Master in PHOTONICS BCN
Master Erasmus+ EUROPHOTONICS-POESII

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http://www.photonics.masters.upc.edu
http://www.photonicsbcn.eu/
http://www.europhotronics.org/
Optics & Photonics

- A traditional area of science and technology
- It is presently evolving very fast that it has become one of the relevant branches of Science and Technology for the XXI-th Century

- Classical optics: geometrical, electromagnetic, physiological
- Nonlinear optics
- Quantum optics, atom optics, quantum information, optomechanics,…
- Imaging and vision
- New photoemitters (lasers,...) and detectors
- Integrated photonics
- Communications, sensors, remote sensing, material analysis
- Materials processing: cutting, welding, marking, 3D printing,…
- New materials and devices: nanophotonics, plasmonics, photonic crystals, metamaterials,…
- Energy, environment: lighting, photovoltaics, green photonics, blue photonics, controlled nuclear fusion,…
- Biophotonics, optogenetics,…
- …
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XXI century:  
- 5 Nobel Prize in Physics to Photonics
- 2 Nobel Prize in Chemistry related with Photonics

2010: The EU selects Photonics as one of the five KETs (“Key-Enabling Technologies”) for sustainable... European industry

2013: USA: National Photonics Initiative

2015: China: “Laser World of Photonics” trade fair, held in China for the first time.

2015: International Year of Light, and of technologies based on light
Laser-beam welding makes aircraft lighter

A new laser-beam welding plant for joining large 3D parts in the aerospace industry was inaugurated on June 25, 2004. © Airbus

Giant passenger airliners of the XXL generation raise huge challenges for aircraft manufacturers, as the production and operating costs for the high-flyers must be kept within reasonable limits. High-precision joining technologies for fuselage sections, saving up to 15 percent of the aircraft's weight, are being developed at an innovative 3D laser welding plant.
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Laser Focus World
Ultrafast lasers write quantum circuits
- Rugged high-energy lasers nearing the battlefield
- Lens design software keeps its edge
- Confocal microscopy scans stainless steel
- Fiber-optic superdots enhance remote sensing

Optics & Photonics News
Lasers determine Red Planet's chemistry
Zapping Mars

Universitat Politècnica de Catalunya
Universitat Autònoma de Barcelona
UNIVERSITAT DE BARCELONA
ICFO Instituto de Ciencies Fòtotòniques
MSc Photonics & Europhotonics

Fotons contra el càncer
L’Ifeo i el Clínic apliquen la física més avançada en la lluita contra els tumors

Tècniques de fotònica afinen el diagnòstic del càncer de pell
Investigadors de la UPC a Terrassa desenvolupen un instrument d’anàlisi ràpida i més precisa

Crean un nano-chip que detecta el càncer en etapes precoces

El dispositivo puede percibir proteínas cancerigènes en una sola gota de sangre

Universitat Politècnica de Catalunya
Universitat Autònoma de Barcelona
ICFO
Since 2007, researchers covering different fields of Photonics from Barcelona Universities (UPC, UAB and UB) and in the Institute of Photonic Science (ICFO), decided to put together their complementary expertise to offer a joint Master in Photonics.

- Official 60 ECTS (1 year) Spanish degree.
- Master Erasmus Mundus 120 ECTS (2 years): multiple degree (Spanish, French and German)
- All courses are taught in English.
- The Master prepares to do a PhD Thesis or to work in a company. It fosters entrepreneurial skills to conduct own initiatives.
• Optical engineering: sensors, vision, metrology, opt. design, adaptive optics, color science
  • Image processing, liquid crystal, machine vision
  • Nonlinear optics and dynamics
  • Nanomaterials, Remote sensing
  • Optical Fiber Communications & networks
  • Integrated photonics
• Applied optics: image proc., diffractive optics
  • Thin films
  • Optical tweezers
  • Optoelectronics devices, CMOS
  • Quantum information

• Quantum & Nonlinear Optics, Quantum information
  • Image processing, diffractive optics, metrology.
  • Synchrotron light, X-ray optics
  • Thin films, multilayers.
• Nanophotonics
  • Advanced optical imaging
  • Quantum & atom optics
  • Nonlinear optics & devices, ultrafast light
  • Biophotonics, optical tweezers
  • Photonic materials

CD6 center
Admission profiles:

• 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 Nanoscience and Nanotechnology.
• 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.
OBJECTIVES

(i) Provide knowledge and training in different areas of Photonics, considering both fundamental and applied aspects.

