The University of Western Ontario  
Faculty of Engineering  

DEPARTMENT OF CHEMICAL AND BIOCHEMICAL ENGINEERING  

CBE 4420 – Computer Process Control  

Course Outline 2014-2015  

The course covers some advanced topics in process control such as Multivariable Control and Digital Control Systems. An introduction to the fundamental concepts in process dynamics and control including the frequency response technique will be provided depending on the background of the participating students. Discrete Process Control Theory using z-transformation is covered and the design of digital controllers will be discussed. Time permitting, the identification of stochastic processes and the design of digital controllers for the stochastic processes will be introduced.

The general outcome of the course is to enable the students to:

- Develop computational skills to analyse the feedback control systems in a variety of configurations
- Develop tools for testing stability of the feedback control systems in the s-domain, frequency domain and z-domain
- Understand the dynamics of multivariate (MV) control systems
- Design feedback controllers for the MV systems based on decoupling
- Design digital controllers in the z-domain and implement them on a real time computer control system

Prerequisites:
An introductory course in Process Dynamics and Control  
Graduate Student Status or permission of the department

Corequisites:
None

Antirequisites:
None

Contact Hours:
3 lecture hours per week, 0.5 course.

Instructor:
Dr. S. Rohani (TEB 469) E.mail srohani@uwo.ca

Recommended Text

Reference Texts:

Units:
SI and British units will be used
Specific Learning Objectives:

Closed Loop Systems
At the end of this topic, students will be able to:
- Understand how to manipulate closed loop block diagrams to calculate the overall transfer functions
- Understand PID control and the role integration in offset removal
- Analyse the effect of chemical process dead time on control quality
- Tune a PID controller by trial and error as well as by using other analytical methods
- Use Simulink/Matlab tools to develop closed loop tuning simulations

Stability in Laplace Domain
At the end of this topic, students will be able to:
- Understand the concept of characteristic equation and be able to calculate it for closed loop systems
- Apply stability criteria to analyse the stability of systems

Stability in Frequency Domain
At the end of this topic, students should be able to:
- Use Matlab to plot various frequency functions (Bode/Nyquist) for control systems with dead time
- Apply Bode/Nyquist stability criteria to processes with dead time
- Use frequency methods to tune controllers

Design of Digital Controller in the z-domain
At the end of this topic, students should be able to:
- Analyze digital controlled systems
- Apply the z-transform, its properties and application in the design of discrete controllers
- Develop the discrete transfer function of the digital PID controllers in the z-domain
- Analyze the stability of sampled-data systems
- Design model-based digital controllers

Multi Variable (MV) Transfer Functions
At the end of this topic, students will be able to:
- Develop a MV Transfer Function Matrix for a MV process
- Understand Relative Gain Array (RGA) for MV systems
- Design Decoupling Controllers

Stochastic Processes
At the end of this topic, students will be able to:
- Carry out offline and online identification of stochastic processes
- Design of minimum variance and generalized minimum variance controllers

Evaluation:
The Computer Process Control Laboratory has a number of processes interfaced to real time computers. A series of goals will be set for the group and a comprehensive project report will be used to assess the group and individual performance. Simulation projects using Matlab + Simulink are also available.

The final course mark will be determined as follows:
Assignments 20%
Midterm Examination 30%
Final Examination 50%

Examination will be closed book. A formulae sheet is allowed. Calculators of any kind will be permitted during examinations. The memory of the calculators should be purged before the examination.

Note: 1) Students must pass the final examination to pass this course. Students who fail the final examination will be assigned 48% if the aggregate mark is higher than 50%, or the aggregate mark.
2) Students must turn in all laboratory reports, and achieve a passing grade in the laboratory component, to pass this course. 3) Assignments are to be handed in the CBE 420 locker located in the Thompson Engineering Building, on the specified due date provided by the Instructor.

Use of English:
In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for the improper use of English. Additionally, poorly written work with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

Attendance:
Any student who, in the opinion of the instructor, is absent too frequently from class or laboratory periods in any course, will be reported to the Associate Chair (Graduate), after due warning has been given. On the recommendation of the Department concerned, and with permission of the Associate Chair, appropriate action will be taken, with the possibility of course failure.

Cheating:
University policy states that cheating is a scholastic offense. The commission of a scholastic offense is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.

Plagiarism:
University policy states that plagiarism is a scholastic offense. Plagiarism is defined as appropriating and passing off writings or ideas of another person’s as one’s own. Penalties may include failure or automatic withdrawal from the course.

