Course guide
230860 - CBS - Complexity in Biological Systems

Last modified: 14/12/2023

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 748 - FIS - Department of Physics.

Degree: MASTER'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2018). (Optional subject).
ERASMUS MUNDUS MASTER'S DEGREE IN BIO & PHARMACEUTICAL MATERIALS SCIENCE (Syllabus 2021). (Optional subject).

Academic year: 2023 **ECTS Credits:** 4.0 **Languages:** English

LECTURER

Coordinating lecturer: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura

Others: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma

PRIOR SKILLS

Linear Stability of nonlinear systems
Minimal Knowledge of computer programming
Minimal Knowledge of numeric methods

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Basic:
CB6. 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
CB7. Students should know how to apply the knowledge acquired and their problem-solving ability in new or little-known environments within broader (or multidisciplinary) contexts related to their area of ¿¿study.
CB10. Students should possess the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.

TEACHING METHODOLOGY

Master class, written work, problem resolutions, practical exercices, search of information, practices

LEARNING OBJECTIVES OF THE SUBJECT

- Understand what a complex system is and how to characterize it.
- Obtain a basic knowledge in biological phenomena, from the molecular/celular scale to the macroscale.
- Dominate numerical techniques and use specific software related with the subject.
- Be able to include the theoretical knowledge to solve biological problems.
- Be able to present the results of a project in a written text and orally, using a precise language and putting the results in the correct context.

STUDY LOAD

Type	Hours	Percentage
Hours large group	36,0	36.00
Self study	64,0	64.00

Total learning time: 100 h

CONTENTS

Complex spatio-temporal dynamics in biology

Description:
Oscillations, excitability, bistability
Synchronization in biological systems
Stochastic biochemistry

Full-or-part-time: 25h
Theory classes: 9h
Self study : 16h

Analisi of complex biosignals

Description:
Deterministic and stochastic signals
Statistical properties
Nonlinear analysis of temporal series

Full-or-part-time: 25h
Theory classes: 9h
Self study : 16h

Self-organization in biological systems

Description:
Excitability and cardiact tissue
Self-assembling: protein folding, and membrane formation
Cell polarization, chemotaxis, and morphogenesis

Full-or-part-time: 25h
Theory classes: 9h
Self study : 16h

Biological networks

Description:
Introduction to networks,
Networks in Biology
Networks in the brain

Full-or-part-time: 25h
Theory classes: 9h
Self study : 16h

GRADING SYSTEM

Written test (40%)
Works done by the student (60%)

Possibility of reevaluation of the 100% of the course with a written examination in case of failure only if all the works have been presented

BIBLIOGRAPHY

Basic:

- Keener, James; Sneyd, James. Mathematical Physiology. vol. 1 [on line]. New York, NY: Springer, 2009 [Consultation: 08/06/2022]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-0-387-75847-3. ISBN 9780387758466.
- Alon, U. An introduction to systems biology: design principles of biological circuits. 2nd ed. Boca Raton, Fla.: Chapman & Hall/CRC, 2020. ISBN 9781439837177.
- Pikovsky, Arkady; Rosenblum, Michael; Kurths, Jürgen. Synchronization : a universal concept in nonlinear sciences. Cambridge: Cambridge University Press, 2001. ISBN 9780521592857.
- Kantz, Holger; Schreiber, Thomas. Nonlinear time series analysis [on line]. 2nd ed. Cambridge: Cambridge University Press, 2004 [Consultation: 13/06/2022]. Available on: https://www-cambridge-org.recursos.biblioteca.upc.edu/core/books/nonlinear-time-series-analysis/519783E4E8A2C3DCD4641E42765309C7#. ISBN 9780521529020.
- Murray, J.D. Mathematical biology. v.2: spatial models and biomedical applications [on line]. New York, NY: Springer, 2002-2003 [Consultation: 13/06/2022]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/chapter/10.1007/0-387-22438-6_1. ISBN 9781280009372.
- Keener, James; Sneyd, James. Mathematical Physiology. vol. 2 [on line]. 2nd ed. New York: Springer, 2009 [Consultation: 08/06/2022]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-0-387-79388-7. ISBN 9780387793870.
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- Hirsch, Morris W; Smale, Stephen; Devaney, Robert L. Differential equations, dynamical systems, and an introduction to chaos. 3rd ed. Oxford, UK: Elsevier, 2013. ISBN 9780123820105.
- Dayan, Peter; Abbott, L. F. Theoretical neuroscience : computational and mathematical modeling of neural systems. Cambridge [etc.]: The MIT Press, cop. 2001. ISBN 9780262541855.