

City Center Campus	School of Industrial Engineering and Design
Program	56IA – Bachelor of Science in Industrial Electronics Engineering and Automation

Course number and name	
Number	565001084
Name	Introduction to chaos in science and technology
Semester	S8 [(February-June)]

Credits and contact hours	
ECTS Credits	3
Contact hours	30

Coordinator's name	Faleiro Usanos, Eduardo [eduardo.faleiro@upm.es]
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Specific course information

Description of course content

The course is about Chaos Theory and is an introduction to the properties of dynamical systems that can exhibit chaotic solutions for certain values taken by their parameters. It examines the background of bifurcation theory to study the transition to chaos. The content of the subject has a medium level in mathematics and uses small programs written in Matlab to illustrate the proposed examples. Some applications to science and engineering are studied at length.

List of topics to be covered

1. Introduction to chaos
 - 1.1. Topics on dynamical systems
 - 1.2. Chaos and randomness.
 - 1.3. Examples
2. Unidimensional dynamical systems
 - 2.1. Stationary solutions: fixed points.
 - 2.2. Stability analysis.
 - 2.3. Discrete systems.
 - 2.4. Examples.
3. Bidimensional dynamical systems
 - 3.1. Fixed points and limit cycles.
 - 3.2. Stability analysis
 - 3.3. Discrete systems.
 - 3.4. Examples.
4. Bifurcation theory

4.1. Bifurcations in unidimensional systems 4.2. Bifurcations in bidimensional systems. 4.3. Bifurcations in discrete dynamical systems 5. Tridimensional continuous dynamical systems 5.1. Special features from 3D. 5.2. The paradigm of chaos: The Lorenz attractor 5.3. Other examples of chaotic systems. 6. Chaos from time series 6.1. Some tools for detecting chaos in time series. 6.2. Attractor reconstruction from time series: Ruelle-Takens theory. 6.3. Examples	
Prerequisites or co-requisites	
None.	
Course category in the program	
<input type="checkbox"/> R (required)	<input checked="" type="checkbox"/> E (elective) <i>(elective courses may not be offered every year)</i>

Specific goals for the course
Specific outcomes of instruction
<ul style="list-style-type: none"> • RA283 – Be acquainted with the theory of dynamical systems. • RA285 – Know the stationary solutions of some types of dynamical systems. • RA287 – Be able to handle some of the most basic tests on the identification of chaos in time series. • RA286 - Understand the theory of bifurcations and their connection to possible routes to chaos. • RA288 - Apply the chaos identification tests to concrete examples. • RA284 - Express simple physical problems in terms of dynamical systems.

Bibliography and supplemental materials
– To be specified.

Teaching methodology			
<input checked="" type="checkbox"/> lectures	<input checked="" type="checkbox"/> problem solving sessions	<input checked="" type="checkbox"/> collaborative actions	<input type="checkbox"/> laboratory sessions
Other:			