OUTLINE OF CHEMICAL ENGINEERING 3P04: JAN-APRIL, 2024
PROCESS CONTROL

Instructor: Dr. C.L.E. Swartz (JHE-360; email: swartzc@mcmaster.ca)

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Office Hours: Drop in, and by appointment.

Tests: Provisional schedule:
Test 1: Tu Feb 13, 9:30AM-10:20AM
Test 2: Tu Mar 19, 9:30AM-10:20AM
Dates to be confirmed.

Examination: Final examination, 2.5 hours.

Calculators: Any calculator may be used in the tests and final exam.

Grading:

Assignments	15 %	of final grade
Mid-term 1	12.5%	" " "
Mid-term 2	12.5%	" " "
Term project	15 %	" " "
Final exam	45 %	" " "

There will be approximately 5 "regular" assignments, with about 5-6 questions each, with due dates about 2 weeks apart. There will also be in-class problems tackled in graded tutorial sessions that will alternate with the "regular" tutorial sessions. The "regular assignments" will contribute 10% toward the final course grade, and the "in-class assignments" will contribute 5%.

The final percentage grades will be converted to letter grades using the registrar's recommended procedure. Adjustments to final grades may be done at the discretion of the instructor.

Recommended Text: Either of

1. D.E. Seborg, T.F. Edgar, D.A. Mellichamp, and F.J. Doyle, *Process Dynamics and Control*, 3rd Edn., Wiley, 2011.(***Highly recommended. Any edition of this book is good***)
2. T.E. Marlin, *Process Control: Designing Processes and Control Systems for Dynamic Performance*, McGraw-Hill, 2000. ***The book is free, and available at http://www.pc-education.mcmaster.ca/Book_Links.htm***

Supplementary References:

3. B.A. Ogunnaike and W.H. Ray, *Process Dynamics, Modeling and Control*, Oxford, 1994.
4. C.A. Smith and A. B. Corripio, *Principles and Practice of Automatic Control*, Wiley, 1985.
5. G. Stephanopoulos, *Chemical Process Control: An Introduction to Theory and Practice*, Prentice Hall, 1984.

Provisional Course Outline

1. Process Dynamics
- Development of mathematical models
- Laplace transforms
- Transfer functions
- Linearization
- Open-loop response of first, second and higher-order systems
- Process identification

2. Feedback Control Fundamentals & Closed-Loop Analysis
- P, PI and PID controllers
- Block diagrams
- Routh-Hurwitz stability criterion
- Instrumentation hardware & representation

3. Feedback Controller Design
- Direct synthesis
- PID tuning methods

4. Advanced Control Systems
- Feedforward control
- Cascade control

5. Control of Multi-Input, Multi-Output Systems
- Model development
- Stability
- Interaction, Loop pairing - Relative Gain Array
- Decoupling
- Control of common industrial process units.

6. Digital Control – an Introduction
- Sampled-data systems
- Design of digital controllers

7. Control of Process Plants

Objective

The course is geared to address the following: Given a process and operational objectives, design a control system which is (i) stable, (ii) has good performance characteristics, and (iii) is robust. This requires knowledge of dynamic behavior of processes (process modeling, solution of dynamic equations, characterization of dynamic behavior); control systems; stability and techniques for assessing it; performance criteria and how they are affected by controller parameters.

APPROVED ADVISORY STATEMENTS

Academic Integrity

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. **It is your responsibility to understand what constitutes academic dishonesty.**

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at https://secretariat.mcmaster.ca/university-policies-proceduresguidelines/

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

Authenticity / Plagiarism

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. Avenue to Learn, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. **All submitted work is subject to normal verification that standards of academic integrity have been upheld** (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

Courses with an On-line Element

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn, LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

Online Proctoring

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

Conduct Expectations

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the Code of Student Rights & Responsibilities (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online**.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

Academic Accommodation of Students with Disabilities

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's Academic Accommodation of Students with Disabilities policy.

Requests for Relief for Missed Academic Term Work

In the event of an absence for medical or other reasons, students should review and follow the Policy on Requests for Relief for Missed Academic Term Work.

Academic Accommodation for Religious, Indigenous, or Spiritual Observances (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office **normally within 10 working days** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

Copyright and Recording

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

Extreme Circumstances

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, Avenue to Learn and/or McMaster email.

ATTRIBUTES

Course outcomes	Corresponding CEAB indicator
Understand that processes do not operate at steady state all the time	
Use mathematical equations to describe changing process dynamics	• Ability to identify a range of suitable engineering fundamentals (including mathematical techniques) that would be potentially useful for analyzing a technical problem
Use the PID controller, and know how to tune the parameters in the control loop	• Competence in Specialized Engineering Knowledge • Recognizes and follows an engineering design process
Determine if a system is stable or unstable, and understand factors that influence closed-loop stability	• Ability to identify a range of suitable engineering fundamentals (including mathematical techniques) that would be potentially useful for analyzing a technical problem
Use of the process reaction curve technique to identify a dynamic process model	• Competence in Specialized Engineering Knowledge • Recognizes and follows an engineering design process
Know when to select and how to implement cascade and feedforward controllers	• Competence in Specialized Engineering Knowledge • Ability to identify a range of suitable engineering fundamentals (including mathematical techniques) that would be potentially useful for analyzing a technical problem • Recognizes and follows an engineering design process
Implement multiloop controllers and understand pairing	• Competence in Specialized Engineering Knowledge • Recognizes and follows an engineering design process
Use of Simulink to simulate dynamic response of control systems	• The ability to use modern/state of the art tools

The above outcomes and indicators are for your information. Graduating from an accredited institution has many advantages. Please read more about it here: http://www.engineerscanada.ca/accreditation