Students must write their essays and assignments in their own words. Whenever students take an idea, or a passage of text from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence.

The University of Western Ontario has software for plagiarism checking. Students may be required to submit their work in electronic form for plagiarism checking.

For further information on plagiarism, consult the Scholastic Offence Policy in the Western Academic Calendar.

Sickness and Other Problems:
Students should immediately consult with the instructor or Associate Chair (Graduate) if they have any problems that could affect their performance in the course. The student should seek advice from the Instructor or Associate Chair (Graduate) regarding how best to deal with the problem. Failure to notify
the Instructor or Associate Chair (Graduate) immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

**Notice:**
Students are responsible for regularly checking their email and notices posted on Instructors' doors.

**Consultation:**
Office hours will be posted. Individual consultation may be arranged by appointment with the instructor.

**Accreditation Unit (AU) Content:**
- Engineering Science = 60%
- Engineering Design = 40%
INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS
OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED

IF, ON MEDICAL OR COMPASSIONATE GROUNDS, YOU ARE UNABLE TO WRITE TERM TESTS OR FINAL EXAMINATIONS OR COMPLETE COURSE WORK BY THE DUE DATE, YOU SHOULD FOLLOW THE INSTRUCTIONS LISTED BELOW. YOU SHOULD UNDERSTAND THAT ACADEMIC ACCOMMODATION WILL NOT BE GRANTED AUTOMATICALLY ON REQUEST. YOU MUST DEMONSTRATE TO YOUR DEPARTMENT (OR THE UNDERGRADUATE SERVICES OFFICE IF YOU ARE IN FIRST YEAR) THAT THERE ARE COMPELLING MEDICAL OR COMPASSIONATE GROUNDS THAT CAN BE DOCUMENTED BEFORE ACADEMIC ACCOMMODATION WILL BE CONSIDERED. DIFFERENT REGULATIONS APPLY TO TERM TESTS, FINAL EXAMINATIONS AND LATE ASSIGNMENTS. READ THE INSTRUCTIONS CAREFULLY. (SEE THE 2014 UWO ACADEMIC CALENDAR).

A. GENERAL REGULATIONS & PROCEDURES

1. Check the course outline to see if the instructor has a policy for missed tests, examinations, late assignments or attendance.

2. Bring your request for academic accommodation to the attention of the chair of your (or the Undergraduate Services office if you are in first year) PRIOR to the scheduled time of the test or final examination or due date of the assignment. If you are unable to contact the relevant person, leave a message with the appropriate department (or with the Undergraduate Services Office if you are in first year). The address, telephone and fax numbers are given at the end of these instructions. Documentation must be provided as soon as possible.

3. If you decide to write a test or an examination you should be prepared to accept the mark you earn. Rewriting tests or examinations or having the value of a test or examination reweighted on a retroactive basis is not permitted.

B. TERM TESTS

1. If you are unable to write a term test, inform your instructor and the Chair of your Department (or the Undergraduate Services Office if you are in first year) PRIOR to the scheduled date of the test. If the instructor is not available, leave a message for him/her at the department office and inform the Chair of the Department (or the Undergraduate Services Office if you are in first year).

2. Be prepared to provide supporting documentation to the Chair and the Undergraduate Services Office (see next page for information on documentation).

3. Discuss with the instructor if and when the test can be rescheduled. N.B. The approval of the Chair (or the Undergraduate Services Office if you are in first year) is required when rescheduling term tests.

C. FINAL EXAMINATIONS

1. If you are unable to write a final examination, contact the Undergraduate Services Office PRIOR TO THE SCHEDULED EXAMINATION TIME to request permission to write a Special Final Examination. If no one is available in the Undergraduate Services Office, leave a message clearly stating your name & student number (please spell your full name).

2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, sleeping in, misreading timetable and travel arrangements.

3. In order to receive permission to write a special examination, you must obtain the approval of the Chair of the Department and the Associate Dean and in order to apply you must sign a "Recommendation for a Special Examination Form" available in the Undergraduate Services Office. The Undergraduate Services Office will then notify the course instructor(s) and reschedule the examination on your behalf.

N.B. It is the student's responsibility to check the date, time and location of the special examination.

D. LATE ASSIGNMENTS

1. Advise the instructor if you are having problems completing the assignment on time (prior to the due date of the assignment).

2. Be prepared to provide documentation if requested by the instructor (see reverse side for information on documentation).

3. If you are granted an extension, establish a due date. The approval of the Chair of your Department (or the Associate Dean if you are in first year) is not required if assignments will be completed prior to the last day of classes.

