230459 - BIOF1 - Biophysics 1

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit: 748 - FIS - Department of Physics
Academic year: 2019
Degree: BACHELOR'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2011). (Teaching unit Compulsory)
ECTS credits: 6  Teaching languages: Catalan

Teaching staff
Coordinator: DANIEL LÓPEZ CODINA
Others:
   Alonso Muñoz, Sergio

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.

General:
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

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>65h</th>
<th>43.33%</th>
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<tbody>
<tr>
<td>Self study:</td>
<td>85h</td>
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<td>56.67%</td>
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</table>

Total learning time: 150h

Hours large group:
- 65h: 43.33%
- 85h: 56.67%
## Content

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Related activities</th>
<th>Learning time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Introduction</strong></td>
<td><strong>Description:</strong> 1.1 Presentation of the course.</td>
<td>Activity 1: Theory classes.</td>
<td><strong>1h</strong> Theory classes: 1h</td>
</tr>
<tr>
<td><strong>2. Biomechanics</strong></td>
<td><strong>Description:</strong> 2.1 Scaling laws. 2.2 Stresses and work. 2.3 Biological materials.</td>
<td>Activity 1: Theory classes. Activity 3: Guided problems sessions.</td>
<td><strong>14h</strong> Theory classes: 4h Practical classes: 2h Self study: 8h</td>
</tr>
<tr>
<td><strong>3. Fluid mechanics and biological systems</strong></td>
<td><strong>Description:</strong> 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.</td>
<td>Activity 1: Theory classes. Activity 3: Guided problems sessions.</td>
<td><strong>23h</strong> Theory classes: 7h Practical classes: 4h Self study: 12h</td>
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</tbody>
</table>
4. Thermodynamics of living systems (I)  

**Learning time:** 19h  
Theory classes: 6h  
Practical classes: 3h  
Self study: 10h

**Description:**  
4.1 Introduction. Biological basis, examples: enzyme 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.

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

**Learning time:** 22h  
Theory classes: 6h  
Practical classes: 5h  
Self study: 11h

**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.
## 6. Wave phenomena and living systems

**Learning time:** 18h  
- Theory classes: 5h  
- Practical classes: 3h  
- Self study: 10h

**Description:**  
6.2 Basis.  
6.3 Sound.  
6.5 Electromagnetic waves. Energy.  

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

## 7. Biological effects of ionizing radiation

**Learning time:** 13h  
- Theory classes: 3h  
- Practical classes: 2h  
- Self study: 8h

**Description:**  
7.1 Introduction. Biological basis, example: genetic material and cancer.  

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

## 8. Physics and mathematics of ecosystems

**Learning time:** 20h  
- Theory classes: 5h  
- Practical classes: 5h  
- Self study: 10h

**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.
### 9. Modelling and simulation of biological systems

<table>
<thead>
<tr>
<th>Learning time: 20h</th>
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<tbody>
<tr>
<td>Theory classes: 2h</td>
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<tr>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td>Guided activities: 10h</td>
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<tr>
<td>Self study: 6h</td>
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**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.
## Planning of activities

| ACTIVITY 1: THEORY CLASSES | Hours: 39h  
Theory classes: 39h |
<table>
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<tr>
<td><strong>Description:</strong></td>
<td>Contents' exposition with the participation of students.</td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>Students will be able to understand the basic concepts about biological systems behaviour.</td>
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| ACTIVITY 2: INDIVIDUAL EVALUATION TESTS | Hours: 23h  
Practical classes: 23h |
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>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.</td>
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<tr>
<td><strong>Specific objectives:</strong></td>
<td>Assessment of the students' achievement of learning objectives.</td>
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| ACTIVITY 3: GUIDED PROBLEMS SESSIONS | Hours: 3h  
Practical classes: 3h |
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<tr>
<td><strong>Description:</strong></td>
<td>The lecturer will solve some problems as examples and will propose different problems to students to be solved either individually or in groups.</td>
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<tr>
<td><strong>Specific objectives:</strong></td>
<td>Students will be able to use basic principles of physics in solving problems in biophysics.</td>
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| ACTIVITY 4: SEMINARS | Hours: 3h  
Practical classes: 3h |
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<tr>
<td><strong>Description:</strong></td>
<td>Lectures on research and technological applications of topics related to the subject that will be given by experts.</td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>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.</td>
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</table>

| ACTIVITY 5: GUIDED ACTIVITY ON MODELLING AND SIMULATION OF BIOLOGICAL SYSTEMS | Hours: 10h  
Guided activities: 10h |
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<tr>
<td><strong>Description:</strong></td>
<td>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.</td>
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</table>
Support materials:
Guide for the execution of the activity.

Descriptions of the assignments due and their relation to the assessment:
Students will hand in a report according to the established format and deadlines. This report will be assessed by the lecturer.

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.

Qualification 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 given by:
Max{EF, 0.60 x EF + 0.30 x EP + 0.10 x P}
Bibliography

Basic:


Villar, R.; López, C.; Cusso, F. Fundamentos físicos de los procesos biológicos. San Vicente [del Raspeig], Alicante: Club Universitario, 2012. ISBN 9788499485096 (V. 1); 9788415787815 (V. 2); 9788415787815 (V. 3).

Complementary:


