UNIVERSIDAD DE CASTILLA - LA MANCHA

GUÍA DOCENTE

1. General information

Course: DYNAMICAL SYSTEMS AND MECHANICS
Code: 310944
Type: ELECTIVE
ECTS credits: 6
Degree: 2351 - MASTER DEGREE PROGRAMME IN PHYSICS AND MATHEMATICS-FISYMAT
Academic year: 2023-24
Center:
Group(s): 20
Year: 1
Duration: First semester
Main language: Spanish
Second language: English
Use of additional languages:
English Friendly: Y
Web site:
Bilingual: N

Lecturer: **MIGUEL ANGEL LOPEZ GUERRERO** - Group(s): **20**

Building/Office	Department	Phone number	Email	Office hours
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Lecturer: **RAQUEL MARTINEZ LUCAS** - Group(s): **20**

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2. Pre-Requisites

BA or Graduated in Physics, Mathematics and other experimental sciences. Technicians are also appreciated, mainly those who have a cross-disciplined profile to develop different activities and a significant knowledge of differential equations.

3. Justification in the curriculum, relation to other subjects and to the profession

A clear trend to the creation of high level interdisciplinary studies has been observed within all of our neighbouring countries. Given the interdisciplinary character of modern science, very versatile graduates are obtained, those who also are better adapted to changing technologies and markets, and technology transfer processes are improved. In many scientific fields, a series of mathematical concepts (such as fractals, chaos, bifurcations, attractors, solitons, complex systems, interfaces, cellular automata, pattern formation, catastrophes, critical phenomena, self-similarity, self-criticality, scale invariance have a relevant role, renormalization group, among others) are today associated to some of the most promising scientific research lines. At present, the relationship between Physics and Mathematics and other sciences is providing important perspectives and new ways of the future. The understanding of reality through its modelling is a fascinating and motivating challenge in nearby fields of interesting evolution such as Ecology, Mathematical Engineering, Astronomy, Economics, Medicine, Biology or Telecommunications. One of the purposes of this subject is to enhance and provide the necessary foundations that allow to connect with these lines of work, introducing and analysing the theoretical concepts that facilitate learning in solving problems in these areas.

Differential equations and dynamic systems appear in the description of real systems infinity. This subject covers, at a medium level, the theory of dynamic systems and their applications to mechanics. The Student target is to handle the tools of differential equations analysis and dynamic systems to approach real problems in Science and Engineering, Astrophysics, Physics and Mathematics in a practical way, those that have been modelled by this type of mathematical objects.

4. Degree competences achieved in this course

Course competences

Code	Description
CB06	Possess and understand knowledge that provides a basis or opportunity to be original in the development and / or application of ideas, often in a research context.
CB07	Apply the achieved knowledge and ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to the area of study
CB08	Be able to integrate knowledge and face the complexity of making judgments based on information that, being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of knowledge and judgments
CB09	Know how to communicate the conclusions and their supported knowledge and ultimate reasons to specialized and non-specialized audiences in a clear and unambiguous way
CB10	Have the learning skills which allow to continue studying in a self-directed or autonomous way
CE02	Develop the ability to decide the appropriate techniques to solve a specific problem with special emphasis on those problems associated with the Modeling in Science and Engineering, Astrophysics, Physics, and Mathematics
CG03	Present publicly the research results or technical reports, to communicate the conclusions to a specialized court, interested persons or organizations, and discuss with their members any aspect related to them
CG05	Gain the ability to develop a scientific research work independently and in its entirety. Be able to search and assimilate scientific literature, formulate hypotheses, raise and develop problems and draw conclusions from the obtained results
CT03	Develop critical reasoning and the ability to criticize and self-criticize

5. Objectives or Learning Outcomes

Course learning outcomes

Description

The point of view of mechanics in the interpretation of known results (for mathematicians)
A coherent development of the theory of Hamiltonian systems
A collection of useful mathematical tools (for physicists)
An integrated view between the mathematical theory of dynamic systems and classic mechanics

Additional outcomes

Use the abilities that have been provided by the usual computer programs of symbolic and numerical calculation, as a resourcefor the analysis and study of some ofthe posed problems.

