Nanoelectronics and Nanophotonics

Academic Year: (2022 / 2023) **Review date: 20-05-2022**

Department assigned to the subject: Department of Electronic Technology

Coordinating teacher: GARCIA CAMARA, BRAULIO

Type: Compulsory ECTS Credits : 6.0

Year : 4 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

It is recommended to have attended and passed the subjects of Advanced Quantum Physics, Electromagnetic Fields and Waves, Fundamentals of Electronic and Photonic Engineering

OBJECTIVES

The objective of this subject is that the student acquires the basic knowledge in the latest advances and the evolution of Nanotechnology with special emphasis on the fields of electronics and photonics. To achieve this goal, it is intended that the student acquires the following knowledge:

1.- A knowledge of the physical principles and basic operation of the main electronic nanodevices
2.- A knowledge of the physical principles of light control at the nanoscale and the operation of some of the current photonic nanodevices.
3.- To understand the main techniques of manufacturing devices in the micro and nano-scale.
4.- To understand the applications in the fields of Nanoelectronics and Nanophotonics.
5.- An ability to analyze the latest advances and challenges in these fields of knowledge.

As for the skills, in this subject the following will be developed:

- Ability to apply and disseminate the knowledge acquired in electronic and photonic nanodevices, as well as the scientific methodology associated with each of the fields.
- Ability to solve problems associated with each thematic block of the subject.
- Ability to consult and analyze the state of the art and technology in nanotechnology.

DESCRIPTION OF CONTENTS: PROGRAMME

CONTENTS OF THE SUBJECT

1.- Review of some fundamental concepts.

1.1 Electron and photon as quantum particles: similarities and differences.
1.2 Uncertainty principle: practical implications
1.3 Top-down and bottom-up approaches to nanoelectronics and nanophotonics.

2.- Nanoelectronics.

2.1 Free electrons, confined electrons and electrons in periodic potential fields. Tunnel Junctions and applications.
2.2 Coulomb Blockade and the single-electron transistor.
2.3 Semiconductor quantum wells, quantum wires and quantum dots.
2.4 Nanowires, ballistic transport and Spin transport.
2.5 Examples of nanolectronic devices and applications

3.- Nanophotonics

3.1 Far-field, near-field, diffraction limit and evanescence waves.
3.2 Mie Theory.
3.3 Plasmonics and dielectric resonant nanoparticles.
3.4 Photonic crystals and nanostructured optical fibers.
3.5 Quantum dots and nanoparticles. Single photon emission.
3.6 Metamaterials: engineering the optical properties of materials.
3.7 Examples of nanophotonic devices and applications

LEARNING ACTIVITIES AND METHODOLOGY

The teaching methodology will include:
- 40% Lectures (2.4 ECTS), where students will be presented with the basic knowledge they must acquire. Class notes will be provided to students and they will have basic reference texts that allow them to complete and delve into the different topics of the subject.
- 40% Practical classes (2.4 ECTS) aimed at solving exercises, case studies and continuous assessment.
- 20% Practices (1.2 ECTS credits), aimed at carrying out and analyzing practical cases through the use of simulation tools and/or experimentally.
- Tutorials Individualized assistance (individual tutorials) or in group (collective tutorials) to the students by the teaching staff

ASSESSMENT SYSTEM

The assessment is based on the following criteria:
a) LABORATORY PRACTICES: They are compulsory. In these practices the knowledge acquired by the student will be assessed with the development of some practical cases and numerical simulations, previously studied in the theory and problems lectures. (40% of the final score).
b) FINAL EXAM (mandatory). The knowledge acquired by the students in each thematic block of the subject will be evaluated. This exam has a weight of 40% in the final score if the student follows the continuous assessment.
Extraordinary Call
Assessment can be fitted to continuous assessment process (with the same percentages as in ordinary exam) or with a final exam with the 100% of qualification

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

BASIC BIBLIOGRAPHY

- George W. Hansons Fundamentals of Nanoelectronics, Pearson , 2004
- L. Novotny and B. Hetch Principles of Nano-optics, Cambridge University Press, 2012
- P.N. Prasad Nanophotonics, Wiley Interscience, 2004
- Rainer Waser Nanoelectronics and Information Technology, Wiley-VCH, 2013

ADDITIONAL BIBLIOGRAPHY

- C. Bohren, D.R. Huffman Absorption and scattering of light by small particles, John Wiley and sons, 1983
- M. Ohtsu, H. Hori Near-field nano-optics, Klumer Academics / Plenum Publishers, , 1999