the course project. There may be one or two extra lectures that are required for graduate students, but optional for undergrads.

Required Text

No textbook is required, but there will be many handouts (copies of papers, etc.). The $10 copy fee should be paid by each student by Tuesday, 7 Sept 99. Checks should be written to the *Department of Chemical Engineering* and given to Ms. Sharon Sorell in Ricketts 104.

Supplementary Material

Students using their own PC's may wish to purchase the student edition of MATLAB/SIMULINK. It is recommended that they also purchase the Control Systems Toolbox.

Homework Assignments

Most of the regular assignments will be performed individually. Special assignments and the course project may be performed in 2-person groups.

Individuals/groups may discuss the problems with other individuals/groups, but are not allowed to share solutions (MATLAB m-files, etc.). Violations will be handled in accordance with the student handbook.

Quizzes/Exams

Since this is an elective course, I will assume that each of you has a strong desire to learn advanced process control techniques. Most of the final grade will be determined from the homework/project grades. There will be a single mid-term examination, but no final exam.

Homeworks and exams will be returned outside the instructor's office (133 Ricketts) or in class.

Course Grade

The course grade will be determined using the following:

Homework and projects	80%
Mid-term exam	20%
Total	100%

Grade Appeals

A student may appeal a grade by attaching a brief memo (to the instructor) to the specific exam or homework assignment which is being appealed. This memo must state the specific reason(s) for the regrade. The student has *one* week after the grades have been assigned to contest the grade.

Case Study Project

Much of the final 1/3 of the course will involve a detailed project that you select based on discussions with the instructor and TA. Each project should include many phases typically associated with a control system design project.

Course Web Page

WebCT (`http://webct.rpi.edu`), will be used to manage the course web pages. Details will be provided during the first week of courses. The current web page can be found by going to the instructors web page (`http://www.rpi.edu/~bequeb`) and selecting `courses`.

Updated lecture and homework information will be placed on the course web page.

Class Schedule

The lecture and exam schedule is given in the table below.

Class Schedule

Week		Tuesday	Thursday
1	31 Aug - 2 Sept	Class	Class
2	7 Sept - 9 Sept	Class	Class
3	14 Sept - 16 Sept	Class	Class
4	21 Sept - 23 Sept	Class	Class
5	5 Oct - 7 Oct	Class	Class
6	12 Oct - 14 Oct	Special lecture	Mid-term Exam
7	19 Oct - 21 Oct	Class	Class
8	26 Oct - 28 Oct	Class & **Van Ness Lecture ****	Class
9	2 Nov - 4 Nov	Project - no class	Project - no class
10	9 Nov - 11 Nov	Class	Class
11	16 Nov - 18 Nov	Class	Class
12	23 Nov - 25 Nov	Thanksgiving Break - No Class	No Class
13	30 Nov - 2 Dec	Class	Class
14	7 Dec - 9 Dec	Class	Class
15	14 Dec - 16 Dec	Class	Review Class

** There will special lectures by Professor Jim Rawlings (U. Wisconsin), the 1999 Van Ness Award Lecturer, at 4:00 pm on 26 and 27 Oct (Tue and Wed.), with refreshments served in the Ricketts Lounge at 3:30 pm. **Attendance at the presentations is required**.

Course Topics

1. Review of incentives for process control, control block diagrams, designing and tuning PID controllers. Review of MATLAB/SIMULINK.

2. Detailed comparison of PID algorithms. Derivative action on process output vs. error. Problems with proportional “kick” and reset “wind-up”.

3. Review of continuous-time Internal Model Control (IMC), and IMC-based PID.

4. Introduction to digital control. Implementation of digital PID algorithms.

5. Identification of discrete models for digital control.

6. Digital model-based control - IMC and Dahlin’s method.

7. Introduction to model predictive control (MPC).

8. Analysis of multivariable systems. Review of RGA and introduction to singular value analysis.

9. The impact of process design on process control. Reactor scale-up example. Analysis of the effect of recycle on chemical process dynamics and control.

10. Frequency response techniques for control system design. Bode and Nyquist plots for SISO systems, singular value analysis for MIMO systems.

11. Special course project involving a detailed study of a process jointly agreed upon by the student, instructor and TA.