6. Units / Contents

Unit 1: Qualitative Theory of Differential Equations.
Unit 2: Discrete and Continuous Dynamic Systems.
Unit 3: Hamiltonian Systems.
Unit 4: Applications to Mechanics.
Unit 5: Practices.

7. Activities, Units/Modules and Methodology

Training Activity	Methodology	Related Competences (only degrees before RD 822/2021)	ECTS	Hours	As	Com	Description
Class Attendance (theory) [ON-SITE]	Lectures	CB06 CB10 CE02 CG05 CT03	1.04	26	N	-	Theoretical development of the subjects contents.
Class Attendance (practical) [ON-SITE]	Problem solving and exercises	CB06 CB07 CB08 CB10 CE02 CT03	0.4	10	N	-	Problems solving.
Workshops or seminars [ON-SITE]	Workshops and Seminars	CB06 CB08 CG03 CT03	0.24	6	Y	Y	Assistance to possible conferences or seminars on topics that are related to the subject. Contact with other research groups that use similar techniques or develop related research. Attendance to the exhibition and defence of the final work of the subject made by each of the students of the subject. Analysis of sources and documents. Professors and lecturers must be contacted by those students who are not able to perform this activity partially or totally for fair reasons.
Writing of reports or projects [OFF-SITE]	Self-study	CB06 CB07 CB08 CB10 CE02 CG05 CT03	2.8	70	Y	Y	Problems solving by the student on the topics of each of the subjects of the subject. Bibliographic review of background, methodology and resources and preparation of a possible final research work (hypothesis, background, objectives, experimental design, methodology, etc.). Analysis of Sources and documents.
Project or Topic Presentations [ON-SITE]	Individual presentation of projects and reports	CB09 CG03	0.04	1	Y	Y	Defence of the subject final work.
Study and Exam Preparation [OFF-SITE]	Self-study	CB06 CB07 CB08 CB10 CE02 CG05 CT03	1.4	35	N	-	Autonomous personal study of the student and defence training for the subject final work.
Individual tutoring sessions [ON-SITE]	Other Methodologies	CB06 CE02 CG05 CT03	0.08	2	N	-	Direct interaction between the faculty members and the student. The student can be assisted by the faculty members to resolve any academic question of the subject. The opening hours will be published at the beginning of the semester. Although the time of attention in ECTS has been valued, each student will use the time that is necessary according to their needs.
		Total:	**6**	**150**			
		Total credits of in-class work: 1.8					**Total class time hours: 45**
		Total credits of out of class work: 4.2					**Total hours of out of class work: 105**

As: Assessable training activity
Com: Training activity of compulsory overcoming (It will be essential to overcome both continuous and non-continuous assessment).

8. Evaluation criteria and Grading System

Evaluation System	Continuous assessment	Non-continuous evaluation*	Description
			Attendance at conferences or seminars that are related to the

Other methods of assessment	5.00%	5.00%	course or contacts with other research groups will be valued through an activity report.
Assessment of problem solving and/or case studies	30.00%	30.00%	Problems solving and memories of practices elaboration by the student on the topics of each one of the subjects by means of symbolic calculation programs such as Matlab, Mathematica, etc.
Theoretical papers assessment	55.00%	55.00%	Bibliographic review of background, methodology and resources and elaboration of a possible research work (hypothesis, background, objectives, experimental design, methodology, etc.). Analysis of sources and documents.
Oral presentations assessment	10.00%	10.00%	For the defence of the subject final work.
Total:	**100.00%**	**100.00%**	

According to art. 4 of the UCLM Student Evaluation Regulations, it must be provided to students who cannot regularly attend face-to-face training activities the passing of the subject, having the right (art. 12.2) to be globally graded, in 2 annual calls per subject , an ordinary and an extraordinary one (evaluating 100% of the competences).

