Universitat Autònoma de Barcelona

2019/2020

Differential equations and modelling I

Code: 100100
ECTS Credits: 9

Degree	Type	Year	Semester
2500149 Mathematics	OB	3	1

Contact

Name: Magdalena Caubergh
Email: Magdalena.Caubergh@uab.cat

Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Teachers

Iván Sánchez Sánchez

Prerequisites

Linear Algebra

Calculus in Several variables.

Objectives and Contextualisation

The Theory of Differential Equations is distinguished both by the richness of ideas and methods as well as by its applicability. Thus the subject Differential Equations and Modeling I has a theoretical aspect (that will be used in theory and problem lessons) as well as a very applied aspect (which will be introduced in the theory sessions and will be developed in problems and practical sessions). Practical lessons will be carried out in the computer lab. On the one hand we will emphasize the presentation of the theory and the demonstration of the results and on the other hand the students will learn how to model real situations that allow them to predict the studied behaviors.

We think that this subject is good to show to the students that certain theoretical results that they already know about other subjects (topological properties of normed spaces and Jordan canonical forms, for example) can be applied to develop the theory of differential equations.

Competences

- Identify the essential ideas of the demonstrations of certain basic theorems and know how to adapt them to obtain other results.
- Recognise the presence of Mathematics in other disciplines.
- Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
- Use computer applications for statistical analysis, numeric and symbolic calculus, graphic display, optimisation or other purposes to experiment with Mathematics and solve problems.
- Work in teams.

Learning Outcomes

1. Apply the main methods for resolving ordinary differential equations and some simple partial derivative equations.
2. Resolve linear systems of ordinary differential equations.
3. Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
4. Translate some real problems into the terms of ordinary differential equations and partial derivative equations.
5. Work in teams

Content

1. Differential Equations of the first order.

1.1 Introduction to differentia equations. Separable equatiuons. Exact equations.

1.2 Applications to modelling.

2. The linear equation.

2.1 Uniqueness and existence theorems. Algebraic properties of the space of solutions. Liouville's theoreme.

2.2 The autonomous case: Exponencial of a matrix.

2.3 The linear equation of order n.

3. Uniqueness and existence theorems

3.1 The Cauchy's problem. Picard and Peano theorems.

3.2 Prolongation of solutions. Wintner's lemma

3.3 Continuous and differentiable dependence on initial data and parameters.

4. Qualitative theory of autonomous systems.

4.1 Dynamical systems.Critical points and periodic orbits. Stability. Conjugation of dynamical systems.

4.2 Tubular flow theorem. Hartman's theorem.

4.3 Qualitative study of the autonomous linear equation.

Methodology

There are three diferent types of classroom activities: theoretical classes, problem classes and practical classes in the computer classroom.

In the theoretical classes the professor exposes new concepts and techniques corresponding to the course. On the Campus Virtual webpage of the course there will be different materials (in catalan) for the better understanding of these concepts and techniques.

On regular basis there will be a list wit exercices that students have to think, try to resolve and that will be worked out in the class of problems.

It is well-known that the only way to learn mathematics is to work out a lots of problems. For that reasaon students should dedicate at least 5 hours per week to resolve problems of this course material.

There will be exams on the problems that require regular study and work by the students.

In the practical sessions each class will deal with a different theme; the students start each practical session in the computer classroom and finish them at home.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Practical modelization problems	12	0.48	
Theory classes	45	1.8	
Type: Supervised			
Problem classes	15	0.6	
Type: Autonomous			
Study of the theory and resolution of problems	122	4.88	

Assessment

50% of the course will be evaluated in a continuous way.

Continuous evaluation:

- Practical sessions: Handout of one report (5%), two exams at the end of two sessions (5%) and a final exam (10%).
- A parcial exam that counts for 30%.

Evaluation that can be repeated to get a new oportunity:

- Final exam that counts for 50%.
- In case the final exam is repeated, the repeated exam counts for 50%.

To pass the course it is necessary to have obtained a note of at least 40% at the final exam.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Exam of practical sessions	10%	3	0.12	3, 2, 4
Final exam	50%	4	0.16	3, 2, 4
Handout of practical work	10%	12	0.48	3, 2, 4, 5
Partial exams	30%	8	0.32	1, 2
Repeated final exam	50%	4	0.16	1, 2

Bibliography

F. Mañosas. *Apunts d'Equacions diferencials.* Campus virtual.

R. Martínez. *Models amb Equacions Diferencials*. Materials de la UAB, Servei de Publicacions de la UAB, no. 149. Bellaterra, 2004.

V. Jimenez. *Ecuaciones diferenciales*. Serie: enseñanza. Universidad de Murcia, 2000.

M. Guzmán. *Ecuaciones diferenciales ordinarias*. Ed. Alhambra, Madrid, 1978.

C. Fernandez y J.M. Vegas. *Ecuaciones diferenciales*. Pirámide, Madrid, 1996.

M. W. Hirsch , S. Smale, R. Devaney. *Differential Equations, Dynamical Systems: An Introduction to Chaos.* Elsevier, 2003.

P. Blanchard, and R.L. Devaney. *Differential Equations*. G.R. Hall, 2002. Traduït al castellà: "Ecuaciones Diferenciales". International Thomson Editores, México, 1999.

E. Boyce, y R.C. Di Prima. *Ecuaciones Diferenciales y Problemas con Valores en la Frontera*. Ed. Limusa, México, 1967.

M. Braun. *Ecuaciones diferenciales y sus aplicaciones*. Grupo Editorial Iberoamérica. México, 2000.

R.L. Borrelli and C.S. Coleman. *Differential equations: a modeling perspective*. Prentice-Hall, 1987.

R.K. Nagle, E.B. Saff and A.D. Snyder. *Fundamentos de Ecuaciones diferenciales*. Addison Wesley, 1992.

C. Perelló. *Càlcul infinitesimal amb mètodes numèrics i aplicacions*. Enciclopèdia Catalana, 1994.

G.F. Simmons. *Ecuaciones diferenciales con aplicaciones y notas históricas*. Mc Graw-Hill, 1977.

D.G. Zill. *Ecuaciones diferenciales con aplicaciones de modelado*. International Thomson Editores,México, 2001.

G. Fulford, P. Forrester, A. Jones. *Modelling with differential and difference equations*. Cambridge University Press, New York, 1997.

H.Ricardo. *Ecuaciones diferenciales: una introducción moderna*. Editorial Reverté, Barcelona, 2008.