# MCG 3307: Control Systems II - Spring/Summer 2010

**Instructor:** Dr. Davide Spinello
email: dspinell@uottawa.ca
office: CBY A-612
phone: 613.562.5800 ext. 2460
web page: http://by.genie.uottawa.ca/~spinello/webpage/

**Lectures:** FTX 135
Tuesday 8:30 - 11:00
Thursday 8:30 - 11:30

**TAs:**
Sharareh Bayat; CBY Lab D110
Tyler O'Byrne; CBY B207

**Tutorial:** FTX 235
Wednesday 10:00 - 12:00
Friday 9:00 - 11:00

**Textbook:** two editions (fourth and fifth) of the textbook (see below) are allowed. For the rest of the syllabus the two editions will be distinguished by enclosing between square brackets entities referred to the fourth edition (for example "Ch. 6" will be referred to the fifth edition, whereas "[Ch. 6]" will be referred to the fourth edition).

Ogata, K.: *Modern control engineering - Fifth edition.* Prentice Hall, 2009
Ogata, K.: *Modern control engineering - Fourth edition.* Prentice Hall, 2001

## Description and objectives

This course presents the concepts of transient and steady-state response analysis for control systems, assess the stability of control systems through the root-locus method and the frequency-response method, and teaches methods for designing controllers that correspond to desired system behaviours. Students will develop the capability of analyzing the stability of a system and of designing simple controllers to regulate systems behaviour.

## Course Outline

**Systems response analysis:** Chapter 5
General structure of controllers; control actions
First order systems
Higher order systems
Routh's stability criterion
Integral and derivative control actions: effects on systems performance
Steady-state errors

**Root-locus method:** Chapter 6 [Chapters 6 and 7]
The concept of root-locus
Rules for constructing root-loci
Root-locus analysis of control systems
Control-systems design by the root-locus approach

**Frequency-response method:** Chapter 7 [Chapters 8 and 9]
Response to sinusoidal inputs
Bode diagrams
Polar plots
Experimental determination of transfer functions
Control-systems design by the frequency-response approach

## Tentative lecture schedule

| Lecture | Reading | Topic |
|---|---|---|
| 1: Tu Jun 22 | 5-1; 5-2; 5-3 [5-1; 5-2; 5-3] | Course introduction and overview; First and second order systems |
| 2: Th Jun 24 | 5-4; 5-6; 5-7 [5-4; 5-6] | Higher order systems; Routh's stability criterion |
| 3: Tu Jun 29 | 5-7; 5-8 [5-7; 5-8] | System performance: effects of integral and derivative control actions; Steady-state errors in unity-feedback control systems |
| 4: Tu Jul 6 | 6-1; 6-2 [6-1; 6-2] | The concept of root-locus; Root-locus plots |
| 5: Th Jul 8 | 6-2; 6-4 [6-2; 6-5] | Gain selection with root-locus plots; Root-locus plots of positive feedback systems |
| 6: Tu Jul 13 | 6-5; 6-6 [7-1; 7-6] | Control-systems design by the root-locus approach; Lead compensation; |
| 7: Th Jul 15 | 6-7; 6-8 [7-7; 7-8] | Lag compensation; Lag-lead compensation; Parallel compensation |
| 8: Tu Jul 20 | 7-1; 7-2 [8-1; 8-2] | Systems output to sinusoidal inputs; Bode diagrams |
| 9: Th Jul 22 | 7-3; 7-4; 7-7 [8-4; 8-6; 8-9] | Polar plots; Log-magnitude-versus-phase plots; Relative stability analysis |
| 10: Tu Jul 27 | 7-8; 7-9 [8-10; 8-11] | Closed-loop frequency response; Experimental determination of transfer functions |
| 11: Th Jul 29 | 7-10; 7-11 [9-1; 9-2] | Control-systems design by the frequency-response approach; Lead compensation |
| 12: Tu Aug 2 | 7-12; 7-13 [9-3; 9-4; 9-5] | Lag compensation; Lag-lead compensation |
| 13: Th Aug 5 | | **Review of the course** |

## Exams: policy and dates

All tests and exams will be closed book - closed notes. A formula sheet will be provided by the instructor if necessary.

Illegible work and loose sheets will not be graded. If a student cannot attend a test/exam due to a medical condition, certified by a doctor, he/she must notify the instructor in advance. Unexcused absence from an exam will result in a grade of 0 for that exam.

The dates of the tests and of the mid-term exam can be changed within the first week of class, according with specific exigences of the students.

**Tests** Four tests will be placed during tutorial sessions. Assigned problems will be based on those solved in class by the TAs. It is strongly recommended that students solve suggested problems at the end of each Chapter.

Test 1: Wed, July 7
Test 2: Fri, July 9
Test 3: Wed, July 21
Test 4: Fri, July 30

**Mid-term exam** Thu, July 15

**Final exam** Fri, Aug 6; CBY B-012

## Marks

Marks from Tests and Mid-term Exam determine the semester mark $S$, computed as follows:

| | |
|---|---|
| Mid-term exam | 60% |
| Tests | 40% |
| Total of semester ($S$) | 100% |

This mark will be combined with the Final exam mark $F$ in the following way:

(a) if $F > 60$ and $F > S$, the final mark will be computed as

$$\frac{1}{100}\left(F^2 + (100 - F)S\right)$$

In this way the weight of the final exam will be enhanced in case of high score.

(b) if the conditions in point (a) are not satisfied, the mark will be computed as follows:

$$0.6F + 0.4S$$

## Suggested problems

**5th edition**

Chapter 5: B-5-2, B-5-5, B-5-8, B-5-20, B-5-21, B-5-23, B-5-27, B-5-28
Chapter 6: B-6-1, B-6-3, B-6-4, B-6-6, B-6-10, B-6-15, B-6-18, B-6-19, B-6-20, B-6-23, B-6-26
Chapter 7: B-7-2, B-7-5, B-7-9, B-7-11, B-7-12, B-7-19, B-7-23, B-7-26, B-7-30, B-7-32, B-7-34

**4th edition**

Chapter 5: B-5-2, B-5-6, B-5-10, B-5-23, B-5-25, B-5-27, B-5-31, B-5-32
Chapter 6: B-6-1, B-6-4, B-6-6, B-6-9, B-6-14
Chapter 7: B-7-7, B-7-10, B-7-11, B-7-12, B-7-16, B-7-20
Chapter 8: B-8-2, B-8-6, B-8-11, B-8-13, B-8-14, B-8-21, B-8-26, B-8-29
Chapter 9: B-9-2, B-9-5, B-9-9