Course Hours

Thursday 18:00 - 20:00  
Location: STE-2052  
Type: LAB 1

Thursday 14:00 - 16:00  
Location: CBY-B02  
Type: LAB 2

Friday 08:00 - 10:00  
Location: DEP-DEPT  
Type: LAB 3

Wednesday 10:00 - 11:30  
Location: UCU-AUD  
Type: LEC 1

Friday 08:30 - 10:00  
Location: UCU-AUD  
Type: LEC 2

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Teaching Assistant

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Phone Number:

Course Description

Modeling of mechanical, fluid, thermal and biomedical systems using a lumped parameter approach. Concepts of through and across variables in systems. Block diagrams for system representation. Linearization and solution of system equations. Transient and frequency response of biomedical systems.

General and Specific Objectives

At the end of the course the students are expected to be able to analyze and to solve basic design problems in the following topics:
- Dynamical system and transfer function representation.
- Linearization and state space representation.
- Modeling and representation of mechanical, electrical, thermal and fluid systems.
- Modeling and representation of a class of biomedical systems through electric and thermo, fluid, and solid mechanical analogues.
- Basic properties of transient responses of linear time invariant systems.

**Required Material**

- The textbook in the Section "Monographies" is mandatory. In the course calendar, sections of the book that cover lectures' material are referenced by numbers in square brackets.
- Additional material extracted from the textbook listed in "Documents and Articles on the Web" will provided by the instructor to cover biomedical systems. It is referenced as "[provided material]" in the course calendar.

**Evaluations**

**Project**

**Evaluation Date:** Ongoing  
**Evaluation Percentage:** 20

The project is individual. It is comprised of four milestones in the form of assignments during the term. Each part will contribute to the overall score of 20%, that is used to calculate the course final grade.

**Written exam (e.g. exam, long answer)**

**Evaluation Date:** Friday, October 16, 2015  
**Evaluation Percentage:** 20

*Midterm exam.* The exam is in class, open book and open notes. Electronic devices are not allowed. The exam covers the material developed in class up to Lecture 11. For additional information, see the course calendar.

**Written exam (e.g. exam, long answer)**

**Evaluation Date:** Monday, December 14, 2015  
**Evaluation Percentage:** 60

*Final Exam - Room DMS1150.* The exam is open book and open notes. Electronic devices are not allowed. The exam will may cover all material developed in class.

**Course Calendar**

- **Wednesday, September 9, 2015**  
  **Lecture 1**  
  - Introductory concepts.
  - Transfer functions and impulse-response function [2-2].

- **Friday, September 11, 2015**  
  **Lecture 2**  
  - Transfer functions and impulse-response function [2-2].
  - Block diagrams and basic operations [2-3].
  *Suggested problems: B-2-1, B-2-2, B-2-4.*
Lecture 3
• Modeling in state space [2-4].

Wednesday, September 16, 2015
• State-Space Representation of Scalar Differential Equation Systems [2-5].
Suggested problems: B-2-8, B-2-9, B-2-10, B-2-11, B-2-12.

Lecture 4
• Linearization of nonlinear mathematical models [2-7].

Friday, September 18, 2015

Lecture 5
• Modeling of mechanical systems [3-2].

Wednesday, September 23, 2015

Lecture 6
• Modeling of mechanical systems [3-2].
Suggested problems: B-3-1, B-3-2, B-3-3, B-3-4, B-3-6.

Lecture 7

Wednesday, September 30, 2015
• Respiratory system: models of chest wall mechanics. [Kutz: Section 5.4; Ref. 1 and 2].

Lecture 8
• Modeling of electrical systems [3-3].
Suggested problems: B-3-7, B-3-8, B-3-9, B-3-13.

Friday, October 2, 2015

Lecture 9
• Circulatory system.
• Linear analog models [Kutz: Chapter 3].

Wednesday, October 7, 2015

Lecture 10
• Servomotor analysis [Problem B-3-13].
• Electrical-mechanical analogy [Example A-3-4].

Friday, October 9, 2015

Lecture 11
• Liquid level systems [4-2].
Suggested problems: B-4-1.

