

## Course guides

# 200902 - SADEM - Seminar on Analysis, Differential Equations and Modelling

Last modified: 19/06/2020

<b>Unit in charge:</b>	School of Mathematics and Statistics	
<b>Teaching unit:</b>	749 - MAT - Department of Mathematics.	
<b>Degree:</b>	MASTER'S DEGREE IN ADVANCED MATHEMATICS AND MATHEMATICAL ENGINEERING (Syllabus 2010). (Optional subject).	
<b>Academic year:</b> 2020	<b>ECTS Credits:</b> 3.0	<b>Languages:</b> English

### LECTURER

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<b>Coordinating lecturer:</b>	GEMMA HUGUET CASADES
<b>Others:</b>	Segon quadrimestre: GEMMA HUGUET CASADES - A JOSE JAVIER MUÑOZ ROMERO - A

### PRIOR SKILLS

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It is important to have some background in one of the following areas: Dynamical Systems, Partial Differential Equations, Numerical methods and discretisation methods for PDEs.

### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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#### Specific:

- MAMME-CE1. RESEARCH. Read and understand advanced mathematical papers. Use mathematical research techniques to produce and transmit new results.
- MAMME-CE2. MODELLING. Formulate, analyse and validate mathematical models of practical problems by using the appropriate mathematical tools.
- MAMME-CE3. CALCULUS. Obtain (exact or approximate) solutions for these models with the available resources, including computational means.
- MAMME-CE4. CRITICAL ASSESSMENT. Discuss the validity, scope and relevance of these solutions; present results and defend conclusions.

### TEACHING METHODOLOGY

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Students will present a topic related to Mathematical Analysis for Oscillatory Systems autonomously on a seminar format. This material will be taken from specialized books and research papers.

There will be some meetings between the instructor and the students before the oral presentation.

Students must prepare an abstract of the seminar to help the rest of the students attending the seminar to understand the topic.

Students must attend at least 90% of the lectures and be active in all the presentations.

### LEARNING OBJECTIVES OF THE SUBJECT

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The main goal is to provide the students with a basic knowledge on the mathematical analysis for oscillatory systems, as well as, several applications in different branches of applied mathematics. The topic intersects with dynamical systems, partial differential equations as well as numerical methods, amongst others.

Additionally, the students will learn how to conduct technical talks in public and prepare technical scientific documents.



## STUDY LOAD

Type	Hours	Percentage
Hours large group	24,0	32.00
Self study	51,0	68.00

**Total learning time:** 75 h

## CONTENTS

### Mathematical tools for periodic orbits and stability analysis

**Description:**

Poincaré Section. Perturbation analysis. Characteristic equations

**Full-or-part-time:** 15h

Theory classes: 4h

Self study : 11h

### Biological oscillators

**Description:**

Reaction-Diffusion equations and Turing patterns. Biological oscillators in neural systems. Electrical + ion concentration fields. Hodgkin-Huxley equations.

**Full-or-part-time:** 30h

Theory classes: 10h

Self study : 20h

### Oscillations in mechanics

**Description:**

Chemo-mechanical oscillators in elasticity. Delay systems in mechanics and biology. Wave Propagation in solids and fluids: acoustics, surface waves, etc. Periodic orbits in celestial mechanics.

**Full-or-part-time:** 30h

Theory classes: 10h

Self study : 20h

## GRADING SYSTEM

The grading of this seminar will be based on three aspects: (C) Continuous evaluation, (M) Material preparation and (P) Presentation.

(C): the grade will be based on the understanding of the material, as well as the meetings that will be held between the student and the instructor to prepare the student's presentation (or presentations). The goal of the seminar is to ensure that the audience understands the lectures and its technicalities.

(M): the grade will be based on the quality of both the presentation slides and the abstract.

(P): the grade will be based on the clarity of the presentation. This will include questions from the teacher and students.

Overall grading of the seminar: 30% (C) + 20% (M) + 50% (P)



## BIBLIOGRAPHY

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### Basic:

- Murray, J. D. Mathematical biology [on line]. 3rd ed. New York [etc.]: Springer, 2002-2003 Available on: <https://link.springer.com/book/10.1007/b98868> (v.1) - <https://link.springer.com/book/10.1007/b98869> (v.2). ISBN 978-0-387-22437-4.
- Strogatz, Steven H. Nonlinear dynamics and chaos : with applications to physics, biology, chemistry and engineering [on line]. 2nd ed. CRC Press, Taylor, 2018 Available on: <https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=1181622>.
- Keener, James; Sneyd, James. Mathematical Physiology [on line]. New York, NY: Springer New York, 2009 [Consultation: 25/06/2020]. Available on: <http://dx.doi.org/10.1007/978-0-387-75847-3> (v.1) - <http://dx.doi.org/10.1007/978-0-387-79388-7> (v.2). ISBN 978-0-387-75847-3.
- Guckenheimer, John; Holmes, Philip. Nonlinear oscillations, dynamical systems, and bifurcations of vector fields. New York, NY [etc.]: Springer-Verlag, 1983. ISBN 0387908196.
- Erneux, Thomas. Applied Delay Differential Equations [on line]. New York, NY: Springer New York, 2009 Available on: <http://dx.doi.org/10.1007/978-0-387-74372-1>. ISBN 978-0-387-74372-1.