How to write a project report

Choose a model of a physiological system from the project list below or from literature, according to your interest. Perform mathematical analysis of the model and evaluate its properties with a comparison of published experimental data, if possible. Otherwise you should make a qualitative assasment of the properties of your model. Draw conclusions on the relationships among structure and function. Perform a critical analysis of the model quality and the accuracy.

The articles given in the project list below are only startup material for your projects. You are expected to perform a litterature survey and present at least 5 articles of the subject matter.

The report should be structured as follows,

- Abstract: summary of the the report with purpose, results and conclusions
- Introduction: short background and purpose
- Methods: Model, assumptions, analysis method
- Results: Simulation results/plots and description of these
- Discussion: Discuss the results and relate to the purpose and analysis of quantitative and qualitative behavior
- Conclusions: Concluding remarks

Additionally,

- Written using a word processor (Microsoft Word, Open Office, Latex, etc), save and send in as a .pdf-file according to the deadlines by e-mail to FRTF01@control.lth.se.
- If you include figures, make sure they are of good quality. If you take pictures from a book or the internet, make sure they are of good quality as well and that you state the source

The FRTF01 course project can be done individually or in groups of two students. Make a short project proposal with a work plan and send it to FRTF01@control.lth.se for approval by November 24. You will be assigned a supervisor. Make sure you set an appointment with him/her to initiate your project. A brief project report on scientific format should be written and sent to FRTF01@control.lth.se no later than December 11. A short presentation (5 min) should be given on the project seminar on Dec 18 at 10-12 in M:E. We expect the project to take less than one week of work.

Project proposals

1 Gene circuits

Consider a gene circuit where a gene sythesizes for a protein that acts as a transcription factor which influences the rate of transcription of the gene itself. If x_1 is the concentration of the gene while x_2 is the concentration of the protein, the dynamics of the gene circuit can be described by,

$$\frac{dx_1}{dt} = k_1\phi(x_2) - \delta_1 x_1$$
$$\frac{dx_2}{dt} = k_2 x_1 - \delta_2 x_2$$

where k_1, k_2 are production rate constants or the gene and protein respectively while δ_1 and δ_2 are degradation rate constants. Compare the dynamics when $\phi(x) = x/(\theta + x)$ and $\phi(x) = 1 - x/(\theta + x)$ where θ is a constant. Implement a model in SIMULINK and find in the litterature a real example of a gene circuit which fits into the dynamics.
Click here for material on Gene Circuits

2 The effect of toxins on neural signaling (2 projects)

The effect of toxins TTX, TEA and/or Pronase on neural signaling. Find articles about the toxins to understand what they affect and try to simulate the neural behavior when impacted by the drugs by the HH-model. Discuss the limitations and benefits of the model when used for this purpose.

3 Metabolism

Lactate metabolism during exercise: analysis by an integrative systems model. Model a part of the system in simulink in some different scenarios.
Click here for article on Lactate metabolism

4 Thyroid hormone metabolism

Construct a model in SIMULINK from the linear model of the thyroid hormone metabolism given in the end of lecture 4. Check some basic behavior of this system in order to validate the model.

5 Insulin pharmacokinetics (2 projects)

Implement at least four different models of pharmacokinetics from Wilinska et al. in Matlab and compare the behavior.
Click here for article by Wilinska et al.

6 Glucose-Insulin dynamics (2 projects)

Implement the Hovorka or the Padova simulation model in Simulink and explore the behavior of insulin and meal perturbations.
Click here for article by Wilinska et al., Click here for article by Balakrishnan et al.

7 Blood Pressure Control

Implement a description of the renin-angiotensin blood pressure control system.
[Ask for articles]

8 Diastolic and systolic pressure modeling

Implement a second, third and fourth order Windkessel model and compare.
[Stated in the book, lectures, articles].
Click here for article by Guillaud et al., Click here for article by Claassen et al..
Ask for article by Perez-Rosas et al.

9 HIV infection

Implement an immunological model incorporating the effect of antiretroviral drug therapy in Simulink.
Click here for article by Kirschner et al.

10 Epidemiological model

Implement an epidemiological SIR model of a disease of choice in Simulink and simulate an outburst. Click here for article by Mkhatshwa et al.

11 Body mass regulation by leptin regulation

Implement a model describing the leptin body mass regulation.
Click here for article by Kirschner et al.

12 Pupil reflex dynamics

Study the model in Longtin, Milton (1989) and compare with homework assignment. Click here for article by Longtin and Milton, 1989

13 Eye movements in response to head motion

Ask Rolf for more information.

14 Biomechanics: Swing-leg retraction

Click here for article by Seyfarth et al. or from lecture 7.

15 A subject of your own choice

Talk to Rolf or the TA's about your ideas.