# Course guide
# 820039 - MCSBB - Modelling and Control of Biomedical Systems

**Last modified:** 04/06/2026

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

**Degree:** BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Optional subject).

**Academic year:** 2026 **ECTS Credits:** 6.0 **Languages:** English

## LECTURER

**Coordinating lecturer:** MARIA MONTSERRAT VALLVERDU FERRER

**Others:** Segon quadrimestre:
MARIA MONTSERRAT VALLVERDU FERRER - Grup: T1

## PRIOR SKILLS

There are no prerequisites.

## REQUIREMENTS

There are not

## DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

**Transversal:**
1. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.

## TEACHING METHODOLOGY

The course uses participative lectures by 15%, the project-based learning by 35% and teamwork by 50%. Entire course will be held in a computer lab.

## 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 modeling biomedical systems, so that can be applied to solve problems in the field of biomedical engineering but also in general engineering.

## STUDY LOAD

| Type | Hours | Percentage |
|---|---|---|
| Hours large group | 45,0 | 30.00 |
| Hours small group | 15,0 | 10.00 |
| Self study | 90,0 | 60.00 |

**Total learning time:** 150 h

## CONTENTS

### T1: Mathematical Modeling

**Description:**
Generalized system properties. Linear models of biomedical systems. Computer analysis and simulation using MATLAB and SIMULINK.

**Related activities:**
Lectures and laboratory work in computer lab room including guided projects.

**Full-or-part-time:** 30h
Theory classes: 7h 30m
Laboratory classes: 4h 30m
Self study : 18h

### T2: Analysis of Biomedical Systems Using Linear Models

**Description:**
Steady-state analysis. Time-domain analysis. Frequency-domain analysis. Stability analysis.

**Related activities:**
Lectures and laboratory work in computer lab room including guided projects.

**Full-or-part-time:** 22h
Theory classes: 5h
Laboratory classes: 3h
Self study : 14h

### T3: Identification of Biomedical Control Systems

**Description:**
Basic problems in biomedical system analysis. Identification methods. Parameter estimation. Identification of physiological systems.

**Related activities:**
Lectures and laboratory work in computer lab room including guided projects.

**Full-or-part-time:** 26h
Theory classes: 7h 30m
Laboratory classes: 4h 30m
Self study : 14h

### T4: Optimization in Biomedical System Control

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

**Related activities:**
Lectures and laboratory work in computer lab room including guided projects.

**Full-or-part-time:** 18h
Theory classes: 2h 30m
Laboratory classes: 1h 30m
Self study : 14h

### T5: Nonlinear Analysis of Biomedical Control Systems: Complex Dynamics

**Description:**
Nonlinear versus linear systems. Nonlinear oscillators. Model of the cardiovascular variability. Model of the circadian rhythms.

**Related activities:**
Lectures and laboratory work in computer lab room including guided projects.

**Full-or-part-time:** 16h
Theory classes: 2h 30m
Laboratory classes: 1h 30m
Self study : 12h

### T6: Application of modeling techniques to biomedical systems

**Description:**
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.

**Related activities:**
Lectures and laboratory work in computer lab room including guided projects.

**Full-or-part-time:** 38h
Theory classes: 12h 30m
Laboratory classes: 7h 30m
Self study : 18h

## GRADING SYSTEM

Any academic fraud, plagiarism or use or possession of unauthorised means in an assessment activity leads to a mark of zero (0) for the affected test or assignment. Furthermore, in accordance with the University's regulations, if disciplinary proceedings are initiated the subject is recorded as "Pending Assessment" until a decision is reached. These incidents are managed in accordance with the **Action Framework for Academic Integrity in Assessment at the UPC**.

La evaluación se realizará mediante la valoración por parte del profesorado de las siguientes partes:

Entregables correspondientes a la parte de teoría (NLL): 30%
Prácticas de Laboratorio incluyendo los informes entregados de cada sesión (NLab): 30%
Trabajo final realizado en grupo (NTF): 35%
Evaluación de la competencia genérica (NCG): 5%

No habrá pruebas de exámenes parciales ni finales

Nota final= 0,3 NLL + 0,3 NLab + 0,35 NTF + 0,05 NCG

## 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. Generic competence will be evaluated.

If it is not done any of the activities of the laboratory or deliverable of continuous assessment, it will be considered as not scored.

## BIBLIOGRAPHY

**Basic:**

- Northrop, R. B. Endogenous and exogenous regulation and control of physiological systems. Boca Raton, FL [etc.]: Chapman & Hall/CRC, cop. 2000. ISBN 0849396948.
- Ljung, L. System identification : theory for the user. 2nd ed. Englewood Cliffs: Prentice-Hall, 1999. ISBN 0136566952.
- Solé Vicente, R.; Manrubia, S. C. Orden y caos en sistemas complejos. Barcelona: Edicions UPC, 2001. ISBN 8483014912.
- IEEE Transactions on Biomedical Engineering [on line]. New York, NY: Antennas and Propagation Society of the Institute of Electrical and Electronics Engineers, 1988- [Consultation: 02/06/2020]. Available on: http://ieeexplore.ieee.org/servlet/opac?punumber=10.- IEEE Pulse [on line]. New York: Institute of Electrical and Electronics Engineers, 2010- [Consultation: 02/06/2020]. Available on: http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=5454060.- Medical & biological engineering & computing [on line]. Berlin: Springer, 1963- [Consultation: 02/06/2020]. Available on: http://www.springerlink.com/content/1741-0444/?sortorder=asc&p_o=234.- European journal of applied physiology [on line]. Berlin: Springer-Verlag, [2000]- [Consultation: 02/06/2020]. Available on: http://www.springerlink.com/openurl.asp?genre=journal&issn=1439-6319.- Medical engineering & physics [on line]. New York, NY: Elsevier Science Pub. Co., [19??]- [Consultation: 02/06/2020]. Available on: http://www.sciencedirect.com/science/journal/13504533.