ESCI upf.
School of International Studies

TEACHING PLAN FOR

Calculus

1. Basic description

Name of the course: Calculus
Module: Mathematics and statistics
Academic year: 2016-2017
Year: 2016
Term: First
Degree / Course: First
Code: 51104
Number of credits: 6
Total number of hours committed: 150
Teaching language: English
Lecturer: Antoni Guillamon, Alejandro Haro
Timetable: See official calendar

2. Presentation of the course

This course aims at providing the necessary background in calculus to deal with requirements in other mathematical, computational or modelling issues that will appear during the students' curricula. We will focus on the mathematical demands that models in biology bring up, by using these models as an "excuse" to present the contents of the syllabus (see Section 4). In order to make this transition from more standard way to learn mathematics to a different methodology oriented to solve biological problems, we have divided the course in two sublines of activity, which we call "conceptual" and "practical" (see again Section 4 for a more detailed description). As it will be seen in Section 8, these two sublines coexist in some periods of the course, but we have put more weight on the conceptual learning than in the practical one in the first part of the course, and vice versa in the second part. The practical subline will mainly involve group tasks.

The last goal of the course, then, is providing calculus tools and strategies to endow the student with a minimal experience to study biological phenomena in a formal and cooperative way.

3. Competences to be worked in the course

General competences	Specific competences
CB1, CB2, CB4, CB5, CG1	CE2, CE5, CE8, CE9

I. General competences

CB1. That the students have demonstrated to have acquired the knowledge and understanding in a field of study that starts from the basis of general secondary education, and is typically at a level that although it is supported by advanced textbooks, includes some aspects that involve knowledge of the forefront of their field of study.

CB2. That the students know how to apply their knowledge to their work or vocation in a professional manner and have competencies typically demonstrated through devising and defending arguments and solving problems within their field of study.

CB4. That the students can convey information, ideas, problems and solutions to both specialist and non-specialist audiences.

CB5. That the students have developed those skills needed to undertake further studies with a high degree of autonomy.

CG1. That the students will acquire an intra- and interdisciplinary training in both computational and scientific subjects with a solid basic training in biology.

II. Specific competences

CE2. To manage and exploit all kinds of biological and biomedical information to transform it into knowledge.

CE5. To apply mathematical foundations, algorithmic principles and computational theories in the modeling and design of biological systems.

CE8. To identify meaningful and reliable sources of scientific information to substantiate the state of arts of a bioinformatic problem and to address its resolution.

CE9. To apply statistical and computational methods to solve problems in the fields of molecular biology, genomics and medical research and population genetics

Learning outcomes

RA2.1. Visualize, manipulate and extract biological data.

RA2.2 Improve understanding of disease onset and progression.

RA5.1. Recognize and use the basic tools of mathematical language.

RA5.2. Apply mathematical and statistical treatment to large amounts of biological data.

RA5.3. Model biological information in mathematical language for further analysis and processing.

RA8.1. Use efficiently specific search tools and resources from databases and information related to biomedicine and bioinformatics.

RA8.2. Quote valid sources of scientific information to support the state of the arts of a bioinformatic problem.

4. Contents

- Basic description of contents outlined for the curriculum

Analysis of real functions of one or multiple variables: continuity, differentiation and integration, with examples of widely used functions in statistics and computer science. Study of sequences, limits and series. Criteria for extreme values. Differential equations and their applications in modelling in bioinformatics.

The course will contain two sublines of activity:

Conceptual subline: It will consist of five introductory lectures, all of them motivated by specific biological problems. Every lecture will include both expository sessions by the teaching staff and problem solving sessions. The five lectures are:

Lecture 1: Sequences, limits and series.
Lecture 2: Continuity and differentiation in one variable.
Lecture 3: Differentiation in one variable.
Lecture 4: Integration in one variable.
Lecture 5: Differential equations and dynamical systems.

Practical subline: It will turn around 5 short projects where the previous motivational biological problems will be developed. Instances of these problems, which will be described using models as simple as possible, are:

1. Population dynamics: one-species logistic growth in discrete time, two-species interactions in continuous time.
2. Models in epidemiology.
3. Models of neuron activity: integrate-and-fire, Fitzhugh-Nagumo,...

