**OUTLINE OF CHEMICAL ENGINEERING 3P04: JAN-APRIL, 2017**
**PROCESS CONTROL**

**Instructor**: Dr. C.L.E. Swartz (JHE-360; Ext. 27945; email: swartzc@mcmaster.ca)

**TAs**: Smriti Shyamal (JHE-370; Ext. 22008; email: shyamas@mcmaster.ca)
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Maria Ruiz Caldas (JHE-296)

**Lectures**: Tu, Th, Fr 08:30-09:20 HH 302

**Tutorials**: M 09:30-11:20 (T02) BSB 137
Th 14:30-16:20 (T01) JHE A101

**Office Hours**: By appointment.

**Tests**: Provisional schedule:
Test 1: Week of Jan 30
Test 2: Week of Mar 6
Dates to be confirmed.

**Examination**: Final examination, 2.5 or 3 hours – to be confirmed.

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

**Grading**:

| | | |
|---|---|---|
| Assignments | 5 % | of final grade |
| Mid-term 1 | 12.5% | " " " |
| Mid-term 2 | 12.5% | " " " |
| Term project | 15 % | " " " |
| Final exam | 55 % | " " " |

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.

**Prescribed Text**: 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:**

1. D.E. Seborg, T.F. Edgar, D.A. Mellichamp, and F.J. Doyle, *Process Dynamics and Control*, 3rd Edn., Wiley, 2011.
2. B.A. Ogunnaike and W.H. Ray, *Process Dynamics, Modeling and Control*, Oxford, 1994.
3. C.A. Smith and A. B. Corripio, *Principles and Practice of Automatic Control*, Wiley, 1985.
4. 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**

**Workshop Sessions, including**
- Simulink

**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 behaviour of processes (process modeling, solution of dynamic equations, characterization of dynamic behaviour); control systems; stability and techniques for assessing it; performance criteria and how they are affected by controller parameters.

**POLICY REMINDERS**:

**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.

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.

It is your responsibility to understand what constitutes academic dishonesty. For information the various types of academic dishonesty please refer to the Academic Integrity Policy, located at **http://www.mcmaster.ca/academicintegrity**

The following illustrates only three forms of academic dishonesty:
1. Plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations.

**Course Changes:**
The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.

## 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<br>• 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<br>• Recognizes and follows an engineering design process |
| Know when to select and how to implement cascade and feedforward controllers | • Competence in Specialized Engineering Knowledge<br>• Ability to identify a range of suitable engineering fundamentals (including mathematical techniques) that would be potentially useful for analyzing a technical problem<br>• Recognizes and follows an engineering design process |
| Implement multiloop controllers and understand pairing | • Competence in Specialized Engineering Knowledge<br>• 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