230850 - CPC - Critical Phenomena and Complexity

Coordinating unit:	230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit:	748 - FIS - Department of Physics
Academic year:	2019
Degree:	MASTER'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2018). (Teaching unit Compulsory)
ECTS credits:	5 Teaching languages: Catalan, Spanish, English

Teaching staff

Coordinator:	Ramirez De La Piscina Millan, Laureano
Others:	Pastor Satorras, Romualdo

Opening hours

Timetable:	By appointment

Teaching methodology

Classroom sessions will be devoted to a careful presentation of the basic concepts and main results which will be illustrated with some examples. With some periodicity students present exercises or topics which have previously been proposed.

Learning objectives of the subject

Becoming familiar with phenomenology and analytical techniques of critical phenomena.
Knowing and being able to apply to physical systems the techniques of bifurcation theory analysis.
Becoming familiar with the modeling of multidisciplinary systems with stochastic behavior.
Being able to apply stochastic process techniques to simple systems.
Becoming familiar with complex network systems, and be able to characterize them.

Study load

Total learning time: 125h	Hours large group:	44h	35.20%
	Self study:	81h	64.80%

230850 - CPC - Critical Phenomena and Complexity

Content

Dynamical systems	Learning time: 31h 15m
	Theory classes: 10h Guided activities: 6h 15m Self study : 15h

Description:
Flows and Maps
Bifurcations
Normal Form
Conservative systems.
Local and global bifurcations
Chaos
Pattern formation

Stochastic Processes	Learning time: 31h 15m
	Theory classes: 10h Guided activities: 6h 15m Self study : 15h

Description:
Introduction to stochastic processes.
Markov Process
Stochastic differential equations
First passage and relaxation times
Spacially distributed systems

Non-equilibrium critical phenomena	Learning time: 31h 15m
	Theory classes: 10h Guided activities: 6h 15m Self study : 15h

Description:
Introduction to equilibrium critical phenomena
Non-equilibrium systems
Percolation
Absorbing-state phase transitions
Other examples of non-equilibrium systems

Universitat Politècnica de Catalunya

230850 - CPC - Critical Phenomena and Complexity

Complex networks	Learning time: 31h 15m
	Theory classes: 10h Guided activities: 6h 15m Self study : 15h

Description:
Introduction to complex networks
The large-scale structure of complex networks
Dynamical processes on complex networks
Network models

Qualification system

Marks will be obtained from written questionnaires and exercises (PE),
and classroom presentations and participation (TC).
The final score will follow from: 0.70*PE+0.30*TC

Bibliography

Basic:

Strogatz, S.H. Nonlinear dynamics and chaos: with applications to physics, biology, chemistry and engineering [on line]. 2nd ed. Cambridge: CRC Press Press, 2015 [Consultation: 26/09/2018]. Available on: <https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=1181622>. ISBN 9780813349107.

Gardiner, C.W. Stochastic methods: a handbook for the natural and social sciences. 4th ed. Berlin: Springer-Verlag, 2009. ISBN 9783540707127.

Universitat Politècnica de Catalunya