



# Master's degree in Photonics

[www.photonicsbcn.eu](http://www.photonicsbcn.eu)

<http://www.youtube.com/watch?v=Tdf15vFGcWE>

## Introduction

The Master's degree in Photonics caters for the needs of different types of students: from those looking to pursue a doctoral degree to those aiming at a professional career.

Thanks to the participation of high-level professors and researchers from universities UPC, UAB and UB and research institute ICFO in Barcelona, this master's degree provides graduates with a broad and flexible profile which can include skills and expertise in different fields: Quantum and Nonlinear Optics, Photonic materials and Nanophotonics, Biophotonics, Imaging, Optical Telecommunications & Photonic systems, and Photonics Engineering.

After a few compulsory subjects providing a basic background in Photonics, students can choose from a variety of elective subjects to define their personal curriculum.

It is intended that Master graduates can pursue a doctoral degree in any of these fields, or join a modern industry company as photonics-expert professionals able to work in multidisciplinary teams. Entrepreneurial skills and employability are promoted through a specific course and through the possibility to do the Master Thesis work in collaboration with a company or a research centre.

The Master in Photonics also has a strong international character. It is taught entirely in English as it is expected that there will be a significant number of students from other countries. There is also a strong collaboration with the European Erasmus Mundus Master *Europhotonics* offered jointly with France & Germany.

## Keywords

Photonics, optics, quantum and nonlinear optics, nanophotonics, biophotonics, optical telecommunications, photonics engineering, optical engineering, imaging, metamaterials.

## Language requirements

Courses are taught in English.

No certificate will be strictly required but students should provide convincing proofs (having English as mother tongue, to have studied in an English-speaking institution, to hold an English language qualification equivalent to Level B2 -Common European Framework, to have studied English at secondary or high school or at university, etc.) that they can follow Master courses.

A modest knowledge of Spanish may be helpful for daily life. Spanish courses are available at Merit School, which is on campus.

## Admission requirements

Admission requirements include an official Spanish university degree or in general a university bachelor's degree that entitles the holder to seek admission to a master's degree in the country in which it was awarded (in one of the academic subjects covered by the master's degree).

Applicants with a degree awarded by a university in a country that is not part of the European Higher Education Area do not need to obtain official recognition for the degree. However, the University must verify that the course of study corresponds to a level of education equivalent to an official Spanish university degree and that the qualification obtained provides admission to a master's degree in the country in which it was awarded. The university centre teaching the master's degree may request any documentation deemed necessary for the purposes of verification. Admission following this process under no circumstances implies the official recognition of the degree or its acceptance for any other purpose other than admission to the master's degree.

## Admission profiles

Holders of:

- Bachelor degree in Physics, or in Engineering Physics.
- Bachelor degree in Electronics and/or Electrical Engineering.
- Bachelor degree in Telecommunications Engineering.
- Bachelor degree in Industrial Engineering (Mechanics, Automatics etc.).
- Bachelor degree in Aeronautics Engineering.
- Bachelor degree in Optics and Optometry.
- Bachelor degree in Engineering of Audio-visual Systems, or Telematics Engineering.
- Other scientific or technical bachelor degrees (Chemistry, Materials, Biology, etc.), with some training complements required.

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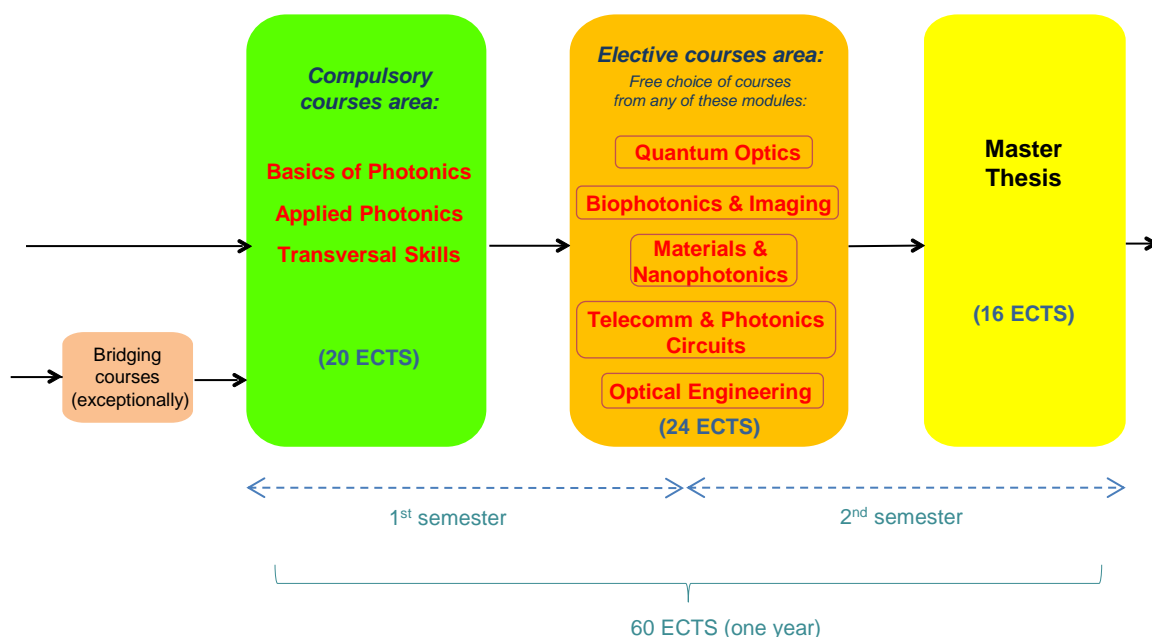
## Programme