4. i) Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean. Documentation is mandatory.

ii) A Recommendation of Incomplete Form must be filled out indicating the work to be completed and the date by which it is due. This form must be signed by the student, the instructor, the department Chair and the Associate Dean.
E. **SHORT ABSENCES**

If you miss a class due to a minor illness or other problems, check your course outlines for information regarding attendance requirements and make sure you are not missing a test or assignment. Cover any readings and arrange to borrow notes from a classmate.

F. **EXTENDED ABSENCES**

If you are absent more than one week or if you get too far behind to catch up, you should consider reducing your workload by dropping one or more courses. (Note drop deadlines listed below). You may want to seek advice from the academic counsellor in your Department or Ms Karen Murray in the Undergraduate Services Office if you are in first year.

G. **DOCUMENTATION**

If you consulted an off-campus doctor or Student Health Services regarding your illness or personal problem, **you must provide the doctor with a Student Medical Certificate** to complete at the time of your visit and then bring it to the Department (or the Undergraduate Services Office if you are in first year). **This note must contain the following information: severity of illness, effect on academic studies and duration of absence.**

**In Case of Serious Illness of a Family Member:** Provide a Student Medical Certificate to your family member's physician to complete and bring it to the Department (or the Undergraduate Services Office if you are in first year).

**In Case of a Death:** Obtain a copy of the death certificate or the notice provided by the funeral director's office. You must include your relationship to the deceased and bring it to the Department (or the Undergraduate Services Office if you are in first year).

**For Other Extenuating Circumstances:** If you are not sure what documentation to provide, ask the Departmental Office (or the Undergraduate Services Office if you are in first year) for direction.

**Note:** Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).

H. **ACADEMIC CONCERNS**

You need to know if your instructors have a policy on late penalties, missed tests, etc. This information may be included on the course outlines. If not, ask your instructor(s).

You should also be aware of attendance requirements in some courses. You can be debarred from writing the final examination if your attendance is not satisfactory.

If you are in academic difficulty, check out the minimum requirements for progression in the calendar. If in doubt, see your academic counsellor.

**Calendar References:** Check these regulations in your 2014 Western Academic Calendar available at [www.westerncalendar.uwo.ca](http://www.westerncalendar.uwo.ca).

Absences Due to Illness: [http://www.westerncalendar.uwo.ca/2014/pg117.html#](http://www.westerncalendar.uwo.ca/2014/pg117.html#)
Academic Accommodations for Students with Disabilities: [http://www.westerncalendar.uwo.ca/2014/pg118.html](http://www.westerncalendar.uwo.ca/2014/pg118.html)
Academic Accommodations for Religious or Holy Days: [http://www.westerncalendar.uwo.ca/2014/pg119.html](http://www.westerncalendar.uwo.ca/2014/pg119.html)
Examinations: [http://www.westerncalendar.uwo.ca/2014/pg129.html](http://www.westerncalendar.uwo.ca/2014/pg129.html)
Scheduling of Term Assignments: [http://www.westerncalendar.uwo.ca/2014/pg131.html](http://www.westerncalendar.uwo.ca/2014/pg131.html)
Student Medical Certificate: [http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf)

**Engineering Academic Regulations:** [http://www.westerncalendar.uwo.ca/2014/pg1442.html](http://www.westerncalendar.uwo.ca/2014/pg1442.html)

**Note:** These instructions apply to all students registered in the Faculty of Engineering regardless of whether the courses are offered by the Faculty of Engineering or other faculties in the University.

**Drop Deadlines:**
- First term half course (i.e. “A” or “F”): November 5, 2014
- Full courses and full-year half courses (i.e. “E”, “Y” or no suffix): November 30, 2014
- Second term half or second term full course (i.e. “B” or “G”): March 7, 2015

Undergraduate Services Office: SEB 2097 telephone: (519) 661-2130 fax: (519) 661-3757
Dept. of Chemical and Biochemical Engineering & Green Process Engineering TEB 477 telephone: (519) 661-2131 fax: (519) 661-3498
Dept. of Civil and Environmental Engineering: SEB 3005 telephone: (519) 661-2139 fax: (519) 661-3779
Dept. of Electrical and Computer Engineering, Software Engineering, Mechatronics Engineering TEB 279 telephone: (519) 661-3758 fax: (519) 850-2436
Dept. of Mechanical and Materials Engineering: SEB 3002 telephone: (519) 661-4412 fax: (519) 661-3020

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