

## **MASTER IN PHOTONICS** ***“Photonics BCN”***

### **COURSE PROGRAM FOR ACADEMIC YEAR 2024-2025**

Master Program jointly offered by the following institutions:

- Universitat Politècnica de Catalunya (UPC)
- Universitat Autònoma de Barcelona (UAB)
- Universitat de Barcelona (UB)
- Institut de Ciències Fotòniques (ICFO)

<http://photonics.masters.upc.edu/en>

## 60 ECTS Master Degree

[ language: English ]

The MSc degree in Photonics has an official extent of 60 ECTS (European Credits Transfer System) and can be obtained in one year. One ECTS credit corresponds to 25-30 hours: 8 are “on-site” hours (lectures or other activities in the presence of a professor) and the rest are dedicated to “off-site” individual work.

The Course Program consists of three modules, as shown below. After the official admission, the Executive Committee of the Master assigns to each student a tutor (a professor of the Master), who will be in touch and will assist the student during the whole academic course. The election of the elective courses must be made in dialog with the tutor and needs his/her agreement.

Module name		ECTS (credits)
Module 1	Compulsory courses	20
Module 2	Elective courses	24
Module 3	Master thesis	16
<b>Total:</b>		<b>60</b>

### Module 1: Compulsory courses (20 ECTS)

Includes four subjects of 5 ECTS each, that have to be followed by all the students. They are divided into two teaching units (or sub-modules)

- Fundamentals of photonics
- Applied photonics and transversal skills.

#### Teaching Unit 1.1: Fundamentals of Photonics (FUNPHO)

Build a solid background on the basics of Photonics.

Course code	Course name	ECTS
230550	Introduction to photonics. Optics and lasers	5
230553	Beam propagation and Fourier optics	5

The course “*Beam propagation and Fourier optics*” is structured in 7 modules of 1 ECTS each, including one of computing environments. Each student will have to choose 5 of these modules (5 ECTS), depending on his/her previous background. For details, see the course description.

## Teaching Unit 1.2: Applied Photonics and Transversal Skills (APATS)

Course code	Course name	ECTS
230551	Photonics laboratory	5
230552	Business and patents in photonics	5

"*Photonics Laboratory*" includes extensive laboratory works on both basic and applied aspects of photonics. Each student, with the advice of a responsible professor, can choose among the available laboratory experiments, those that can better complement his/her previous expertise.

The complementary skills associated to the second course can be useful for future work, be it professional or research oriented.

## Module 2: Elective courses (24 ECTS)

Contains elective courses of 3 ECTS each, divided into five sub-modules (or teaching units), corresponding to different branches of photonics:

- **Quantum Optics** (QUANTOP),
- **Biophotonics and Imaging** (BIOIMA),
- **Materials and Nanophotonics** (MATNANO),
- **Optical Engineering** (OPTENG).
- **Telecommunications and Photonics Circuits** (TELPHO)

Students **must choose 24 ECTS from any of these sub-modules**. Since the official Master Degree Diploma does not define a specialty, the choice of courses is completely free (there is no minimum nor maximum number of credits to be chosen from each module), although student's tutor must previously approve it. This classification into modules is only for scientific (thematic) guidance purpose. Some of the courses fit in two different modules and thus are included in both.

Before election, the student should check the timetables for the compatibility in time between different courses.

## Teaching Unit 2.1: Quantum Optics (QUANTOP)

<b>Course code</b>	<b>Course name</b>	<b>ECTS</b>
230555	Quantum optics	3
230579	From cooling and trapping of neutral atoms to Bose-Einstein condensates	3
230578	Quantum simulators with ultracold quantum gases	3
230558	Advanced quantum optics with applications	3
230584	Machine learning on classical and quantum data	3
2301117	Qubit application	3

## Teaching Unit 2.2: Biophotonics and Imaging (BIOIMA)

<b>Course code</b>	<b>Course name</b>	<b>ECTS</b>
230554	Experimental optical techniques in biology	3
230561	Image processing in biophotonics	3
230582	Visual optics and biophotonics	3
230581	Active and spectral imaging	3
2301115	3D light control for biological applications	3

## Teaching Unit 2.3: Materials and Nanophotonics (MATNANO)

<b>Course code</b>	<b>Course name</b>	<b>ECTS</b>
230562	Photonics materials and metamaterials	3
230563	Nonlinear optics	3
230564	Nanophotonics	3
230565	Ultrafast and ultraintense laser light	3
230566	Fibers and telecommunications	3
230567	Integrated photonics	3
230569	Optoelectronics and photovoltaic technology	3
2301116	Semiconductor photonics: applications and technology	3

