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| **COURSE INFORMATION** | |
| **Course Number and Title** | ChE 421  Process Control |
| **Semester** | Fall 2018 |
| **Class Meetings** | T/Th 12:40 to 2:00 PM  Durham 171 |
| **Course Description** | Control of industrial chemical processes. Device applications and limitations. Dynamics of chemical process components and process control systems. |
| **Philosophy** | Welcome to ChE421! In your other courses you have learned about the many dynamic processes a chemical engineer can face (movement of fluids, heat, and mass). In this course, you will learn how to first **model** these systems and their perturbations and then how to **control** them. This is grounded in many real-world situations (process start-up, shut-down, and fluctuations) as no real process is perfectly static. That would be boring. This class will apply some seemingly obscure mathematical principles (Laplace transforms?) and numerical simulation (Matlab!) to tackle these problems. |
| **Learning Outcomes** | By the end of this course you should be able to:   * Mathematically model dynamic chemical processes and understand the relevance of modeling * Understand the importance of process control * Understand the strengths and limitations of various process control schemes and how the schemes relate to the process * Identify, formulate, and solve engineering problems * Conduct and evaluate experiments in process control * Design process controls, including consideration of safety and environmental concerns * Demonstrate the ability to work effectively as a member of a team * Demonstrate knowledge through written communication * Recognize the need for lifelong learning * Use computational tools |
| **Prerequisites** | The prerequisites for this course are CH E 358, CH E 382, MATH 267.  Course prerequisites will be enforced according to University policy: <http://catalog.iastate.edu/informationaboutcourses/#prerequisitetext>. This means that students who are enrolled in this course but have not met the prerequisite requirements must drop the course. The instructor will not grade any coursework submitted by a student who has not met the course prerequisites and if the student does not drop this course, the student will earn an “F” grade for this course.  Students who do not meet prerequisites but do have equivalent preparation may submit a request for a prerequisite waiver to the instructor. Waivers are available on the CBE website. |
| **INSTRUCTOR INFORMATION** | |
| **Primary Instructor** | Nigel F. Reuel - 3051 Sweeney  reuel@iastate.edu  515-294-4592  Thursday 2:00 to 5:00 (Sweeney 2126 open as study hall, Reuel there or in 3051) |
| **Teaching Assistant** | Dillon Hurd  dghurd@iastate.edu  Monday 2:00 to 5:00 (Sweeney 1059) |
| **TEXTBOOKS AND SUPPLIES** | |
| **Required Textbooks** | Process Dynamics and Control 3rd Edition, by Dale E. Seborg et al. ISBN-13: 978-0470128671 |
| **Required Supplies** | Internet enabled device (phone, tablet, or laptop) for in class exercises, Matlab for homework and group lab project (you will NOT need this for in class exams). |
| **Web Access** | The course will be managed through Prof. Reuel’s group webpage - <http://www.reuelgroup.org/process-control-che-421.html> . This will be the landing site for homework assignments and where grades will be posted.  Class interaction, collaboration, and interactions will be managed on our class SLACK page. Each student will need to setup a profile in the first week. (you will receive an email invitation).  <https://che421fall2018.slack.com> |
| **ASSIGNMENTS AND EVALUATION** | |
| **In-Class Problems** | In each class period there will be ONE graded in class problem that you work on individually or in small groups. This will occur at different times each day (spot check for attendance). If it occurs at the start of class, it will cover the expected reading for the day, so please come prepared. |
| **Homework** | One problem set is assigned (2-5 problems) per week**. It will be posted on the class page at 3:00 PM each Tuesday and will be due the following Tuesday at the start of class**. **The submission box will be removed promptly at 12:45** by the TA, so submit your homework on time. Obvious items if you want to get full credit: don’t forget your name on each page and staple problems that span multiple pages.  Most weeks there will be a TEAM problem that you work on with your group (see below). Complete the TEAM assignment on a separate page.  **PSET Grading** – you will receive full credit if you make a full attempt at solving the problem. In other words, you are graded on the learning process and NOT trying to find the correct solution. My intent on this is to 1) encourage real learning process on the homework, 2) to relieve the mad pressure to get perfect scores on homework, and 3) to diffuse any interest in finding old keys. After the due date, the answer key will be posted so save your precious time and money (*e.g.* no need to pay for a Chegg subscription). Make a full attempt at the solution (as best you can) and you will get full points. |
