Course guide
230459 - BIOF1 - Biophysics 1

Last modified: 25/05/2023

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

Degree: BACHELOR'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2011). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan

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

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Ability to describe in general the structure of living things, from cellular to systemic level. Ability to analyze the constraints imposed by the physics laws to the development of biological systems, and the biological solutions to engineering problems.
2. Ability to analyze biological systems as complex systems.

Generical:
4. ABILITY TO IDENTIFY, FORMULATE, AND SOLVE PHYSICAL ENGINEERING PROBLEMS. Planning and solving physical engineering problems with initiative, making decisions and with creativity. Developing methods of analysis and problem solving in a systematic and creative way.

Transversal:
2. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.
3. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.
1. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.

TEACHING METHODOLOGY

Classes (2.6 ECTS): contents' exposition (theory and problems) with the participation of students. Practical activities and problems solving either individually or in groups.

LEARNING OBJECTIVES OF THE SUBJECT

- Students will be able to understand the basic concepts about biological systems behaviour.
- Students will be able to use basic principles of physics in solving problems in biophysics.

STUDY LOAD

Type	Hours	Percentage
Hours large group	65,0	43.33
Self study	85,0	56.67

Total learning time: 150 h

CONTENTS

1. Introduction

Description:
1.1 Presentation of the course.

Related activities:
Activity 1: Theory classes.

Full-or-part-time: 1h
Theory classes: 1h

2. Biomechanics

Description:
2.1 Scaling laws.
2.2 Stresses and work.
2.3 Biological materials.

Related activities:
Activity 1: Theory classes.
Activity 3: Guided problems sessions.

Full-or-part-time: 14h
Theory classes: 4h
Practical classes: 2h
Self study : 8h

3. Fluid mechanics and biological systems

Description:
3.1 Introduction. Biological basis, example: respiration.
3.2 Hydrostatics. From physical basis to surface energy in alveoli.
3.3 Fluid dynamics. Fundamentals, blood circulation, respiration, xylem.

Related activities:
Activity 1: Theory classes.
Activity 3: Guided problems sessions.

Full-or-part-time: 23h
Theory classes: 7h
Practical classes: 4h
Self study : 12h

4. Thermodynamics of living systems (I)

Description:
4.1 Introduction. Biological basis, examples: enzime kinetics, microbial growth.
4.2 Temperature and living systems. Life and temperature ranges, temperature and metabolic activity, temperature control in living systems.
4.3 First law. Conservation principles, energetic balance of living systems, calorimetry.
4.4 Second law. Second law and living systems, energetic yield, entropy, MAXENT.

Related activities:
Activity 1: Theory classes.
Activity 3: Guided problems sessions.

Full-or-part-time: 19h
Theory classes: 6h
Practical classes: 3h
Self study : 10h

5. Thermodynamics of living systems (II). Thermodynamics of irreversible processes

Description:
5.1 Introduction. Biological basis, example: the cell.
5.2 Basis.
5.3 Transport phenomena. Diffusion. Osmotic flow (alveoli, blood capillaries, transport in plants,...).
5.4 Cell membrane.
5.5 Action potential.

Related activities:
Activity 1: Theory classes.
Activity 3: Guided problems sessions.
Activity 4: Seminars.

Full-or-part-time: 22h
Theory classes: 6h
Practical classes: 5h
Self study : 11h

6. Wave phenomena and living systems

Description:
6.1 Waves. Introduction. Biological basis, example: solar radiation and photosyntesis.
6.2 Basis.
6.3 Sound.
6.4 Electromagnetic waves. Wave-matter interaction. Eyes.
6.5 Electromagnetic waves. Energy.

Related activities:
Activity 1: Theory classes.
Activity 3: Guided problems sessions.
Activity 4: Seminars.

Full-or-part-time: 18h
Theory classes: 5h
Practical classes: 3h
Self study : 10h

7. Biological effects of ionizing radiation

Description:
7.1 Introduction. Biological basis, example: genetic material and cancer.
7.2 Nuclear reactions, radiation alpha, beta and gamma. Doses. Measures. Biological effects.

Related activities:
Activity 1: Theory classes.
Activity 3: Guided problems sessions.

Full-or-part-time: 13h
Theory classes: 3h
Practical classes: 2h
Self study : 8h

8. Physics and mathematics of ecosystems

Description:
8.1 The concept of ecosystem. Physical and mathematical basis of ecology.
8.2 Mathematical models and ecosystems.