This is a full-time, one-year program (60 ECTS credits) which covers two semesters ([www.photonicsbcn.eu](http://www.photonicsbcn.eu)). The courses (subjects) are grouped into three areas:

- The first area (20 ECTS credits) is composed of compulsory courses that provide basic knowledge in Photonics as well as complementary skills:
  - Module of Fundamentals of Photonics (10 ECTS credits), with 2 courses, and
  - Module of Applied Photonics and Transversal skills (10 ECTS credits), including Lab experiments and a course on entrepreneurial (business and patents in photonics) and communication skills.
- The second area (24 ECTS credits) is composed of 8 elective courses which can be chosen among a long list of courses grouped into the following five modules of 4 courses each (students, with the advise from a tutor, may choose any course from any module):
  - *Quantum Optics*, with courses about light-matter interaction, Bose-Einstein condensation and ultracold quantum gases, quantum information (communication and computation), and photon-level experiments.
  - *Biophotonics and Imaging*, with courses about high-resolution optical imaging, image processing in biology and medicine, optical tweezers and micro-manipulation, visual biophotonics and multispectral imaging.

- *Materials and Nanophotonics*, with courses about photonic materials and metamaterials, nonlinear optics, nanophotonics and ultra-short and ultra-intense laser pulses.
- *Telecommunications and photonic circuits*, with courses about optical fibers and photonic systems in telecommunications, integrated photonics, optoelectronics and photovoltaics.
- *Optical engineering*, with courses about laser systems and applications, building optomechanical systems, managing light with devices, and measuring with light (high-resolution metrology).

- Finally, the third area (16 ECTS credits) comprises the Master Thesis, which can be performed at any university or research institute in Barcelona (in particular at UPC, UAB, UB, ICFO, CD6,...) or even at any other center and country, if admitted, or in a company.
- As pointed out above, students with a bachelor degree with low contents in Physics (in particular in Electromagnetism and Optics) or Mathematics might be asked to enrol for one or a few bachelor courses ("bridging courses"), to strengthen their background.





Laser setups (UPC)

## Course objectives

- To provide students with the theoretical background and the applied knowledge that they need to design, analyse or understand photonic experiments, devices or systems, in the fields that they choose within the wide scope of elective master courses.
- To provide a gateway to doctoral studies in theoretical or experimental photonics, and in particular to the PhD programs with Mention of Excellence of the Departments of UPC, UAB and UB universities or of ICFO research institute collaborating with the Master in Photonics.
- To provide students with sufficient knowledge to work in companies where photonic technologies are used.

## Academic calendar

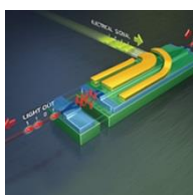
Students typically start the master's degree in September. Lecture period ends at the beginning of April of subsequent year, and the Master Thesis can be presented in July or September of that year.

The master's degree can be taken on a full- or part-time basis. Lectures are mostly given in the afternoons.