5. Assessment

At the beginning, it is assumed that the student has already a basic knowledge on elementary functions and derivatives in one variable
The course will be evaluated at three different stages, called A1, A2, A3:

A1: Assessment of Lectures 1, 2 and 3.
Period: Week 5
Assessment agent: teacher

Type of activity: conceptual
Grouping: individual
Weight/value: 30%

A2: Assessment of Lectures 4 and 5, and basic knowledge from short-projects.
Period: Week 11
Assessment agent: teacher
Type of activity: conceptual
Grouping: individual
Weight/value: 40%

A3: Assessment of practical abilities in solving short projects L1-L5.
Period: Week 5
Assessment agent: teacher
Type of activity: application-based
Grouping: individual
Weight/value: 30%

To obtain a PASS it is necessary to have obtained a grade above 3 over 10 in A1, A2 and A3.

- Complete the table taking into account that it is necessary to design learning activities and assessment that make it possible to ***assess each and every one of the competences*** discussed in section 3. Indicate elements subject to re-assessment and other considerations for the extraordinary exam sitting.

Assessment elements	Time period	Type of assessment		Assessment agent			Type of activity	Grouping		Weight (%)
		Comp	Opt	Lecturer	Self-assess	Co-assess		Indiv	Group (#)	
Assessment of Lectures 1, 2 and 3.	Week 5	x		x			Conceptual and pursuit of the subject	x		30%
Assessment of Lectures 4 and 5, and basic knowledge from short-projects.	Week 11	x		x			Conceptual and pursuit of the subject			40%
Assessment of practical abilities in solving short projects L1-L5.	Week 5-8	x		x		application-based				30%

Extraordinary exam will take place according to the schedule fixed by the Degree Coordination. Failure to attend this exam imply student will keep his initial score.

Working competences and assessment of learning outcomes:

	CB1	CB2	CB4	CB5	CG1	CE2	CE5	CE8	CE9
Assessment of Lectures 1, 2 and 3.	x	x	x	x	x	x	x	x	x
Assessment of Lectures 4 and 5, and basic knowledge from short-projects.	x	x	x	x	x	x	x	x	x
Assessment of practical abilities in solving short projects L1-L5.	x	x	x	x	x	x	x	x	x

6. Bibliography and teaching resources

- **Basic bibliography**

Salas, Saturnino L.; Etgen, Garret T.; Hille, Einar. *Calculus: One and Several Variables*, 10th Edition. Wiley [hardcover: January 2007, ISBN : 978-0-471-69804-3] [electronic version: August 2010, ISBN: 978-0-470-47276-7]

Strang, Gilbert. Calculus, 2nd edition, Wllesley-Cambridge Press, 2010. ISBN 978-09802327-4-5. Also available at the MIT Open CourseWare. http://ocw.mit.edu/resources/res-18-001-calculus-online-textbook-spring-2005/textbook/

Allman, Elizabeth S.; Rhodes, John A. *Mathematical models in biology: an introduction*. Cambridge: Cambridge University Press, 2004. ISBN 978-0-521-81980-0. See http://cataleg.upc.edu/record=b1297072~S1*cat

Istas, Jacques. *Mathematical modeling for the life sciences* [on line]. Berlin: Springer, 2005. Available on: http://dx.doi.org/10.1007/3-540-27877-X. ISBN 354025305X.

- **Supplementary bibliography**

Ermentrout, Bard G.; Terman, David H. *Mathematical foundations of neuroscience*. New York: Springer, 2010. ISBN 978-0-387-87708-2.

Hirsch, Morris W.; Smale, Stephen. *Differential equations, dynamical systems, and linear algebra*. Academic Press; American Elsevier Publishing Co., 1975. ISBN : 978-0-720-42609-0.

Murray, J.D. *Mathematical biology* [on line]. 3rd ed. Berlin: Springer, 2002. Available on: http://link.springer.com/book/10.1007/b98868 (volume 1). ISBN 978-0-387-95223-9.

