Course guides
34964 - NMDS - Numerical Methods for Dynamical Systems

Last modified: 17/04/2021

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

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

Academic year: 2021 **ECTS Credits:** 7.5 **Languages:** English

LECTURER

Coordinating lecturer: MERCEDES OLLE TORNER

Others: Primer quadrimestre:
MERCEDES OLLE TORNER - A

PRIOR SKILLS

Good knowledge of a programming language.

REQUIREMENTS

Knowledge of theory of systems of differential equations, algebra, calculus and numerical analysis.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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

Transversal:
5. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.
6. EFFICIENT ORAL AND WRITTEN COMMUNICATION. Communicating verbally and in writing about learning outcomes, thought-building and decision-making. Taking part in debates about issues related to the own field of specialization.
7. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
8. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.
9. EFFECTIVE USE OF INFORMATION RESOURCES. Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.

TEACHING METHODOLOGY

Theoretical sessions (presence of the students is necessary) and weekly practical tutorized assignments.

LEARNING OBJECTIVES OF THE SUBJECT

-To reach an advanced formation in using numerical methods applied to dynamical systems
- Carry out numerical simulations of particular examples
- To relate different aspects of the dynamics in order to have a global picture of the behavior of a given problem
- To learn different tools to analyse and deal with a problem
- Ability in programming algorithms dessigned to solve particular problems in dynamical systems

STUDY LOAD

Type	Hours	Percentage
Hours large group	60,0	32.00
Self study	127,5	68.00

Total learning time: 187.5 h

CONTENTS

Numerical (preliminary) tools for practical purposes: integrators for ODE and graphical interfaces. Examples.

Full-or-part-time: 4h
Theory classes: 2h
Practical classes: 2h

Dynamical systems: introduction, definitions. Continuous and discrete dynamical systems. Orbit generation. Numerical computation of Poincare maps. Examples.

Full-or-part-time: 6h
Theory classes: 3h
Practical classes: 3h

Computation and stability of fixed points. Vector fields and maps. Implementation and examples.

Full-or-part-time: 10h
Theory classes: 5h
Practical classes: 5h

Computation of tori: representation, computation and continuation. Implementation and examples.

Full-or-part-time: 15h
Theory classes: 7h 30m
Practical classes: 7h 30m

Analysis of bifurcations. Some examples.

Full-or-part-time: 15h
Theory classes: 7h 30m
Practical classes: 7h 30m

GRADING SYSTEM

65% of the qualification will be obtained from the practical assignments done and 35% from short exams.

EXAMINATION RULES.

No rules, in principle.

BIBLIOGRAPHY

Basic:
- Strogatz, S.H.. Nonlinear dynamics and chaos : with applications to physics, biology, chemistry, and engineering [on line]. 2nd ed. CRC Press, Taylor and Francis Group, 2018 [Consultation: 26/06/2020]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=1181622.
- Lichtenberg, Allan J; Lieberman, M. A. Regular and stochastic motion. New York: Springer-Verlag, 1983. ISBN 0387907076.
- Press, William H. Numerical recipes in C : the art of scientific computing. 2nd. Cambridge: Cambridge University Press, 1992.
- Arrowsmith, D. K; Place, C. M. An introduction to dynamical systems. Cambridge: Cambridge University Press, 1990. ISBN 0521303621.
- Particular articles related to the topics of the course and some notes from suitable web pages.
- Stuart, A.M. ; Humphries, A. R. Dynamical systems and numerical analysis. Cambridge University Press, 1996.