(ii) Flexibility: the student can choose from many courses, to get either general (or fundamental or broadband) training, or more specialized training, in different possible areas.

(iii) Develop competences and skills that will help the student to initiate a research or a professional carrier.
### MSc Photonics

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## COURSE PROGRAM

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<tr>
<th>Module 1:</th>
<th>Compulsory courses</th>
<th>20 ECTS</th>
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<tr>
<td>Module 2:</td>
<td>Elective courses</td>
<td>24 ECTS</td>
</tr>
<tr>
<td>Module 2:</td>
<td>Master Thesis</td>
<td>16 ECTS</td>
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<tr>
<td><strong>Total:</strong></td>
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<td>60 ECTS</td>
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COURSE PROGRAM

Compulsory courses area:
- Basis of Photonics Laboratories
- Complement. skills (20 ECTS)

Elective courses area: Free choice of courses from any of these modules:
- Quantum Optics
- Biophotonics & Imaging
- Materials & Nanophotonics
- Telecomm & Phot. circuits
- Optical Engineering (24 ECTS)

Master Thesis (16 ECTS)

Bridging courses (exceptionally)

1st semester 2nd semester

60 ECTS (one year)

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Module 1:
Compulsory courses 20 ECTS

Teaching Unit 1.1: Fundamentals of Photonics 10 ECTS
- Introduction to photonics. Optics and Lasers 5 ECTS
- Beam Propagation and Fourier Optics 5 ECTS

Teaching Unit 1.2: Applied Photonics & Transversal Skills 10 ECTS
- Photonics Laboratory 5 ECTS
- Business and Patents in Photonics 5 ECTS
Module 2: Elective courses  
24 ECTS

Free choice of 24 ECTS from any Teaching Unit

<table>
<thead>
<tr>
<th>Course</th>
<th>ECTS</th>
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<tr>
<td>2.1 Quantum Optics (QUANTOP)</td>
<td>12</td>
</tr>
<tr>
<td>2.2 Biophotonics and Imaging (BIOIMA)</td>
<td>12</td>
</tr>
<tr>
<td>2.3 Materials and Nanophotonics (MATNANO)</td>
<td>12</td>
</tr>
<tr>
<td>2.4 Telecomm. &amp; Photonics Circuits (TELPHO)</td>
<td>12</td>
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<tr>
<td>2.5 Optical Engineering (OPTENG)</td>
<td>12</td>
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Module 2: **Elective courses** (free choice of 24 ECTS)

### Teaching Unit 2.1: Quantum Optics 12 ECTS

- Quantum Optics 3 ECTS
- Quantum simulators, Bose Einstein condensates and ultracold quantum gases 3 ECTS
- Quantum Information theory: communic. & comput. 3 ECTS
- Advanced Quantum Optics with Applications 3 ECTS

### Teaching Unit 2.2: Biophotonics and Imaging 12 ECTS

- Optical image in biology and medicine 3 ECTS
- Optical micromanipulation workshop 3 ECTS
- Visual biophotonics and multispectral imaging 3 ECTS
- Image processing in biophotonics 3 ECTS
### Teaching Unit 2.3: Materials and Nanophotonics 12 ECTS
- Photonics materials and metamaterials 3 ECTS
- Nonlinear Optics 3 ECTS
- Nanophotonics 3 ECTS
- Ultrafast and ultraintense laser light 3 ECTS

### Teaching Unit 2.4: Telecommunications and Photonic Circuits 12 ECTS
- Fibers and telecommunications 3 ECTS
- Integrated Photonics 3 ECTS
- Photonics systems in telecommunications 3 ECTS
- Optoelectronics and photovoltaic technology 3 ECTS

### Teaching Unit 2.5: Optical Engineering 12 ECTS
- Laser systems and applications 3 ECTS
- Building optomechanical systems 3 ECTS
- Managing light with devices 3 ECTS
- Measuring with light 3 ECTS
SPECIAL (PEDAGOGICAL) FEATURES

▪ “TRANSVERSAL or COMPLEMENTARY SKILLS”
  Course on “Business and Patents in Photonics” allows contacts with professionals with high responsibility in companies, and fosters entrepreneurial and communication skills.
  “Seminars and skills” – Escola de idiomes (UB)

▪ “ACTIVITIES” Weeks
  One “activities wee” after 6 regular teaching weeks
  Visits to labs. Or to companies, seminars, presentations...

