Programme of “Nanofotonica”
“Nanophotonics”

- Code: I0271 and I0419
- type of course unit: compulsory for the Master degree in Electronic Engineering
- level of course unit (e.g. first, second or third cycle; sub-level if applicable): master degree - second cycle
- year of study (if applicable), semester: first year, first semester

Number of ECTS credits: 9 (workload of 90 hours of teaching + work at home; 1 credit = 25 hours of total activities)

Teacher: Prof. Elia Palange

1	**Course objectives**	The course has the aim to introduce the students to the concepts of modern optics starting by studying the principles of classical optics based on the use of the Maxwell equations for the description of the fundamental optical phenomena: reflection, refraction, interference, diffraction and polarisation status an electromagnetic wave. These notions are the basis to study the optoelectronic effects, the laser physics and those electromagnetic phenomena related to the excitation and use of surface plasmon-polaritons in metal films and in nanometer sized metal/dielectric complex structures. All this introduces to the understanding of the more advanced topics employed for the design and fabrication of novel nanophotonic devices based on quantum effects that find now applications in a wide range of research fields spanning from chemistry to medicine and biotecnology.
2	**Course content and Learning outcomes (Dublin descriptors)**	The Course discusses the following main topics: Maxwell equations in free space; laws of light reflection and refraction; polarisation status of the light; birefringent crystals and their use in changing the light polarisation status; the Jones matrix method; wave retarder plates; the electro-optic effect: light amplitude and phase modulators; light interference: Michelson and Fabry Perot interferometers; laser sources; three and four level laser systems; laser rate equations; continuous wave operation of a laser; semiconductor lasers; introduction to quantum mechanics; quantum well, quantum wire and quantum dot structures; interaction of light with metals and with composites of metal and dielectric nanoparticles; plasmonic phenomena in metal nanoantennas and their use for the design of ultra-sensitive sensors for spectroscopic detection and characterisation of chemical and biological compounds. The students design, prepare and employ experimental configurations to verify some fundamental optical phenomena. Moreover, the students are introduced to the use of COMSOL Multiphysics for the simulation of the response of simple photonic devices. On successful completion of this module, the student should - acquire profound knowledge of the fundamental and advanced optical phenomena; - have the knowledge of the fundamental quantum mechanic structures used to design and fabricate photonic devices; - have the knowledge of the novel composite materials: metamaterials and metasurfaces; - demonstrate the ability to read and understand other texts and scientific papers on related topics.
3	**Prerequisites and learning activities**	Prerequisites: fundamental physics; mathematics; solid state devices; the students must acquire abilities in solving optical problems by designing photonic structures that can be used for different applications in fundamental research and in industry.
4	**Teaching methods and language**	Lectures and exercises. Language: Italian / English Didactic materials, problems and exercises are published by the teacher in the website e-learning@AQ (http://www.didattica.univaq.it/moodle/)
5	**Assessment methods and criteria**	Written and oral examination. A final report on the laboratory activities is requested at the end of the course.