SI1410 Basic Modeling in Biotechnology 6.0 credits

Intended Learning Outcomes

This class aims at giving the basis to create and solve simple models of biological phenomena. It is part of an effort to enhance your quantitative thinking about biological questions. The general plan is to:

1. Create simple models of the biological process of interest, i.e. translate the problems into mathematical formulation
2. Solve these models, analytically using pen and paper and/or MATLAB code and numerically using MATLAB.
3. Visualize the solutions graphically, vary model parameters to visualize their effect.
4. Analyze and discuss the outcomes of the model, and propose solutions to improve it.

Organization

The class is organized in six modules, with each module taking place over one week. The first week (v. 35) will focus on continuous models of growth, the second week (v. 36) on parametrization and analytical solutions to ordinary differential equations, the third week (v. 37) to growth in multiple species systems. The fourth week (v. 39) will cover applications of these continuum models in neurophysiology, in infectious disease models and others, the fifth week (v. 40) will tackle discrete models of growth and the sixth (v. 41) applications of such discrete models in genetics.

Module organization

Each module is organized over a week and consists of one or two lectures, a workshop, an exercise session and a computer lab.

Reading material is given in each module, and should be read before the lecture. The lectures will be given at the beginning of the week and will give you on overview of the module's content. Lectures slides and lecture notes will be uploaded in the modules page to help you follow the class.

For the workshops, which will be held after the lecture, you will work in groups of ~5, in order to prepare for the exercise session. The exercise questions will be uploaded in

each of the modules. You will meet independently in each of your groups and you will be able to ask for help to a teachers or TA. During the exercise session, we will correct these exercises in the whole class.

For the computer labs, you will be divided into two groups. You will work alone or in pairs on a computer lab for which the text will be found in the corresponding module. You will hand in individual reports for modules 2 and 4, which will be graded P/F.

Course Literature

We will cover several sections of the course book, which can be found in PDF format at the KTH library: *Ronald W. Shonkwiler, James Herod: Mathematical Biology: An Introduction with Maple and Matlab.*

Most of the new mathematical tools you will learn are well described in *Steven H. Strogatz: Non-linear dynamics and* chaos, in *Fredrick R. Adler: Modeling the dynamics of life* and in *Erich Steiner: The Chemistry Math Book.*

The book chapters that will be covered in each module are listed in the module section of canvas.

Evaluation

The evaluation of this course consists of two parts:

- You will hand in reports for two computer labs (the 2nd and the 4th), which will be graded Pass/Fail for 1.5hp each.
- Your global understanding or the class will be evaluated by a final written exam on several of the topics covered in class and labs (A, B, C, D, E, FX, F; 3 hp). You will be allowed a single personal cheat sheet, filled in using a computer (template found under Files) to bring to the exam. Programmable calculators are not allowed, but simple calculators for basic operations are allowed.

The lab reports are graded as P/F

There will be an opportunity to resubmit *once* after written feedback from teacher. The two labs need to be passed to pass the course.

Each report is personal, even though the lab can be done in pairs. Each lab report is graded with the following ***criteria***:

P The student has written a correct code that computes appropriate quantities and produces the desired figures. No optimization of the code is necessary. The report

correctly describes the problem, the methods used, describes the results and provides correct answers to all the questions posed to formulate a discussion of the results.

F A grade F is given if the criteria for a grade P are not achieved.

The final grade on the course depends on the grade on the final exam only

The total grade of the final exam depends on the grade received for each exercise, since they evaluate different ILOs.

Each exercise is graded independently according to the following ***criteria***:

A The student has presented solutions to all parts of the problem. The solutions are clearly motivated, correct and the results are discussed thoroughly and quantitatively. Minor obvious typos can be accepted.

C The student's solutions treat most of the problem and is largely correct but may contain computational errors and lack motivation of a few steps. A qualitative discussion of the results is present. Faulty arguments and inconsistent results can be accepted to a minor degree.

E The student's exam demonstrates a basic understanding of the major issues and concepts treated in the problem. The student has attempted to make proper progress towards a solution to the problem. A discussion at the basic level is present.

F A grade F is given if the criteria for a grade E are not achieved.

Combination rules determining the final grade

In order to obtain a given grade, the following must be fulfilled:

- The labs have to be passed.
- That grade must be reached on 3 out of the 4 problems on the exam.
- The remaining problem cannot have a grade that is more than two grades lower than the 3 top grades.
- In order to obtain a passing grade (E and higher), at least an E must be obtained on all exam problems.

How does the grading test your completion of the intended learning outcomes?

ILO		Lab 1	Lab 2	Exam Pb 1	Exam Pb 2	Exam Pb 3	Exam Pb 4
1- Create simple models for systems of						x	

relevance in biotechnology							
2- Solve these models	a- Analytically			x	x		
	b- Numerically	x	x				x
3- Visualize the solutions graphically	a- Analytically			x	x		
	b- Numerically	x	x				
4- Analyze and discuss the plausability of the results	a- Analyze	x	x	x	x		x
	b- Discuss	x	x	x	x		x

Test exam partial credit

Partial credit can be obtained thanks to the mid-term exam (v. 38). The grade on *one* problem from the midterm may replace the corresponding problem grade from the exam (i.e., the grade on the first problem on the exam may be replaced by the grade on the first problem of the test exam). This will be done as beneficial to the student as possible.

The grade Fx

Students who obtain passing grades *on 3 out of 4* exam problems will be given the grade Fx and provided with an opportunity to do an extra assignment in order to complete their grade to an E. A complimentary exam will then be administered and the E criterion will need to be reached for the problem posed. In case you have been given an Fx and want to do the extra assignment, contact the examiner *as soon as possible*.