SI1410 Basic Modeling in Biotechnology 6.0 credits

Background

The *basic modeling in biotechnology* class is a mandatory 6 credits class in the biotechnology degree program at the third year level. The aim of the class is three-fold: to teach 1- new mathematical tools, which the students have never encountered previously, and which entails profound understanding of mathematical concepts; 2- basic programming skills that they will use to visualize the outcomes of the models they produce in 1-, and 3- critical analysis of the outcomes of the models. Through this class, the students should acquire not only transferable competencies, such as programming, but also develop their analysis skills and their critical thinking of models.

The course is designed such that the applications are driving the learning material, this way they do not learn mathematical skills without an understanding of what these are useful for. The class is organized in 6 learning cycles, grouping the topics according to mathematical tools used, which are the most difficult concepts to grasp for these students. For each learning cycle, there is one lecture, one workshop, where the students work independently in a small group of 4-5, one problem solving session where students present solutions to the problems they have worked on during the workshop and one computer lab. The same set of problems is thus examined during the 4 different activities from different angles. The class is evaluated by a written exam that contains 4 problems and 2 computer lab reports. We also have a mid-term mock-exam for which students can receive feedback without obtaining a grade but for which the results can help rescue a failed problem at the exam.

Intended Learning Outcomes

Upon completing the class, the students should be able to:

1. Create simple models for model systems and systems of relevance in biotechnology.
2. Solve these models both analytically and numerically by primarily using course materials Matlab codes with own edits.
3. Visualize the solutions graphically.
4. Analyze and discuss the plausability of the results.

Where are the ILOs and the assessable elements assessed?

ILO		Lab 1	Lab 2	Exam Pb 1	Exam Pb 2	Exam Pb 3	Exam Pb 4
1- Create simple models for systems of relevance in biotechnology						x	
2- Solve these models	a- Analytically			x	x		

	b- Numerically	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

To which level should each assignment be assessed?

ILO		E	C	A
1- Create simple models for systems of relevance in biotechnology		x	x	x
2- Solve these models	a- Analytically	x	x	x
	b- Numerically	x		
3- Visualize the solutions graphically	a- Analytically	x	x	x
	b- Numerically	x		
4- Analyze and discuss the plausability of the results	a- Analyze	x	x	x
	b- Discuss	x	x	x

Not that ILO 2.b and 3.b are only assessed to the E level because they are assessed only by computer labs that are graded at a P/F level.

Assessment tasks

The lab reports are graded as P/F, with opportunity to resubmit after written feedback from teacher. The two labs need to be passed to pass the course.

Each 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.
- In order to obtain a passing grade (E and higher), at least an E must be obtained on all exam problems.

Test exam partial credit

Partial credit can be obtained thanks to the mid-term exam. 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. An oral exam will then be administered and the E criterion will need to be reached for the problem posed.

Reflection on the design

This class contains fours ILOs that were broken down into smaller assessible units.

Some assessible units, in particular those that involve solving equations and visualizing the results numerically, are better assessed by computer labs. In such case, as P/F scale is best suited, since a finer breakdown is prevented by the fact that the students work in pairs, and that they have access to all course material and other resources throughout the labs. It is thus difficult to assess individual achievements.

Other assessible units, those involving creating the models, solving equations and visualizing results analytically, and analyzing and discussing results are also assessed during the computer labs but more importantly during the written exam. An A/C/E/F scale was developed for exam exercises such as to allow a finer assessment of the student's skills. Each of the four problem assesses a set of assessible units (see Table 1) and is graded separately. This allows to evaluate each ILO.

The final grade on the exam is obtained through combination rules that reflects the general level reached by the student. First, the exam cannot be passed if a single problem is failed, this is done such that the class cannot be passed if one of the ILOs is not achieved, *i.e.* to avoid compensation by performing very well on the other exercises. Then, a very good grade cannot be achieved if one of the problems is barely passed, which is why the final exam grade must be reached on 3 out of the 4 problems on the exam, while the remaining problem cannot have a grade that is more than two grades lower. In this way, a student that has barely reached an understanding of one of the ILOs cannot obtain an A grade, even if the other ILOs are very well fulfilled. On the other hand, this is designed to allow some leeway: a B or C grade one of the exercises should not prevent a student who has otherwise obtained three A grades from obtaining an A on the exam.

Also because accidents can happen, especially in high-pressure environments such as written exam settings, the grading system also allows for forgiveness for specific cases: one of the grades from the mock-exam can be transferred to the equivalent problem on the final exam if this benefits the student. This is done because one can assume that an ILO is fulfilled if a problem was successful once, it is also meant to encourage students to take the non-mandatory mock exam. Second, if only one of the problems on the exam out of four is failed, the grade obtained is Fx and the student can take an oral exam to verify the missing ILO is fulfilled and obtain an E grade on the exam. This is again designed such that fulfilment of all the ILOs is achieved to obtain a passing grade.

In summary, the grading system is designed to allow assessment of the four ILOs in a fair and transparent way, yet trying to bring reassurance to the students that they can be forgiven for accidental mistakes.