



# 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](http://www.control.lth.se)).

## Personnel & Instructors

The lectures are given by Rolf Johansson (Rolf.Johansson@control.lth.se, tel. 046-222 8791, office M:5147; Office hour M16.00-17.00 (except Nov 12)). Problem solving sessions and labs are given by Martin Heyden (tel. 046-222 4287, Martin.Heyden@control.lth.se, Office hour W 11-12, M:2160A). Johan Ruuskanen (tel.222 1570, Johan.Ruuskanen@control.lth.se, M:2427) will grade home work assignments HW2 and HW4.

News are available on [www.control.lth.se/course/FRTF01](http://www.control.lth.se/course/FRTF01).

## Prerequisites

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

## Course Material

- R. Johansson, *Physiological Cybernetics*, Lund University, Dept. Automatic Control, Lund, Sweden, 2018 (Lecture notes distributed at lectures).
- Visit web site [www.control.lth.se](http://www.control.lth.se) 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 usually be held in M:E, M:B or M:2112B on Tuesdays 13.15–15.00, Thursdays 10.15–12.00. according to the schedule:

W.	Date	N°	Contents
45	5/11	L1	Introduction. Physiological Complexity. <b>(M:2112B)</b>
	6/11	L2	Modeling in Physiology. <b>(M:E)</b>
	7/11	L3	Control in Physiological Systems. <b>(M:2112B)</b>
47	20/11	L4	Physiological Feedback, Adaptation, Learning (Pupil Dynamics). <b>(M:E)</b>
	22/11	L5	Pharmacokinetics & Tracers. <b>(M:E)</b>
48	27/11	L6	Metabolism, Glucose & Insulin Dynamics. <b>(M:E)</b>
	29/11	L7	Biomechanics: Muscle Models, Postural Control, Gait. <b>(M:E)</b>
49	4/12	L8	Electrophysiology. The Hodgkin-Huxley Model. <b>(M:E)</b>
	6/12	L9	Blood Flow Control, Temperature Control, Concentration & pH Control. <b>(M:E)</b>
50	10/12		<b>Project Presentation Seminar. (M:E)</b>
	11/12	L10	System Identification. Measurements & Data-based modeling. <b>(M:E)</b>

## Problem Solving Sessions

Problem solving sessions are given twice weekly.

W.	Date	N <sup>o</sup>	Contents
45	6/11	E1	Introduction to computation and simulation in Matlab
	8/11	E2	Biochemical Reactions: Equilibrium, Steady state & Control
46	13/11	E3	Compartment models and simulation in Simulink
	15/11	E4	Linear systems and linearization
47	20/11	E5	Stability of linear systems & Pharmacokinetics
	22/11	E6	Feedback in linear systems & Tracer kinetics
48	27/11	E7	Metabolism & Glucose and insulin kinetics
	29/12	E8	State feedback & Biomechanics and Posture Control
49	4/12	E9	The Hodgkin-Huxley Model
	6/12	E10	Blood Flow Control & Heart-rate dynamics
50	11/12	E11	State estimation & System Identification.

## Interaction

Use office hours, home-work assignments, tutorials and lectures for interaction with the instructors.

## 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 Exercise #1.

## 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 (calendar weeks 47, 48, 49 and 50) with deadlines as follows:

HW	Time	Contents	Responsible	Phone	Place
HW1	w.47—23/11	Enzyme Dynamics	M. Heyden	222 4287	M:2160A
HW2	w.48—30/11	Pupil Dynamics	J. Ruuskanen	222 1570	M:2427
HW3	w.49—6/12	Glucose & Insulin Dynamics	M. Heyden	222 4287	M:2160A
HW4	w.50—14/12	The Hodgkin-Huxley Model	J. Ruuskanen	222 1570	M:2427

You may undertake the assignments and send in your solutions in groups of two. Send your solution to <FRTF01@list.control.lth.se>. If you prefer, you may complete HW3-4 in the format of laboratory sessions without requirements on reports.

## FRTF01 Project

The projects will be done in small groups or individually. You should sign up for a project no later than Monday, November 13. The project should be presented on Tuesday, December 10, at 13-15 in M:E. Submission of report on December 11.

## Examination

The examination will be of a problem solving type. It is to be held on Monday, January 14, 14.00–19.00 in MA:10I, MA:10J. You may use the text book and lecture notes at the examination.