BME 667-001 - SYSTEMS STUDIES IN BIOMEDICAL ENGINEERING

CLASS HOURS

Monday 2:30 PM – 5:25 PM Fenster 640

OFFICE HOURS (GITC 2104)

Monday 1:00 PM – 2:00 PM
Wednesday 10:00 AM – 11:15 AM

Or by appointment: **(973) 642-7155** or **rockland@njit.edu**

HOME PAGE: HTTP://WEB.NJIT.EDU/~ROCKLAND

TEXT

Khoo, Michael C.K., Physiological Control systems, Wiley Interscience, 2000 ISBN 0-7803-3408-6.

To get a CD of Matlab, you can download it from csd.njit.edu or obtain it from the library. It is a very large download (over 500 MB) so if you want to download this program, you should do it from the PC mall (where you can burn a CD). One of the toolboxes of Matlab is Simulink, which we will be using extensively in this course.

To get the examples from Khoo, go to ftp://ftp.ieee.org/uploads/press/Khoo/ . I would recommend setting up folders in your computer for each chapter, and copying/pasting these files (can also use an ftp program to do this).

There are other links for MATLAB, SIMULINK and other related topics. They can be found at http://web.njit.edu/~rockland/links.html

COURSE DESCRIPTION

Prerequisite: undergraduate or graduate course in linear systems. Basic techniques of simulation including digital simulation languages. Physiologic systems of current interest using systems analysis techniques leading to formulation of mathematical, digital computer, or electric circuit models. Systems examined include the circulatory, respiratory or hormonal control systems. Basic techniques of signal processing are explored which are necessary to analyze data from physiologic systems

COURSE OBJECTIVE

By the end of the course you should be able to do the following:

- **Analysis of Dynamic Systems** - Understand how to apply various concepts and laws to analyze a variety of dynamic systems.
- **Physiological Control Systems –** Develop an understanding for control system theory as applied to human physiology.
- **Non-linear Analysis** - To obtain a basic introduction to the field of non-linear analysis, as applied to physiological systems.
- **Signal Processing** – Apply various signal processing techniques to specific cardiovascular applications.
- **Communication Skills** - Develop an understanding of effective technical presentation skills.
- **Simulation and Analytical Software** - Understand the basic concepts behind SIMULINK, and how this application, along with other software tools, are applied to physiological problems.
- **Teamwork** - Learn how to interact with others to analyze physiological system response.

COURSE OUTLINE

Week	Week of	Homework	Examples	Topics
1.	11-Sep	1.2, 1.4	• Muscle Stretch reflex (5-6)	General introduction to course Chapter 1 – Intro to Matlab and Simulink – examples • Basic definitions (modeling, control systems • Dynamic systems • Distributed vs. lump parameters •
2.	18-Sep	Diff. Eq problems	• Lung mechanics (19) • Skeletal muscle (20)	Chapter 2 (up to page 24) • Electrical/Mechanical equivalence • Introduction to Simulink • Differential equations (classical method) • Simulink use
3.	**25-Sep**	2.3, 2.7,	Page 30-33 – examples from web (revise for integration)	Chapter 2 (page 24-26, 30-end) • Review of Basic Circuit Laws • Linearity • Laplace Transforms • Solving differential equations using Laplace Transform
4.	2-Oct		• Simulink web example p. 45 • Cardiac Output • Glucose regulation Ventilation	**Exam 1** Assignment (no class after exam)
5.	**9-Oct**	4.3, 4.5	Neuromuscular reflex (p. 91-96) web	Chapter 2 – rest of chapter • Circuit Analysis with Laplace Transforms • Transfer Functions • Impulse response and Convolution
6.	16-Oct			**Team Assignment – no lecture (ABET visit)**
7.	**23-Oct**	3.2	• Instructors problems • Cardiac output, p.49 • Glucose, p.55	• Transfer Algebra • Block reduction Chapter 3 • Steady State Analysis
8.	**30-Oct**	4.3, 4.5	• p. 94 example	**Exam 2** Chapter 4 • Time Domain Analysis • Feedback and Control
9.	**6-Nov**	I5.2, 5.3	• Instructor example	Chapter 5 (p. 101-108) • Frequency Analysis – part 1

10.	**13-Nov**	Instructor homework	• Section 5-5 Glucose Insulin	Chapter 5 (remainder) and Chap. 6 (part) • Review of Bode analysis • Nyquist Criterion for Stability • Nyquist Stability with Matlab • Nichols chart
11.	**20-Nov**	6.1, 6.2	• p. 150 example	**Exam 3** Chapter 6 (part) • Stability • Root Locus plots • Routh Stability Criterion
12.	**27-Nov**	Instructor Homework	Instructor examples	(teacher notes) • Introduction to LabView • Fourier Series and Transform • Introduction to Heart Rate Variability • Start of in-class project •
13.	**4-Dec**	Instructor homework		• Heart Rate Variability – project • Sampling/Quantitzation • Windowing • Filtering • Continuation of in-class project
14.	**11-Dec**			• Introduction to non-linear analysis • Review

The Course Outline may be modified at the discretion of the instructor or in the event of extenuating circumstances. Students will be notified in class of any changes to the Course outline and laboratory sessions.

GRADING:

Class Participation and Homework	10 %
Presentations	15 %
Tests	50 %
Final Exam	25 %

There are three tests during the semester. The lowest grade will be dropped. However, if you achieve an A for all three tests, you will **not** be excused from the final. Students achieving an A on **all three** tests will receive 5 bonus points that will count for the final grade.There will be no makeup tests – if you miss one test, then that is the test you will drop.

HONOR CODE AND BEHAVIOR

NJIT has a zero-tolerance policy regarding cheating of any kind and student behavior that is disruptive to a learning environment. Any incidents will be immediately reported to the Dean of Freshman Studies. In the cases the Honor Code violations are detected, the punishments range from a minimum of failure in the course plus disciplinary probation up to expulsion from NJIT with notations on students' permanent record. Avoid situations where honorable behavior could be misinterpreted. For more information on the honor code, go to http://www.njit.edu/academics/honorcode.php

No eating or drinking is allowed at the lectures, recitations, workshops, and laboratories.
Cellular phones must be turned off during the class hours.

STRUCTURE OF THE COURSE

The course will be a blend of teacher instruction, laboratory/computer work, problem solving during class (as well as homework assignments) and presentations. Students are expected to be an active part of the class.

HOMEWORK

Homework is **due the week following the date they are assigned (see syllabus), and must be given to the instructor.** The homework will consist of questions at the end of each chapter and problems assigned by the instructor.

In addition, starting the first week, problems will be assigned to teams. While all students should try to solve the problem, the team will be expected to present their solution, as well as lead the class in a 5-10 discussion.

PRESENTATIONS

Students, as a team, will be given problems during the lecture. A team will be chosen to present their findings, as well as lead a class discussion, in the problem solution.

PAPER

A paper will be assigned to students during the semester, related to information for the chapters. Students must develop a PowerPoint presentation that will be 10-15 minutes in length, summarizing the key features/information of this paper, a critique of the paper, and how it relates to the assigned topic. More information will be given during the first session.