Wednesday, October 14, 2015

Lecture 12
Midterm exam. The exam is scheduled in the lecture room, with the same duration as the lecture.

Friday, October 16, 2015

Lecture 13
• Pneumatic systems [4-3].

Wednesday, October 21, 2015

Lecture 14
• Pneumatic systems [4-3].
• McKibben model of pneumatic artificial muscles [Ref. 3].
Suggested problems: A-4-4, B-4-3.

Friday, October 23, 2015

Lecture 15
• Thermal systems [4-5].

Wednesday, November 4, 2015

Lecture 16
• Thermal systems [4-5].
• Lumped parameter model of cold stressed fingertip, and vascular reactivity in the fingertip [Refs. 4 and 5].
Suggested problems: A-4-10, A-4-11, B-4-12.

Lecture 17

Wednesday, November 11, 2015
• PID controllers transfer functions [2-3].
• Pneumatic controller devices [4-3].

Friday, November 13, 2015

Lecture 18
• Pneumatic controller devices [4-3].
Suggested problems: A-4-5, B-4-3, B-4-4.

Wednesday, November 18, 2015

Lecture 19
Q&A about the project.
Friday, November 20, 2015  
**Lecture 20**  
• Transient response of first order systems [5-2].  
_Suggested problems: A-5-1, B-5-1._

Wednesday, November 25, 2015  
**Lecture 21**  
• Transient response analysis of second order systems [5-3].

Friday, November 27, 2015  
**Lecture 22**  
• Transient response analysis of second order systems [5-3].  
_Suggested problems: A-5-5, A-5-7, A-5-9, A-5-14, B-5-2, B-5-3, B-5-4, B-5-5, B-5-6, B-5-10, B-5-11._

Wednesday, December 2, 2015  
**Lecture 23**  
• Second-order systems and transient response specifications [5-3].  
_Suggested problems: B-5-12, B-5-15, B-5-16, B-5-18, B-5-19._

Friday, December 4, 2015  
**Lecture 24**

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**Other Information**

At the beginning of the course the students are assumed to be familiar with the theory of ordinary differential equations and with Laplace transforms. You are strongly encouraged to review the related material from pre-requisite courses.
Monographs


Scientific Articles


Documents and Articles on the Web

- Matlab online tutorial.
Plagiarism

Beware of academic fraud!

Academic fraud is an act by a student that may result in a false evaluation (including papers, tests, examinations, etc.). It is not tolerated by the University. Any person found guilty of academic fraud will be subject to severe sanctions.

Here are some examples of academic fraud:

- Plagiarism or cheating of any kind;
- Present research data that has been falsified;
- Submit a work for which you are not the author, in whole or part;
- Submit the same piece of work for more than one course without the written consent of the professors concerned.

Please consult this webpage; it contains regulations and tool to help you avoid plagiarism. An individual who commits or attempts to commit academic fraud, or who is an accomplice, will be penalized. Here are some examples of possible sanctions:

- Receive an “F” for the work or in the course in question;
- Imposition of additional requirements (from 3 to 30 credits) to the program of study;
- Suspension or expulsion from the Faculty.

You can refer to the regulations on this webpage.

Student Services

Academic Writing Help Centre
At the AWHC you will learn how to identify, correct and ultimately avoid errors in your writing and become an autonomous writer.
In working with our Writing Advisors, you will be able to acquire the abilities, strategies and writing tools that will enable you to:

- Master the written language of your choice
- Expand your critical thinking abilities
- Develop your argumentation skills
- Learn what the expectations are for academic writing

Career Services
Career Services offers various services and a career development program to enable you to recognize and enhance the employability skills you need in today's world of work.
Counselling Service
There are many reasons to take advantage of the Counselling Service. We offer:

- Personal counselling
- Career counselling
- Study skills counselling

Access Service
The Access Service acts as intermediary between students, their faculty and other University offices to ensure that the special needs of these students are addressed and that the best possible learning conditions are being offered.

Note that the University of Ottawa is affiliated with AERO and ACE services for the adaptation of accessible academic materials for students with perceptual disabilities. If you have any questions, please contact the Accessibility Librarian or the Access services for textbooks.