Evaluation criteria for the final exam:

Continuous assessment:

In the ordinary call, the grade will depend on the marks obtained in each one of the training activities evaluated. The delivery dates of problems (practices) and the final essay title of the subject will be communicated in advance in the virtual platform. The final grade will be the weighted average according to the assessments (percentages) established in the evaluation criteria. To pass the subject it is necessary to obtain a minimum grade of 4 in each of these criteria corresponding to the compulsory overcoming training activities.

Non-continuous evaluation:

In the ordinary call, the grade will depend on the marks obtained in each one of the training activities evaluated. The delivery dates of problems (practices) and the final essay title of the subject will be communicated in advance in the virtual platform. The final grade will be the weighted average according to the assessments (percentages) established in the evaluation criteria. To pass the subject it is necessary to obtain a minimum grade of 4 in each of these criteria corresponding to the compulsory overcoming training activities. Assessment will take place in the non-teaching weeks during the examination period.

Specifications for the resit/retake exam:

The same criteria will be followed as in the Ordinary Call.

Specifications for the second resit / retake exam:

The same criteria will be followed as in the Ordinary Call.

9. Assignments, course calendar and important dates

Not related to the syllabus/contents

Hours **hours**

General comments about the planning: The subjects will be taught consecutively taught by means of being adapted to the current calendar that corresponds to the first term of the 2021-22 academic year. The topics delivery order may be altered for any justified cause. The "Applications to Mechanics" and "Practices" subjects (Topics 4 and 5) will be alternated throughout the Semester. The dates that have been planned for each week are estimated. The last week of the semester will be focused on the subject final work presentation.

Unit 1 (de 5): Qualitative Theory of Differential Equations.

Teaching period: Weeks 1-4

Comment: The dates that have been planned for each week are estimated.

Unit 2 (de 5): Discrete and Continuous Dynamic Systems.

Teaching period: Weeks 5-10

Comment: The dates that have been planned for each week are estimated.

Unit 3 (de 5): Hamiltonian Systems.

Teaching period: Weeks 11 - 13

Comment: The dates that have been planned for each week are estimated.

Unit 4 (de 5): Applications to Mechanics.

Teaching period: Weeks 1 - 13

Comment: This subject will be developed throughout the Semester. The dates that have been planned for each week are estimated.

Unit 5 (de 5): Practices.

Teaching period: Weeks 1 - 13

Comment: This subject will be developed throughout the Semester. The dates that have been planned for each week are estimated.

10. Bibliography and Sources

Author(s)	Title/Link	Publishing house	Citv	ISBN	Year	Description
Bellido Guerrero, J. Carlos	Ecuaciones diferenciales ordinarias	Paraninfo,	Madrid	978-84-283-3015-2	2014	
Block, L. S.(Louis Stuart)1947-	Dynamics in one dimension	Springer-Verlag		0-387-55309-6	1992	
Devaney, Robert L.1948-	An Introduction to chaotic dynamical systems	Addison-Wesley Company		0-8053-1601-9	1987	
George F. Simmons y Steben G. Krantz	Ecuaciones diferenciales. Teoría, técnica y práctica	MacGraw-Hill	México	978-0-07-286315-4	2007	
Guckenheimer, John	Nonlinear oscillations, dynamical systems and bifurcations of vector fields	Springer-Verlag		0387-90819-6	1997	
K,R. Meyer, G.R. Hall and D. Offin	Introduction to Hamiltonian Dynamical Systems and the N-Body Problem	Springer-Verlag		978-0-387-09723-7	2009	
Lampart, M.	Dynamical Systems for Geoinformatics				2013	

Siegel, C., Moser, J.	Lectures on Celestial Mechanics	Springer		1971
Strogatz, Steven H.Steven Henry	Nonlinear dynamics and chaos: with applications to Physics, Biology, Chemestry, and Engineering	Westview	978-0-7382-0453-6	2000
Víctor Jiménez López	Ecuaciones diferenciales	Servicio de Publicaciones de la Universidad de Murcia Murcia		2000
Wiggins, Stephen	Introduction to applied non linear dynamical systems and chaos	Springer-Verlag	0-387-00177-8	2003
Lynch, S.	Dynamical Systems with Applications using MATLAB	Birkhäuser	978-3-319-06819-0	2014