ChE 421XE – Process Dynamics and Control
Fall 2011


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294-3024
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Office Hours: T 9:00-9:50, R 9:00-9:50
Or by appointment

Course Description: This course will introduce basic principles of dynamic modeling of processes, Laplace transforms, block diagrams, controllers, instrumentation, stability and design and tuning of controllers. The course will include reading, lectures, homework, projects and exams.

The basic objective of this course is to teach you fundamental concepts and principles in the modeling of dynamic chemical processes and in the application of process control. This objective will be accomplished by covering the following topics (in the order given):

1. Introduction to process control (chapter 1)
2. Theoretical and semi-empirical mathematical modeling of chemical processes (chapter 2)
3. Process dynamics including Laplace transforms, transfer functions, state-space models, block diagrams, first-, second- and higher-order systems and the development of empirical dynamic models (chapters 3 to 7)
4. Feedback control: controllers, instrumentation, dynamics, stability, design and tuning ( chapters 8 to 12)
5. Advanced control techniques: feedforward, cascade, adaptive, MIMO, and supervisory control (chapters 15 to 16), as time permits

See page 3 for more specific information on course objectives.

Course Requirements:

❖ Homework will be assigned on a weekly basis. You may choose to work with others but each individual must submit his or her own paper. Homework is due at the beginning of the period on its due date. It may be handed in late for up to 2 weeks after the due date. However, you will receive half-credit for any late assignments. If it is more than two weeks late, it will be corrected but will receive zero points.

❖ Two projects will be assigned during the semester. You will be assigned to groups of up to four for each project, and the projects will include laboratory work using a real process and control system as well as simulation work and computer programming.

**Note: students in ChE 421XE who are in Ames will be assigned to these project groups together. Those who are off-campus will be assigned alternative projects.**

**Note: team members are not allowed to consult with classmates outside of their own teams for projects. This is really for your benefit. In the past, students have misdirected classmates in serious ways that resulted in wasted efforts and poor performance.**
Two exams will be given during the semester. Dates of the exams are noted on the course schedule. There will not be a final exam in this course. Instead, your second project will be a more comprehensive problem and will be due at the time scheduled for the final exam.

The academic integrity policy of the university is a guideline for this course. Students are expected to follow this policy. Any student who violates this policy will be subject to disciplinary action, as specified in by the Dean of Students Office (DSO). Refer to the DSO for further information. (Information is available on the web at http://www.dso.iastate.edu/ja/academic/misconduct.html)

### Grading Scale:

<table>
<thead>
<tr>
<th>Grade</th>
<th>92-100</th>
<th>89-91</th>
<th>85-89</th>
<th>82-84</th>
<th>79-81</th>
<th>75-78</th>
<th>72-74</th>
<th>69-71</th>
<th>65-68</th>
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<th>Below 60</th>
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<tbody>
<tr>
<td>A</td>
<td>A-</td>
<td>B+</td>
<td>B</td>
<td>C+</td>
<td>C</td>
<td>C-</td>
<td>D+</td>
<td>D</td>
<td>D-</td>
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<td>F</td>
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### Grading System:

- **Homework**: 15%
- **Exam 1**: 20%
- **Exam 2**: 20%
- **Project 1**: 20%
- **Final Project**: 25%

### Additional Information:

- If you have a disability and require accommodations, please contact the instructor early in the semester so that your learning needs may be appropriately met. You will need to provide documentation of your disability to the Disability Resources (DR) office, located on the main floor of the Student Services Building, Room 1076, 515-294-7220.

- Blackboard Learn will be the primary source of communication for this course. You will be required to check the website regularly and to post questions, comments and concerns on the bulletin board, or email me whenever necessary. **Note: All students will be enrolled in the CBE 421_XE Blackboard Learn course, and should check it regularly for announcements, documents and links that are related to the course. All course lectures have already been recorded (during the Spring 2011 semester) and are available for download and watching at your own pace. However, I recommend that you maintain a standard 3 lectures per week schedule in order to maintain consistency with the homework assignments and exams that will be given. Homework assignments will be posted each Monday on the website, and may not be the same as those discussed in the lectures since this is a new semester.**

- Old exams and solutions will be posted on Blackboard Learn for your reference. Homework solutions will also be posted after the homework has been collected. You are encouraged to visit during office hours if you need assistance. If you are unable to visit during scheduled office hours, please feel free to email me to arrange a time to meet with me.

- If at the end of the semester your grade is bordering between two of the points noted above, your homework grade will be the determining factor. (i.e., if you have a total homework grade of >90%, you will be given the higher of the two grades. If <90%, you will receive the lower of the two grades.)
Basic Objectives

The basic objective of this course is to teach you fundamental concepts and principles in the modeling of dynamic chemical processes and in the application of process control.

Specific Objectives:

1. To teach you to dynamically model chemical processes using theoretical principles.
2. To teach you to dynamically model processes using empirical and semi-empirical modeling methods.
3. To teach you to design and implement feedback and other control schemes.
4. To teach you how to assess the stability of self-regulating and automatically controlled processes.
5. To familiarize you with basic equipment in controlled processes.
6. To give you an appreciation for the importance of process control in industrial processes.
7. To teach you how to develop transfer functions and block diagrams for linear and non-linear processes.
8. To expose you to a variety of topics in the process control literature, such as PLC’s, inferential control, adaptive control, statistical process control, etc.
9. To give you familiarity and understanding of the three modes of control for feedback controllers.
10. To teach you to exploit process modeling in the design and development of process control systems.
11. To give you a perspective on the importance of process control on safety, quality, cost, the environment, productivity, and technical feasibility.
# Tentative Course Outline

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<thead>
<tr>
<th>Week of:</th>
<th>Chapters</th>
<th>Notes:</th>
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<tbody>
<tr>
<td>8/22</td>
<td>1,2</td>
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<tr>
<td>8/29</td>
<td>2</td>
<td>First project assigned</td>
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<tr>
<td>9/5</td>
<td>2,3</td>
<td>No Class Monday (Labor day)</td>
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<td>9/12</td>
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<td>9/19</td>
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<td>9/26</td>
<td>5,6</td>
<td><strong>First project due</strong>, Friday 9/30</td>
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<td>10/3</td>
<td>6,7</td>
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<tr>
<td>10/10</td>
<td>7</td>
<td><strong>Exam 1, Friday 10/14</strong>, Chapters 1-7</td>
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<td>10/17</td>
<td>8</td>
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<td>10/24</td>
<td>9,10</td>
<td>Field Trip (TBA)</td>
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<td>10/31</td>
<td>10,11</td>
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<tr>
<td>11/7</td>
<td>11,12</td>
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<td>11/14</td>
<td>12, 15</td>
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<td>11/21</td>
<td><strong>Thanksgiving Break Week</strong></td>
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<td>11/28</td>
<td>16</td>
<td><strong>Exam 2, Friday 12/2</strong>, Chapters 8-12, 15-16</td>
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<tr>
<td>12/5</td>
<td>13</td>
<td>Other topics, Final project, Review</td>
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<tr>
<td>12/12</td>
<td><strong>Final Exam Week</strong></td>
<td><strong>Final project due</strong></td>
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