| **Teamwork** | Our class of ~80 will be divided into teams of 3-5. I will allow for self-assembly of groups during the first week and will then do some rearranging as needed. You may help each other and discuss homework problems (this is encouraged) but you MUST complete your own work and turn in your own paper. Collaboration on exams is strictly prohibited and will result in a zero on the test and academic discipline actions (see below). |
| **Professionalism** | My expectation is preparation for future career. Be on time, be attentive, be courteous, and be engaged. |
| **Exams** | There are two, in-class, mid-term exams (see schedule for dates) and one comprehensive final (TBD). All exams are open book, open notes, open calculator. Closed phone, tablet, computer or any other internet connected device. |
| **Grading** | Point break down as follows  Midterm Exam 1 = 15%  Midterm Exam 2 = 15%  Final Exam = 30%  In-class, daily problems (some group, some solo) = 10%  Individual Weekly Problem Sets = 10% [graded on completeness, see above]  Team Weekly Problems = 5%  Team LAB Project = 15%  The minimum grade assignments will be:    However, I reserve the right to adjust this scale **in your favor**, depending on the overall performance of the class. |
| **COURSE POLICIES** | |
| **Attendance** | Formal attendance is not taken, but in class problems necessitate being present. If you cannot make a course for an approved reason (see University Policies below), please contact me **at least 48 hr.** in advance to accommodate getting you class notes and allowing you to make up the daily problem. |
| **Late Assignments** | Not accepted. You have a full week to submit. The deadline for each problem set is **Tuesday at 12:45** for each week (physical submission at start of class). If there are extenuating circumstances, please contact me ahead of time and I will do my best to accommodate. |
| **Requests for Regrading** | If you feel a problem set or exam has a grading error, please allow **48 hr.** to pass before approaching the instructor or TA. This will allow you adequate time to look at the posted answer key. |
| **Computer Use** | Computers are to be used only for coursework. Do not peruse the internet; use email, Facebook or any other social network; play games; or indulge in other diversions. Again, during class we develop skills together that can be used in problem sets and exams. It is to your advantage to follow along, take notes, and complete the in-class example problems. |
| **General Expectations** | You are expected to spend an average of 9 hours per week preparing for class and completing homework assignments (this includes reviewing the textbook). |
| **UNIVERSITY POLICIES** | |
| **Academic Dishonesty** | You are expected to practice academic honesty in every aspect of this course and all other courses. Information on academic misconduct and the consequences can be found on the Dean of Students webpage (<http://www.dso.iastate.edu/ja/academic/misconduct.html>).  Students who engage in academic misconduct are subject to university disciplinary procedures, as well as consequences with regard to this course. Here is an online video guide - <https://www.youtube.com/watch?v=U3DxTWybvlQ>  Consulting a solution manual, student solutions from a previous semester, or using any unauthorized assistance from other people or resources (including the internet) **will not improve your grade**. Again, your PSETs are graded on completeness and you will not have internet enabled devices in the exams. It behooves you to attempt each problem, to your best ability, and then learn from the key when it is posted.  You are encouraged to seek help from the primary instructor, the teaching assistant, and your classmates to complete homework assignments and in-class problems. If you do seek help from your classmates, then you must acknowledge this help at the end of the assignment with the following statement:  “Problem x.x was completed with assistance from [classmate’s name].” |
| **Disability Accommodations** | Iowa State University is committed to assuring that all educational activities are free from discrimination and harassment based on disability status. Students requesting accommodations for a documented disability are required to meet with staff in Student Accessibility Services (SAS) to establish eligibility and learn about related processes. Eligible students will be provided with a Notification Letter for each course and reasonable accommodations will be arranged after timely delivery of the Notification Letter to the instructor. Students are encouraged to deliver Notification Letters as early in the semester as possible. SAS, a unit of the Dean of Students Office, is located in room 1076 Student Services Building or online ([www.sas.dso.iastate.edu](http://www.sas.dso.iastate.edu) ). Contact SAS by e-mail ([accessibility@iastate.edu](mailto:accessibility@iastate.edu) ) or by phone at 515-294-7220 for additional information. |