## Competences acquired

The Master's degree in Photonics will ensure students acquire the following abilities:

- Understanding of the physical principles of optics and light-matter interaction, at classical and quantum levels.
- Capacity to perform basic experiments in photonics and to analyze and understand advanced experiments or calculations in the fields chosen by the student.
- Understanding of laser physics and knowledge of the variety of laser types and main related applications.
- Knowledge of image formation fundamentals, light propagation through different class of media, and Fourier optics.
- For the photonics field(s) chosen by the student through elective courses (quantum optics, biophotonics and imaging, nanophotonics, telecomm, optical engineering, etc.), knowledge of the main concepts, underlying phenomena and most recent applications.
- Ability to deal with a problem of advanced research in photonics from start to finish; i.e., from conceptual planning and bibliographic search to oral and written communication of the results, according to the procedures and conventions of scientific presentations in English.
- Ability to understand optical engineering as an economic and business activity considering, among others, social, ethical and sustainability aspects.
- Awareness of the importance of patents, and ability to understand and write a patent in the field of photonics.



Electro-optical microswitch (ICFO)

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## Career



The sectors in which students can develop their profession are becoming very broad, given the interdisciplinary character and increasing relevance of photonics (photonics has been selected by the European Union as one of the five KET -“Key-Enabling Technologies”- for the future of the Union.

A Master in Photonics is a suitable complement to bachelor degrees in sciences (especially in physics) and in engineering (especially telecomm, electronics or industrial engineering) to get a wider and deeper training on new cross-disciplinary scientific advances and technologies.

Possible career issues include:

- Doing a PhD in Photonics, Optics, Physics, Optical Engineering, Nanophotonics, Biophotonics, Telecommunications, Electronics, Imaging, Quantum Information, etc.
- Joining, after PhD, R&D and innovation programs in companies, basic or applied research centers, and universities.
- Joining a large company as a consultant or engineer on photonics-related issues, as applications development engineer, or as commercial or laboratory technical professional.
- Freelance professional acting as advisor and consultant in photonics-related subjects.
- Incorporation to the professional world of photonics in high-level qualification technical positions for control of services like microscopy, x-ray diffraction, thin films, etc.
- Joining (and promoting) spin-off or other technology-based small companies.
- Joining education and high-level training in the field of photonics.



## Enrolment and fees

Student's registration is taken care by ETSETB (Escola Tècnica Superior d'Enginyeria de Telecomunicacions de Barcelona, at Campus Nord of **UPC university**, building B3, Barcelona), with support from the Dept. of Optics & Optometry.

Fees: €50 per ECTS credit. For non-resident foreign students who are not EU nationals, the fee is 1.5 the amount stated.

## Interested students:

Send a message to [master.photonics@etsetb.upc.edu](mailto:master.photonics@etsetb.upc.edu).

Next to that, or in parallel, online pre-enrolment and admission request may be uploaded through:

[https://preinscripcio.upc.edu/home\\_candidat.php?idioma=3](https://preinscripcio.upc.edu/home_candidat.php?idioma=3), taking into account instructions at: [http://www.upc.edu/learning/courses/access-admission/requirements-to-enrol-masters-degree#condicionada\\_mu](http://www.upc.edu/learning/courses/access-admission/requirements-to-enrol-masters-degree#condicionada_mu).

Complementary information (*additional to main information contained in the addresses on the left margin of this page*) can be found at:

<http://www.upc.edu/sri/> or [http://www.upc.edu/sri?set\\_language=en](http://www.upc.edu/sri?set_language=en)  
<http://www.youtube.com/watch?v=TDf15vFGcWE>

Director of the Master, Prof. R. Vilaseca, [ramon.vilaseca@upc.edu](mailto:ramon.vilaseca@upc.edu)

Coordinators at institutions:

UPC: Prof. C. M. Cojocar, [crina.maria.cojocar@upc.edu](mailto:crina.maria.cojocar@upc.edu)

UAB: Prof. J. Mompert, [jordi.mompert@uab.es](mailto:jordi.mompert@uab.es)

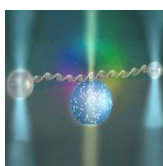
UB: Prof. S. Bosch, [sbosch@ub.edu](mailto:sbosch@ub.edu)

ICFO: Prof. D. Artigas, [david.artigas@icfo.es](mailto:david.artigas@icfo.es)

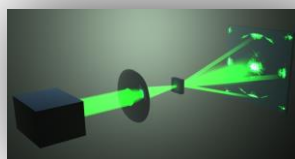
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[master.photonics@etsetb.upc.edu](mailto:master.photonics@etsetb.upc.edu)  
Contact address: [master.photonics@etsetb.upc.edu](mailto:master.photonics@etsetb.upc.edu) (at UPC)



ICFO – Institut de Ciències Fotòniques



Single DNA molecule under mechanical stress using optical tweezers (ICFO)



Photonic crystal effects on light (UPC)



$\lambda/20$  interferometer for Gran Telescopio Canarias (UPC-CD6)