Course guide
240IBI33 - 240IBI33 - Modelling and Simulation of Biomedical Systems

Last modified: 16/05/2023

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control.

Degree: MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Optional subject).
MASTER'S DEGREE IN NEUROENGINEERING AND REHABILITATION (Syllabus 2020). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 4.5 **Languages:** English

LECTURER

Coordinating lecturer: Vallverdu Ferrer, Maria Montserrat

Others:

PRIOR SKILLS

No prerequisites are required

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEEBIO5. Acquire concepts and techniques related to the modelling and simulation of the biological systems.

TEACHING METHODOLOGY

This course uses participative lectures, project-based learning and teamwork. The entire course will be held in a computer laboratory.

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course, the student will be able to:
- Analyze the behavior of a dynamical system; use software tools; design models to understand its performance; evaluate various strategies for its operation.
- Apply proper working methods of biomedical system modeling, with the aim of being applied to solve problems in the field of biomedical engineering as well as in general engineering.

STUDY LOAD

Type	Hours	Percentage
Hours large group	27,0	24.00
Self study	72,0	64.00
Hours small group	13,5	12.00

Total learning time: 112.5 h

CONTENTS

T1: Mathematical Modeling of Biomedical Systems using Linear Models

Description:
Generalized system properties. Linear models of biomedical systems. Steady-state analysis. Time-domain analysis. Frequency-domain analysis. Stability analysis. Computer analysis and simulation using Matlab and Simulink.

Full-or-part-time: 10h 30m
Practical classes: 7h 30m
Laboratory classes: 3h

T2: Identification of Biomedical Control Systems

Description:
Identification methods. Identification of physiological systems. Parameter estimation.

Full-or-part-time: 10h
Practical classes: 6h 30m
Laboratory classes: 3h 30m

T3: Optimization in Biomedical System Control

Description:
Application to models of biomedical systems: Optimization in systems with negative feedback; Single-parameter optimization; Constrained optimization.

Full-or-part-time: 10h
Practical classes: 6h 30m
Laboratory classes: 3h 30m

T4: Nonlinearities in Biomedical Control Systems: Complex Dynamics

Description:
Nonlinear versus linear systems. Nonlinear oscillators. Several models of biomedical systems will be developed in Matlab and Simulink. Tools of modeling and simulation will be applied. Various strategies for its operation will be evaluated.

Full-or-part-time: 10h
Practical classes: 6h 30m
Laboratory classes: 3h 30m

GRADING SYSTEM

The evaluation will be performed through the assessment of the following parts:
Deliverables (SDL): 35%
Final exam (SFE): 25%
Final work (SFP): 40%
Final score= 0,35 SDL + 0,25 SFE + 0,40 SFP

Attendance at labs is compulsory and the presentation of the final work.

Examination of Re-Evaluation (ReE) replaces the final exam (SFE) failed. In no case replaces the note of the assessment of SDL and SFP.

Re-Evaluation (ReE): 25%. therefore,
Final mark with Re-Evaluation = 0,35 SDL + 0,25 ReE + 0,40 SFP

Students with an NP in SDL or SFP and NP in the ordinary exam, that is SFE = NP, have not option for being re-evaluated.

EXAMINATION RULES.

- In theory class, deliverables guided exercises will be developed, conducted individually or in groups of 2 students
- The lab will be assessed based on class attendance and delivery of practice reports. Practices can be individual or in groups of 2 students.
- The final work will take place individually or in groups of 2 students. Students may choose the final work with the advice and approval of the teacher. It will be presented orally with audiovisual support.

BIBLIOGRAPHY

Basic:
- Ljung, Lennart. System Identification. The theory for the user. Englewood Cliffs: Prentice Hall, 1999. ISBN 0136566952.
- Khoo, Michael C.K. Physiological control systems : analysis, simulation, and estimation [on line]. 2nd ed. Hoboken: John Wiley & Sons, 2018 [Consultation: 30/03/2023]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?docID=5349055. ISBN 9781119058786.
- Solé Vicente, Ricard ; Susanna C. Manrubia. Orden y caos en sistemas complejos. Barcelona: Edicions UPC, 2001. ISBN 8483014912.

Complementary:
- Medical & biological engineering & computing [on line]. Berlin: Springer International, [1977]- [Consultation: 20/04/2023]. Available on: https://www-springer-com.recursos.biblioteca.upc.edu/journal/11517.- IEEE transactions on biomedical engineering [on line]. New York: IEEE, 1964- [Consultation: 13/09/2022]. Available on: https://ieeexplore-ieee-org.recursos.biblioteca.upc.edu/xpl/RecentIssue.jsp?punumber=5483695.- Journal of Applied Physiology [on line]. Rockville, MD: The American Physiological Society, 1948- [Consultation: 14/09/2022]. Available on: https://journals.physiology.org/journal/jappl.- Journal Neurophysiology [on line]. Rockville, MD: American Physiological Society, 1938- [Consultation: 14/09/2022]. Available on: https://journals.physiology.org/journal/jn.- Medical engineering & physics [on line]. New York, NY: Elsevier Science, [19??-]- [Consultation: 20/04/2023]. Available on: https://www-sciencedirect-com.recursos.biblioteca.upc.edu/journal/medical-engineering-and-physics.- IEEE Engineering in medicine an biology magazine [on line]. New York: IEEE Institute of Electrical and Electronics Engineers, 1982- [Consultation: 14/09/2022]. Available on: https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=51.