| **Discrimination and Harassment** | Iowa State University does not discriminate on the basis of race, color, age, ethnicity, religion, national origin, pregnancy, sexual orientation, gender identity, genetic information, sex, marital status, disability, or status as a U.S. Veteran. Inquiries regarding non-discrimination policies may be directed to Office of Equal Opportunity, 3410 Beardshear Hall, 515 Morrill Road, Ames, Iowa 50011, Tel. 515-294-7612,  Hotline 515-294-1222, email [eooffice@iastate.edu](mailto:eooffice@mail.iastate.edu) |
| **Religious Accommodations** | Iowa State University welcomes diversity of religious beliefs and practices, recognizing the contributions differing experiences and viewpoints can bring to the community. There may be times when an academic requirement conflicts with religious observances and practices. If that happens, students may request reasonable accommodation for religious practices. In all cases, you must put your request in writing. The instructor will review the situation in an effort to provide a reasonable accommodation when possible to do so without fundamentally altering a course. For students, you should first discuss the conflict and your requested accommodation with your professor at the earliest possible time. You or your instructor may also seek assistance from the [Dean of Students Office](http://www.dso.iastate.edu/sa/) at 515-294-1020 or the [Office of Equal Opportunity](http://www.eoc.iastate.edu/) at 515-294-7612. |
| **Emergency Awareness** | * For an immediate emergency, call [ISU Police](http://www.police.iastate.edu/) at 515-294-4428. * During a campus emergency, go to [www.iastate.edu](http://www.iastate.edu) for additional information. * Classroom management emergencies   + For immediate health/safety concerns, call ISU Police at 515-294-4428   + For other concerns regarding classroom management, contact the instructor and/or the chair of the academic department for guidance * Know the following information posted in your building [Emergency Map](http://www.ehs.iastate.edu/prep/building-information)   + Locate the evacuation routes   + Locate the [severe weather shelter areas](http://www.ehs.iastate.edu/prep/building-information) * Keep your contact information up-to-date in the [ISU Alert](http://www.isualert.iastate.edu/) * Additional emergency information is available at [www.ehs.iastate.edu/prep/students](http://www.ehs.iastate.edu/prep/students). * ISU PD Facebook ([www.facebook.com/ISUPD](http://www.facebook.com/ISUPD)) and Twitter ([www.twitter.com/ISUPD](http://www.twitter.com/ISUPD)) * To be better prepared during an act of violence on campus and understand the principles of A-D-D (Avoid Deny Defend), please attend [Violent Incident Response Training (VIRT)](http://www.police.iastate.edu/services/outreach/VIRT). |
| **TENTATIVE COURSE SCHEDULE** | |
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| **Date** | **Day** | **Topic** | **Reading Assignment Due** | **Homework Assignment Due** |
| 8/21/2018 | T | Introduction | Chp. 1 |  |
| 8/23/2018 | R | Mathematical Modeling | Chp. 1 + 2 |  |
| 8/28/2018 | T | Simulation with Matlab | Chp. 2 | PSET 1 |
| 8/30/2018 | R | Dynamic Responses | Chp. 2 |  |
| 9/4/2018 | T | Laplace Transforms | Chp. 3 | PSET 2 |
| 9/6/2018 | R | Transfer Functions | Chp. 4 |  |
| 9/11/2018 | T | First and Second Order Systems | Chp. 5 | PSET 3 |
| 9/13/2018 | R | Complex Processes | Chp. 6 |  |
| 9/18/2018 | T | [Career Fair] (no class) | --- | PSET 4^ |
| 9/20/2018 | R | Fitting Models to DATA | Chp. 7 |  |
| 9/25/2018 | T | [Career Fair] (no class) | --- | PSET 5^ |
| 9/27/2018 | R | Instrumentation and Safety | Chp.9 +10 |  |
| 10/2/2018 | T | EXAM 1 (Chp. 1-7) | --- | [study for test] |
| 10/4/2018 | R | Feedback, PID Controllers | Chp. 8 |  |
| 10/9/2018 | T | Feedback, PID Controllers | Chp. 8 | PSET 6 |
| 10/11/2018 | R | Closed loop transfer function | Chp. 11 |  |
| 10/16/2018 | T | Block Diagrams, Stability | Chp. 11 | PSET 7 |
| 10/18/2018 | R | Intro to LAB Online (no class) | --- |  |
| 10/23/2018 | T | Closed Loop Analysis | Chp. 12 | PSET 8 |
| 10/25/2018 | R | Frequency Response | Chp. 14 |  |
| 10/30/2018 | T | LAB DEMO and Groups in CLASS\* | --- | PSET 9 |
| 11/1/2018 | R | Feedforward Control | Chp. 15 |  |
| 11/6/2018 | T | Advanced Control Strategies | Chp. 16 | PSET 10 |
| 11/8/2018 | R | Review + Multivariable Control | Chp. 18 |  |
| 11/13/2018 | T | EXAM 2 (Chp. 8-12, 14-15) | --- | [study for test] |
| 11/15/2018 | R | Real-time Optimization | Chp. 19 |  |
| 11/20/2018 | T | THANKSGIVING BREAK - NO CLASS | | |
| 11/22/2018 | R |
| 11/27/2018 | T | Model Predictive Control | Chp. 20 | PSET 11 |
| 11/29/2018 | R | Computer Control | Appendix A |  |
| 12/4/2018 | T | Field Trip (TBD) |  | PSET 12 |
| 12/6/2018 | R | LAB 'Commercials' + Review |  |  |
| 12/11/18  2:15 - 4:15 |  | FINAL EXAM (Everything) |  |  |

\* Dr. Reuel at conference

^PSET 4 and 5 must be turned in directly to TA by 1:00 PM (they will coordinate location)