



- 1. Code:** 35682      **Name:** Sensing, quantum and computing applications
- 2. Credits:** 6,00      **–Lecture:** 3,00      **–Practice:** 3,00      **Type of Course:** Elective
- Degree:** 2314-Master's Degree in Telecommunication Engineering
- Module:** 3-Elective Module      **Subject:** 5-Elective training
- University Center:** SCHOOL OF TELECOMMUNICATIONS ENGINEERING
- 3. Coordinator:** García Rupérez, Jaime
- Departament:** COMMUNICATIONS

#### 4. References

Planar Waveguide Optical Sensors : From Theory to Applications  
Infrared Spectroscopy [electronic resource] : Fundamentals and Applications  
Biomedical optical imaging

Quantum mechanics for scientists and engineers.  
Silicon Photonics III : Systems and Applications

Silicon photonics IV : innovative frontiers

Dutta, Aradhana.  
Stuart, Barbara H.  
Fujimoto, James G., editor. | Fujimoto, James G., |  
Farkas, Daniel L., editor. | Farkas, Daniel L.,  
Miller, David A.B.  
Pavesi, Lorenzo. editor. | Pavesi, Lorenzo. |  
Lockwood, David J. editor. | Lockwood, David J.  
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Lockwood, David J., editor. | Lockwood, David J.,

#### 5. Course Outline

##### Course objectives

The main objective of the subject is to provide an understanding of how optical and photonic technology is applied across various application fields, even beyond the traditional telecommunications sector. We will study different existing applications where optical/photonic technology is already in use, as well as others that are expected to reach the market in the near/medium future. As a result, the course aims at providing the students with knowledge and skills in various high-potential optical and photonic technology applications, thereby preparing them for adoption and utilization in both industrial and research sectors.

The subject will focus on three primary application areas:

- i) Quantum: An introduction to the key principles of quantum mechanics will be provided to understand the potential of quantum systems for implementing new components and systems across the Telecom industry. Applications of quantum technology for Telecom will be reviewed. This review will target a Telecom engineering background and will describe what this revolutionary technology can provide but also what cannot be done.
- ii) Sensing: We will explore different technological approaches for the implementation of imaging and (bio)sensing systems (e.g., LiDAR, spectroscopy, Lab-on-a-Chip, etc.) with application in sectors such as automotive, healthcare or industrial quality control, among others.
- iii) Computing: We will examine how optics and photonics can address some of the limitations of current electronic-based systems, showing examples such as electronic-photonic integration or the development of photonic hardware for Artificial Intelligence.

##### Contextualization of the course

Optical and photonic technologies are increasingly being adopted by a wide range of markets and sectors. Beyond telecommunications, where fiber-based optical networks are one of the cornerstones of the current 'digital society', numerous other fields can tremendously benefit from optics and photonics. These include healthcare, automotive, cybersecurity, defense and agrifood, among others. Projections from various market analyses forecast an annual growth rate for the photonics sector ranging between 6-8%, potentially surpassing a global market size exceeding 2 trillion USD. The potential adoption of the technologies considered in the subject in novel application areas is expected to contribute to this growth significantly.

#### 6. Recommended Prior Knowledge

- (35476) Photonic integrated circuits
- (35680) Photonic integration manufacturing and test
- (35681) Advanced fiber optics

Previous and simultaneous knowledges are recommendable but not mandatory.

#### 7. Results

##### Fundamental results

BA2(GE) Students should know how to apply acquired knowledge and have the ability to resolve problems in new or unknown environments within wider (or multidisciplinary) contexts related to their field of study;

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## 7. Results

### UPV-Generic Student Outcomes

#### (5) Responsibility and decision-making

- Activities carried out to achieve the student outcome

To assess this ability, students will carry out several activities in which they will address different aspects of the subject, using both concepts and methodologies introduced in class as well as employing self-directed learning strategies to determine and utilize additional resources as necessary.

- Assessment criteria

Students will present the results of these activities.

#### Specific Learning Outcomes

RA5.3 - Acquire and apply new knowledge as needed, using appropriate learning and time management strategies.

## 8. Syllabus

1. Introduction
2. Quantum applications
  1. Introduction
  2. Fundamentals of Quantum Mechanics
  3. Entanglement
  4. Quantum information
  5. Hardware for Quantum Optics
  6. Applications
3. Sensing applications
  1. (Bio)sensing devices
  2. Imaging systems
4. Computing applications
  1. Electronic-photonics integration
  2. Photonics for Artificial Intelligence
  3. Reconfigurable photonics

## 9. Teaching and Learning Methodologies

<u>UN</u>	<u>LE</u>	<u>SE</u>	<u>PS</u>	<u>LS</u>	<u>FW</u>	<u>CP</u>	<u>AA</u>	<u>CH</u>	<u>NCH</u>	<u>TOTAL HOURS</u>
1	2,00	--	2,00	--	--	--	--	4,00	6,00	10,00
2	8,00	--	4,00	2,00	--	--	--	14,00	20,00	34,00
3	12,00	--	8,00	6,00	--	--	--	26,00	36,00	62,00
4	8,00	--	4,00	4,00	--	--	--	16,00	28,00	44,00
<b>TOTAL HOURS</b>	<b>30,00</b>	<b>--</b>	<b>18,00</b>	<b>12,00</b>	<b>--</b>	<b>--</b>	<b>--</b>	<b>60,00</b>	<b>90,00</b>	<b>150,00</b>

UN: Unit. LE: Lecture. SE: Seminar. PS: Practical session. LS: Lab sessions. FW: Field work. CP: Computer-mediated practice. AA: Assessment activities. CH: Contact hours. NCH: Non contact hours.

## 10. Assessment

### Outline

(15) Practical laboratory/field/computing/classroom test

(05) Academic work

### Num. Acts Weight (%)

4 25

4 75

The course evaluation will consist of various components assessed throughout the semester. On one hand, the progress will be assessed through the realization of different monitoring activities after each unit and practical sessions (25%). On the other hand, several academic activities (75%) will be conducted throughout the course; this includes a presentation on a chosen topic and various short in-class discussions.

Students with attendance waivers ("dispensa de asistencia") may complete online test exams for the theoretical sessions and a recorded presentation on a chosen topic (to replace the in-class assessments). For the remaining evaluation components (exams for practical sessions and short discussions), these students will complete an oral exam that will cover selected topics from the course content.

Students who have passed the course but wish to improve their grade on any component or take a final exam will have the opportunity to do so. The mark obtained on the retake/exam will replace the previous one, regardless of whether it is higher or lower.

## 11. Absence threshold

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11. Absence threshold

<u>Activity</u>	<u>Percentage</u>	<u>Observations</u>
Lecture Theory	100	
Seminar Theory	0	
Lecture Practice	100	
Laboratory Practical	100	
Field Practice	0	