Keener, James P.; Sneyd, James. *Mathematical physiology*. Vol 1. 2nd ed. New York: Springer Verlag, 2009. ISBN 978-0-387-75846-6.

- **Teaching resources**

Octave (https://www.gnu.org/software/octave/, distributed under the terms of the GNU General Public License).

Kahoot (www.kahoot.it, learning game made from series of multiple choice questions).

Other useful resources: C, C++ or Python programming, SAGE (www.sagemath.org), Khan academy (www.khanacademy.org: precalculus, differential calculus, integral calculus, multivariate calculus), Paul's online math notes (http://tutorial.math.lamar.edu/),...

7. Methodology

DIRECTIONS: When designing the model for a subject, a methodological model is also established with regard to what the teaching-learning process will be like. This information is useful for students, because it helps them understand the model to be followed as well as the planned activities for learning, since it integrates three large areas of activity to be carried out by students and the overall commitment that the subject as a whole requires of them.

- Face-to-face (in the classroom)
- Directed (outside the classroom)
- Independent (outside the classroom)

Different methodologies will be applied for the *conceptual* and the *practical* sublines (see Section 4).

In the conceptual subline, there will be two types of sessions: (T) expository "masterclasses", based on slides and blackboard explanations, and (P) problem-solving, where students will be entitled to solve problems on the concepts developed in the T-sessions.

In the practical subline, the sessions, which will be generically denoted by "L-sessions", will be organized following the statement of the corresponding short projects. The students will work in groups and will be required to both apply previously acquired knowledge (T- and P-sessions) and use the suggested resources (see also Section 6).

8. Scheduling activities

Concerning the activities in the classroom, we follow the notation used in Section 7 followed by the number of lecture (for T- and P-sessions) or the number of short-project (L-sessions), and finally the number of hours

devoted. We identify T-sessions as (1) lecture classes, P-sessions as (4) “regulated” practical classes, while L-sessions could be also defined as “project-developing classes”. Both P- and L- sessions will hold in two class subgroups in case the number of registered students requires this subgroup division.

We distinguish two different types of activity outside the classroom: (5) group work in the L-sessions, (6) individual work (reports, exercises…), basically linked to P-sessions, and (8) independent study, mostly oriented to fix concepts and prepare evaluation milestones.

Assessment events follow the notation introduced in Section 5.

Seminars
Seminar group A -101
Seminar group B- 102

Practical classes (lab)
Practical group A -111
Practical group B- 112

Week	Activity in the classroom Grouping/type of activity	Activity outside the classroom Grouping/type of activity
Week 1	T1: 4h	8: 8h
Week 2	T2: 4h P1: 2h (101) P1: 2h (102)	6: 4h 8: 4h
Week 3	T3: 4h P2: 2h (101) P2: 2h (102)	6: 4h 8: 4h
Week 4	P3: 4h (101) P3: 4 h (102)	6: 6h 8: 2h
Week 5	A1-Exam: 2h	8: 8h
Week 6	T4: 4h L1: 4h (111) L1: 4h (112)	5: 4h 8: 4h
Week 7	L2: 2h (111) L2: 2h (112) P4: 2h (101) P4: 2h (102)	5: 4h 6: 2h 8: 3h
Week 8	T5: 2h P5: 4h (101) P5: 4h (102) L3: 2h (111) L3: 2h (112)	5: 4h 6: 2h 8: 3h
Week 9	T5: 2h L4: 2h (111) L4: 2h (112) P6: 2h (101) P6: 2h (102)	5: 4h 6: 2h 8: 2h
Week 10	P7: 2h (101) P7: 2h (102) L5: 4h (111) L5: 4h (112)	5: 4h 6: 4h 8: 2h
Week final exams (4h / 10h)	A2-Exam: 3h A3-Exam: 1h	8: 10h
58h in-classroom / 92h out-classroom		

La còpia i/o plagi total o parcial als treballs i/o exàmens comportarà suspendre l'assignatura amb una qualificació de zero sense dret a recuperació, sense perjudici de

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