MCG 3307: Control Systems II

Winter 2010

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office hours: Thursday 11:00 - 12:00

Lectures: TBT 070
Tuesday 11:30 - 13:00
Friday 13:00 - 14:30

Tutorial: LMX 221, Thursday 8:00 - 10:00

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

Web page: http://by.genie.uottawa.ca/~spinello/webpage/teaching.html

TAs:
Sharareh Bayat; CBY Lab D110
office hours: Monday 13:00 - 16:00
Hui-Hsien Wu; CBY B08D
office hours: Friday 9:00 - 10:00

Course Outline

Systems response analysis: Chapter 5
General structure of controllers
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

PID controllers: Chapter 8 [Chapter 10]
Ziegler-Nichols rules for tuning PID controllers

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.

Individual assignments

Three individual assignment will be placed, with solutions provided after the grading of the related set of problems. One individual assignment will be take home, and two will be in class closed book and closed notes. For in class assignments, formula sheets will be provided by the instructor if necessary. The individual assignments will globally determine the 30% of the final grade.

Exams

There will be one mid-term exam and one final exam, determining, respectively, the 30% and the 40% of the final grade. Tests will be closed book and closed notes. Formula sheets will be provided by the instructor if necessary. Illegible work and loose sheets will not be graded. If a student cannot attend an 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.

Mark

30% Individual assignments
30% Mid-term exam
40% Final exam

Tentative lecture schedule

Lecture	Reading	Topic
1: Tu, Jan 5	5-1; 5-2; 5-3 [5-1; 5-2; 5-3]	Course introduction and overview; First and second order systems
2: Fr, Jan 8	5-3 [5-3]	Second order systems
3: Tu, Jan 12	5-4; 5-6 [5-4; 5-6]	Higher order systems; Routh's stability criterion
4: Fr, Jan 15	5-6; 5-7 [5-6; 5-7]	Routh's stability criterion; System performance: effects of integral and derivative control actions
5: Tu, Jan 19	5-7 [5-7]	System performance: effects of integral and derivative control actions
6: Fr, Jan 22	5-8 [5-8]	Steady-state errors in unity-feedback control systems
7: Tu, Jan 26	6-1; 6-2 [6-1; 6-2]	The concept of root-locus; Root-locus plots
8: Fr, Jan 29 9: Tu, Feb 2 10: Fr, Feb 5 11: Tu, Feb 9	6-2 [6-2]	Root-locus plots
12: Fr, Feb 12		**Mid-term exam**[1]
13: Tu, Feb 23	6-2; 6-4 [6-2; 6-5]	Gain selection with root-locus plots; Root-locus plots of positive feedback systems
14: Fr, Feb 26	6-5; 6-6; 6-7 [7-5; 7-6; 7-7]	Control-systems design by the root-locus approach; Lead compensation; Lag compensation
15: Tu, Mar 2	6-7; 6-8 [7-7; 7-8]	Lag compensation; Lag-lead compensation; Parallel compensation
16: Fr, Mar 5	7-1; 7-2 [8-1; 8-2]	Systems output to sinusoidal inputs; Bode diagrams
17: Tu, Mar 9	7-2; 7-3 [8-2; 8-3]	Bode diagrams; Polar plots
18: Fr, Mar 12	7-3; 7-4; 7-7 [8-4; 8-6; 8-9]	Polar plots; Log-magnitude-versus-phase plots; Relative stability analysis
19: Tu, Mar 16	7-7; 7-8 [8-9; 8-10]	Relative stability; Closed-loop frequency response
20: Fr, Mar 19	7-8; 7-9 [8-10; 8-11]	Closed-loop frequency response; Experimental determination of transfer functions
21: Tu, Mar 23	7-10; 7-11 [9-1; 9-2]	Control-systems design by the frequency-response approach; Lead compensation
22: Fr, Mar 26	7-12; 7-13 [9-3; 9-4; 9-5]	Lag compensation; Lag-lead compensation
23: Tu, Mar 30	8-1; 8-2 [10-1; 10-2]	Ziegler-Nichols rules for tuning PID controllers
24: Tu, Apr 6 25: Fr, Apr 9		*Course review with solved comprehensive examples*

[1] The midterm exam will cover topics lectured up to lecture 10 (remind: this is a *tentative* lecture schedule). In case the actual schedule will not match the tentative one material in Chapter 7 [Chapter 8] will not be included anyway.

Suggested problems

Fifth 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

Chapter 8: B-8-2, B-8-3

Fourth 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

[**Chapter 10:**] B-10-2, B-10-3