Course guide
200902 - SADEM - Seminar on Analysis, Differential Equations and Modelling

Last modified: 01/06/2023

Unit in charge: School of Mathematics and Statistics
Teaching unit: 748 - FIS - Department of Physics.
749 - MAT - Department of Mathematics.

Degree: MASTER'S DEGREE IN ADVANCED MATHEMATICS AND MATHEMATICAL ENGINEERING (Syllabus 2010). (Optional subject).

Academic year: 2023 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: JOSE JAVIER MUÑOZ ROMERO

Others: Segon quadrimestre:
GEMMA HUGUET CASADES - A
JOSEP JOAQUIM MASDEMONT SOLER - A
ALVARO MESEGUER SERRANO - A
JOSE JAVIER MUÑOZ ROMERO - A

PRIOR SKILLS

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

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

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/report 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

The main goal is to provide the students with a basic knowledge on mathematical methods for the 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/report.
(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

Basic:

- Murray, J. D. Mathematical biology, vol. 1 [on line]. 3rd ed. New York [etc.]: Springer, 2002-2003 [Consultation: 10/07/2023]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/b98868. ISBN 9780387224374.
- Strogatz, Steven H. Nonlinear dynamics and chaos : with applications to physics, biology, chemistry and engineering [on line]. 2nd ed. CRC Press, Taylor, 2018 [Consultation: 10/07/2023]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=1181622. ISBN 9780813349107.
- Keener, James; Sneyd, James. Mathematical physiology [on line]. New York, NY: Springer New York, 2009 [Consultation: 10/07/2023]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-0-387-75847-3 (v.1) - https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-0-387-79388-7 (v.2). ISBN 9780387758473.
- 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 [Consultation: 10/07/2023]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-0-387-74372-1. ISBN 9780387743721.