FRTF01 Physiological Models and Computation

Welcome to the course *FRTF01 Physiological Models and Computation* given by the Department of Automatic Control, Lund University (WWW-address www.control.lth.se).

Personnel & Instructors

The lectures are given by Rolf Johansson (Rolf.Johansson@control.lth.se, tel. 046-222 8791; Office hour M16.00-17.00 via Zoom https://lu-se.zoom.us/j/63200414646. Problem solving sessions, labs and grading of home-work assignments are given by Henry Pigot (tel. 046-222 1570, Henry.Pigot@control.lth.se), Ylva Wahlquist (Ylva.Wahlquist@control.lth.se, tel. 046-222 4785).

News are available on Canvas: canvas.education.lu.se/courses/8023.

Prerequisites

FMAA01 Calculus, FMA420 Linear Algebra, TEK015 Physiology, ETI265 Signal Processing

Course Material

- R. Johansson, Physiological Cybernetics, Lund University, Dept. Automatic Control, Lund, Sweden, 2020.Visit web site www.control.
- Visit web site www.control.lth.se Canvas page canvas.education.lu.se/courses/8023 to download home-work assignments, exercises and solutions.

Alternative reading

- C. Cobelli & E. Carson, *Introduction to Modeling in Physiology and Medicine*, Academic Press, Amsterdam, 2008;

Lectures

Lectures will be held remotely by Zoom and uploaded according to the schedule:

W.	Date	N^o	Contents
45	2/11	L1	Introduction. Physiological Complexity.
	3/11	L2	Modeling in Physiology.
46	10/11	L3	Control in Physiological Systems.
47	17/11	L4	Physiological Feedback, Adaptation, Learning (Pupil Dynamics).
	19/11	L5	Pharmacokinetics & Tracers.
48	24/11	L6	Metabolism, Glucose & Insulin Dynamics.
	26/11	L7	Biomechanics: Muscle Models, Postural Control, Gait.
49	1/12	L8	Electrophysiology. The Hodgkin-Huxley Model.
	3/12	L9	Blood Flow Control, Temperature Control, Concentration & pH Control.
50	7/12	L10	System Identification. Measurements & Data-based modeling.
	8/12		**Project Presentation Seminar.**

Problem Solving Sessions

Problem solving sessions are given twice weekly, one on Zoom and one in person. See Canvas for location and time details.

W.	Date	N^o	Contents
45	3/11	E1	Introduction to computation and simulation in Matlab.
	5/11	E2	Biochemical Reactions: Equilibrium, Steady state & Control.
46	10/11	E3	Compartment models and simulation in Simulink.
	12/11	E4	Linear systems and linearization.
47	17/11	E5	Stability of linear systems & Pharmacokinetics.
	19/11	E6	Feedback in linear systems & Tracer kinetics.
48	24/11	E7	Metabolism & Glucose and insulin kinetics.
	26/12	E8	State feedback & Biomechanics and Posture Control.
49	1/12	E9	The Hodgkin-Huxley Model.
	3/12	E10	Blood Flow Control & Heart-rate dynamics.
50	8/12	E11	State estimation & System Identification.

Interaction

Use office hours, home-work assignments, discussion forum, and email to interact with the instructors throughout the course.

Computer Simulations

Computer simulation is an excellent way to explore physiological systems for development of insight and ideas for analysis. Simulation is also required for the problems you have to hand in and for several projects. An introduction to computer simulation is given in E1.

Home-Work Assignments

There will be four home-work problems that you have to solve and hand in during course weeks 3, 4, 5, 6 (calender weeks 47, 48, 49 and 50) with deadlines as follows:

HW	Time	Contents	Responsible	Phone
HW1	w.47—21/11	Enzyme Dynamics	Y. Wahlquist	222 4785
HW2	w.48—28/11	Pupil Dynamics	H. Pigot	222 1570
HW3	w.49—4/12	Glucose & Insulin Dynamics	Y. Wahlquist	222 4785
HW4	w.50—12/12	The Hodgkin-Huxley Model	H. Pigot	222 1570

You may undertake the assignments and send in your solutions in groups of two. Submit your solutions via the corresponding assignment page on Canvas. HW3-4 in the format of laboratory sessions rather than submitting a formal report. Sign-up and location for the laboratory sessions will be available on Canvas.

FRTF01 Project

The projects will be done in groups of three. You should sign up for a project no later than Monday, November 9, via Canvas. The project should be presented on Tuesday, December 8, at 13-15. Submission of report on December 9.

Examination

The examination will be of a problem solving type. It is to be held on Monday, January 11, 8.00–13.00. You may use the printed text book and printed lecture notes at the examination.