### Teaching Unit 2.4: Optical Engineering (OPTENG)

<b>Course code</b>	<b>Course name</b>	<b>ECTS</b>
230570	<b>Laser systems and applications</b>	<b>3</b>
230572	<b>Managing light with devices</b>	<b>3</b>
230573	<b>Measuring with light</b>	<b>3</b>
230581	<b>Active and spectral imaging</b>	<b>3</b>
230587	<b>Optical Design</b>	<b>3</b>
2301116	<b>Semiconductor photonics: applications and technology</b>	<b>3</b>

### Teaching Unit 2.5: Telecommunications and Photonics Circuits (TELPHO)\*

<b>Course code</b>	<b>Course name</b>	<b>ECTS</b>
230566	<b>Fibers and telecommunications</b>	<b>3</b>
230567	<b>Integrated photonics</b>	<b>3</b>
230569	<b>Optoelectronics and photovoltaic technology</b>	<b>3</b>

\*Students who are especially interested in this sub-module can also enroll the course “Optical Remote Sensing: LIDAR (LASER RADAR)” taught in the Master’s degree in Telecommunications Engineering (MET) (Course code: 230704; ECTS: 5, spring semester).

### Module 3: Master Thesis or Project (16 ECTS)

<b>Course code</b>	<b>Course name</b>	<b>ECTS</b>
230574	<b>Master Thesis</b>	<b>16</b>

This module is entirely dedicated to the Master Thesis that has to be performed by the student under the supervision of one of the Master’s professors. External supervisor might also be possible, under some restrictions.

At the beginning of November, a list of the available proposals for master thesis projects are published on the Master’s web-page. Students have to make his/her choice and contact the corresponding professor. We advise the students to choose and start working as soon as the supervisor accepts it, if possible, well in advance to the starting date of the 3<sup>rd</sup> module. There are two sessions for the Master Thesis presentation: one in the middle of July and another one in the first week of September.

The Master Thesis offers two possibilities: it can be oriented toward a research activity (fundamental or applied character), or it can be oriented toward the deployment of a more technological activity in collaboration with companies: innovation, improving or testing, implementation of advanced production process, etc. Ideally, in this second case, the activity should be performed through an internship in a company (or in close connection with a company).

*All information about the Program, the index of each course as well as a short CV of the professors can be found in the website:*

<https://photonics.masters.upc.edu/en/academic-year-2021-22>

## General remarks

### Minimum background requirements

Students with different backgrounds are welcome. Nevertheless, a good background is required in **physics**, particularly in **optics** (geometrical and wave optics, electromagnetic waves), **solid-state physics** (electronic bands in semiconductors), and **mathematics** (complex numbers, derivatives, integrals, basic types of differential equations, vectors and vectorial operators). Also, some minimum knowledge about **quantum physics** would be necessary (a deeper knowledge of quantum physics would only be necessary for students that want to take courses dealing with quantum optics phenomena).

For students that lack such background, or part of it, in September, during the first 2 months, leveling lectures and bibliographic selected material will be given to reinforce and enlarge such background.

Very exceptionally, some of the compulsory courses included in Module 1 can be replaced by elective courses. If the student comes from another Master and has already learnt the contents or laboratory experiments included in the compulsory courses of Module 1, the Executive Committee of the Master might allow the student to permute some of these courses by other ones, with the same total amount of credits. These substitutive courses would then be considered as courses of Module 1, in the student's curriculum. The change requires a previous agreement from the tutor.

### Seminars

Seminars related to different subjects of the Master and given by visiting professors, researchers or consultants will be periodically scheduled. There seminars will be held, if possible, in the 2 hour/week slot reserved in the timetable. Attending these seminars, or related activities, is part of the master program.

### Minimum number of courses to register, per academic year

The student has the option to register for a reduced number of courses and follow the Master program in more than one year. University rules require that the student must approve a minimum of 15 ECTS during the first academic year. (\*) The registration fees are proportional to the number of credits registered, plus a small fixed amount.

### **Maximum number of courses to register**

Present Ministry and University regulations establish that a student should register for 60 ECTS in our Master in Photonics. However, in case the student is interested, an extra of 10% of the total ECTS number is allowed (permission should be requested). This is independent on whether these courses are taken in one academic year or along more than one academic year.

### **Courses with very few students**

Elective courses with very few registered students might not be offered. This depend on the University regulations to be established before the beginning of the lecture period. In these cases, the student could then register for alternative courses, without any additional fees.

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(\*) The rules stated in this Section are based on the general regulations for Master Programs at UPC University for academic year 2023-2024. If some change for academic year 2024-25 is introduced it will be updated in this Course Program document.