Related activities:
Activity 1: Theory classes.
Activity 3: Guided problems sessions.
Activity 4: Seminars.

Full-or-part-time: 20h
Theory classes: 5h
Practical classes: 5h
Self study : 10h

9. Modelling and simulation of biological systems

Description:
9.1 Methodology for modelling in biology.
9.2 Methods for simulation of biological systems.

Related activities:
Activity 1: Theory classes.
Activity 3: Guided problems sessions.
Activity 5: Guided activity on modelling and simulation of biological systems.

Full-or-part-time: 20h
Theory classes: 2h
Practical classes: 2h
Guided activities: 10h
Self study : 6h

ACTIVITIES

ACTIVITY 1: THEORY CLASSES

Description:
Contents' exposition with the participation of students.

Specific objectives:
Students will be able to understand the basic concepts about biological systems behaviour.

Related competencies :
BIOC2. Ability to analyze biological systems as complex systems.
BIOC1. Ability to describe in general the structure of living things, from cellular to systemic level. Ability to analyze the constraints imposed by the physics laws to the development of biological systems, and the biological solutions to engineering problems.
02 SCS N2. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.

Full-or-part-time: 39h
Theory classes: 39h

ACTIVITY 2: INDIVIDUAL EVALUATION TESTS

Description:
Students will solve theoretical questions and problems individually. There will be two tests along the course: a mid-semester partial exam and an end-semester global exam.

Specific objectives:
Assessment of the students' achievment of learning objectives.

Related competencies :
BIOC2. Ability to analyze biological systems as complex systems.
BIOC1. Ability to describe in general the structure of living things, from cellular to systemic level. Ability to analyze the constraints imposed by the physics laws to the development of biological systems, and the biological solutions to engineering problems.
02 SCS N2. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.

ACTIVITY 3: GUIDED PROBLEMS SESSIONS

Description:
The lecturer will solve some problems as examples and will propose different problems to students to be solved either individually or in groups.

Specific objectives:
Students will be able to use basic principles of physics in solving problems in biophysics.

Related competencies :
BIOC2. Ability to analyze biological systems as complex systems.
BIOC1. Ability to describe in general the structure of living things, from cellular to systemic level. Ability to analyze the constraints imposed by the physics laws to the development of biological systems, and the biological solutions to engineering problems.
02 SCS N2. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.
05 TEQ N1. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.

Full-or-part-time: 23h
Practical classes: 23h

ACTIVITY 4: SEMINARS

Description:
Lectures on research and technological applications of topics related to the subject that will be given by experts.

Specific objectives:
Students will be able to understand the basic concepts about biological systems behaviour.
Students will be able to use basic principles of physics in solving problems in biophysics.

Related competencies :
BIOC1. Ability to describe in general the structure of living things, from cellular to systemic level. Ability to analyze the constraints imposed by the physics laws to the development of biological systems, and the biological solutions to engineering problems.
BIOC2. Ability to analyze biological systems as complex systems.
02 SCS N2. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.

Full-or-part-time: 3h
Practical classes: 3h

ACTIVITY 5: GUIDED ACTIVITY ON MODELLING AND SIMULATION OF BIOLOGICAL SYSTEMS

Description:
Guided activity that involves either the use of an existing program or the building of a simulator in order to study the behaviour of a specific biological system.

Specific objectives:
Students will be able to understand the basic concepts about biological systems behaviour.
Students will be able to use basic principles of physics in solving problems in biophysics.

Material:
Guide for the execution of the activity.

Delivery:
Students will hand in a report according to the established format and deadlines. This report will be assessed by the lecturer.

Related competencies :
BIOC2. Ability to analyze biological systems as complex systems.
BIOC1. Ability to describe in general the structure of living things, from cellular to systemic level. Ability to analyze the constraints imposed by the physics laws to the development of biological systems, and the biological solutions to engineering problems.
02 SCS N2. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.
05 TEQ N1. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.

Full-or-part-time: 10h
Guided activities: 10h

GRADING SYSTEM

The evaluation consists of a final exam (EF) and an evaluation during the course that considers both a mid-semester partial exam (EP) and the practical activities (P). The final grade is be given by:
Max{EF, 0.60 x EF + 0.30 x EP + 0.10 x P}

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Complementary:
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