Course guide
230860 - CBS - Complexity in Biological Systems

Last modified: 02/06/2022

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: 2022 **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. (ENG) Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación
CB7. (ENG) Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.
CB10. (ENG) Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

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.
- 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.
- Murray, J. D. Mathematical biology. v.1: an introduction [on line]. 3rd ed. New York [etc.]: Springer, 2002-2003 [Consultation: 13/06/2022]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/b98868. ISBN 9780387224374.
- 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.
- 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.