▪ VISITING SPEAKERS & SEMINARS
  Short Courses (funded by Erasmus Mundus Europhotonics program)
  Seminars, conferences open to all master’s students
Module 3: Master Thesis

More than 40 Master thesis proposals from UPC, UAB, UB and ICFO

- Institute of Photonic Sciences, ICFO - [http://www.icfo.es](http://www.icfo.es)
- Centre for Sensors, Instrumentation and Systems Development, CD6 (UPC) - [http://www.cd6.upc.edu](http://www.cd6.upc.edu)
- Remote Sensing Research Group, RSLAB (UPC) - [http://www.tsc.upc.edu/rs/](http://www.tsc.upc.edu/rs/)
- Free-space Optical Communications (UPC) - [http://www.tsc.upc.edu/fsoc/](http://www.tsc.upc.edu/fsoc/)
- Applied Optics and Image Processing Research Group, GOAPI (UPC) - [http://www.goapi.upc.edu](http://www.goapi.upc.edu)
- Optical Communications Group, GCO (UPC) - [http://www.tsc.upc.es/gco](http://www.tsc.upc.es/gco)
- Group on Nonlinear Dynamics, Nonlinear Optics and Lasers, DONLL (UPC) - [http://donll.upc.edu](http://donll.upc.edu)
- Micro and Nano-technologies Research Group, MNT (UPC) - [http://webmnt.upc.es](http://webmnt.upc.es)
- Optics Group (UAB) - [http://optica.uab.es](http://optica.uab.es)
- Quantum Information Group (UAB) - [http://grupsderecerca.uab.cat/giq](http://grupsderecerca.uab.cat/giq)
- Quantum and Atom Optics Group (UAB) - [http://grupsderecerca.uab.cat/qaos](http://grupsderecerca.uab.cat/qaos)
- Optical Trapping Lab (UB) - [http://www.ub.edu/biopt](http://www.ub.edu/biopt)
Number of students:

- 2008-09: 32
- 2009-10: 25
- 2010-11: 26
- 2011-12: 26 + 18 (+2)
- 2012-13: 26 + 5 (+3+1+2 Mobility) (+3 second year)
- 2013-14: 27 + 5 (+4 Mobility) (+4 second year)
- 2014-15: 23 + 7 (+3 + 1 Mobility) (+4 second year)
- 2015-16: 30 + 4 + 3 Mobility
2015-16: \(29 + 4\)

- 13 Physics (3 UB, 3 Santiago, 1 UAB, 1 Valencia, 1 Zaragoza, 1 Sevilla, 1 Oviedo, 1 Córdoba, 1 Ukraine).
- 2 Physical Engineering (2 UPC).
- 6 Electrical/Electronics Engineering (1 UPC, 1 Leuven, 1 London, 1 India, 1 China, 1 USA?).
- 3 Optics & Optometry (2 UPC, 1 Granada).
- 2 Telecommunications Engineering (1 UPC, 1 UB)
- 1 Nanoscience & Nanotechnology (1 UAB)
- 1 Biomedical Engineering (1 Madrid -UC3-)

Erasmus & some courses:
- 1 Optronics Engineering (1 U. Rennes)
- 1 Aeronautics Engineering (1 Madrid -UPM-)
- 1 Electronics Eng. (Roma) + 1 Electronics & Informatics MSc (Darmstadt)

Origin: 23 Spain, 1 Belgium, 1 Hungary, 1 Ukraine, 1 India, 1 China, 1 Japan

Erasmus & some courses: 1 Italy, 1 India, 1 Mexico, 1 Spain
The sectors in which students can develop their profession are becoming very broad, given the interdisciplinary character and increasing relevance of photonics. Possible career issues include:

- 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.
Other links with companies
(for sponsoring, internships, job offers,...)

Spanish Platform FOTONICA 21

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