Boston University

Department of Biomedical Engineering

ENG BE 402

Control Systems in Biomedical Engineering

Spring 2009

Professor Jim Collins
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Office hours: Th 12-2 pm

Content: Mathematical analysis of dynamic and feedback control systems, including physiological systems modeling and physiological control systems modeling. Stability criteria, parameter sensitivity, and performance evaluation. State space analysis. Design techniques for feedback systems. Emphasis on biological and biomedical systems.

Prerequisites: ENG BE 401

Textbook: (Required) Norman S. Nise, *Control Systems Engineering*, Fourth Edition (John Wiley & Sons, Inc., 2004).

Homework: Weekly problem sets. Due at the start of the first lecture of the week. Late homework will not be accepted or graded. It is expected that you will complete the homework on your own. The examination questions will be similar in style to the homework, so it is to your advantage to try to master the questions without assistance.

Examinations: Two class exams and one comprehensive final exam. Test times and places subject to change.

Grading:

Homework: 15%
Class Exam 1: 25%
Class Exam 2: 25%
Final Exam: 35%

Graduate Teaching Fellows:

Dorea Ruggles (ruggles@bu.edu)
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Week	Lecture Topics	Reading
1	Introduction to Control Systems, Review of Frequency Domain Systems Analysis (Laplace Transform, Transfer Function), Modeling Dynamic Systems (e.g., Mechanical Systems, Biomechanical Systems)	Ch. 1, Ch. 2
2, 3	State-Space Analysis (Matrix Algebra, State-Space Representation, Case Study: Pharmacokinetics), Review of Time Domain Systems Analysis (Poles and Zeros)	Ch. 3, Appendix F, Ch. 4.1–4.3
4, 5	Second-Order Systems, Physiological Systems Modeling, Analysis of Feedback Systems, Feedback Control	Ch. 4.4–4.8, 4.10, Ch. 5.1–5.3
6	**Class Exam 1: Thursday, February 19th**	
7, 8	Performance of Feedback Systems: Steady-State Errors, Physiological Control System Modelling	Ch. 7, Class Notes
9–12	Stability and Design of Feedback Systems (Routh-Hurwitz Criterion, Root Locus Techniques, Compensators)	Ch. 6, Ch. 8, Ch. 9
12	**Class Exam 2: Thursday, April 9th**	
13	Stability and Design of Feedback Systems via Compensation and Frequency Response Techniques (Nyquist Criterion)	Ch. 9, Ch. 10
14–15	Design of Feedback Systems via State-Space Techniques (Controllability), Design of Biomedical Systems	Ch. 12, Class Notes