Degree competences to which the subject contributes

Specific:
1. Knowledge and understanding of the interaction between radiation and matter in photonic systems. Knowledge of photonic devices and ability for using them. Knowledge of applications in nanotechnology, materials science, communications and biophysics.

General:
2. 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:
1. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
2. TEAMWORK - Level 3. Managing and making work groups effective. Resolving possible conflicts, valuing working with others, assessing the effectiveness of a team and presenting the final results.
3. EFFECTIVE USE OF INFORMATION RESOURCES - Level 3. Planning and using the information necessary for an academic assignment (a final thesis, for example) based on a critical appraisal of the information resources used.
4. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

Teaching methodology

There will be three theoretical and two practical weekly sessions. The theoretical lectures will be devoted to a careful presentation of the basic concepts and the main results which will be illustrated with some examples. The practical sessions will be devoted to the solution of a variety of exercises and problems.

Learning objectives of the subject

After attending the course the student will be able to:
- Know the main properties of light and the basic concepts involved in its characterization
- Identify different aspects concerning the emission of radiation and light-matter interaction
- Apply Maxwell's equations for the resolution of light propagation problems, in particular those related with interference,
### 230478 - FOT - Photonics

**diffraction and dispersion**
- Describe the light propagation in anisotropic and structured media
- Identify different aspects of radiation detection
- Apply the studied concepts to the field of photonics
- Identify and describe the most relevant applications in the field of photonics

### Study load

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

<table>
<thead>
<tr>
<th>Part I: FUNDAMENTALS OF PHOTONICS</th>
<th>Learning time: 132h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 34h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 24h</td>
</tr>
<tr>
<td></td>
<td>Self study: 74h</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>I1 Fundamental properties of light (classical approach)</th>
<th>Learning time: 10h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 3h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 5h</td>
</tr>
</tbody>
</table>

Description:
I1.1 Historical introduction
I1.2 Basic magnitudes and properties from a classical point of view

<table>
<thead>
<tr>
<th>I2 Basic models and equations</th>
<th>Learning time: 18h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 4h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 4h</td>
</tr>
<tr>
<td></td>
<td>Self study: 10h</td>
</tr>
</tbody>
</table>

Description:
Basic models for monochromatic beams

<table>
<thead>
<tr>
<th>I3 Generation and emission</th>
<th>Learning time: 22h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 4h</td>
</tr>
<tr>
<td></td>
<td>Self study: 12h</td>
</tr>
</tbody>
</table>

Description:
I3.1 Radiation by a dipole and a set of dipoles
I3.2 Light-matter interaction models
I3.3 Light sources
## 14 Introduction to quantum aspects of light

**Learning time:** 31h  
Theory classes: 10h  
Practical classes: 5h  
Self study: 16h

**Description:**  
14.1 Light-Matter interaction from a quantum approach (comparison with classical model):  
- Einstein model  
- Semiclassical theory  
14.2 Introduction to the quantum theory of light. Photons. Properties  
14.3 Applications:  
- Momentum of light  
- Lasers

## 15 Propagation

**Learning time:** 49h  
Theory classes: 12h  
Practical classes: 7h  
Self study: 30h

**Description:**  
15.1 Crystal optics  
15.2 Short pulse propagation. Dispersion  
15.3 Propagation in free space. Interferences and diffraction

## 16 Detection

**Learning time:** 10h  
Theory classes: 3h  
Practical classes: 2h  
Self study: 5h

**Description:**  
16.1 Temporal characterization of radiation  
16.2 Spatial characterization of radiation  
16.3 Spectral characterization of radiation
PART II: APPLICATIONS OF PHOTONICS

<table>
<thead>
<tr>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>II1 Microscopy and image processing</td>
</tr>
<tr>
<td>II2 Optical communications</td>
</tr>
<tr>
<td>II3 Nanophotonics</td>
</tr>
<tr>
<td>II4 Metrology and material treatment</td>
</tr>
<tr>
<td>II5 Nonlinear optics</td>
</tr>
<tr>
<td>II6 Quantum optics</td>
</tr>
</tbody>
</table>

Learning time: 10h
- Theory classes: 1h
- Guided activities: 3h
- Self study: 6h

Qualification system
The evaluation is obtained from the mark of a first partial exam (EP) at the middle of the semester, a second partial exam at the end of the semester (EP2) and the realization of a proposed task (T)
The final score will follow from: \[ NOTA = (0.4\times EP + 0.5\times EP2 + 0.10\times T) \]

There is a second evaluation option including an exam of the whole content of the course (EF) and the realization of a proposed task (T)
The final score will follow from: \[ NOTA = (0.90\times EF + 0.10\times T) \]

Regulations for carrying out activities
The students doing the final exam will loose the mark of the first partial

Bibliography

Basic:

Complementary: