Basic/Essential Course Information	
Course title	Laboratory of Photonics
Degree Course title	Physics
ECTS	6
Compulsory attendance	No
Course teaching language	ENGLISH

Teacher	Maurizio Dabbicco	maurizio.dabbicco@uniba.it

ECTS Details	Disciplinary area/broad field:	SSD	ECTS
	Characterizing	FIS/03	6

Time management and teaching activity type	Period	Year	lesson type
	2nd semester	1st	Lessons (32h) Exercises (30h)

Time management	Total hours	in-class/in-lab study hours	out-of-class study hours
	150	62	88

Course calendar	Starting date	Ending date
	First week of March	Last week of May

Syllabus	
Prerequisites	Electromagnetism and waves, linear optics, bases of crystal symmetry and electronic energy levels in atomic, molecular and condensed matter, laser systems, differential calculus and complex functions, classical and quantum statistical distributions.
Expected learning outcomes (according to Dublin Descriptors)	**Knowledge and understanding.** The properties of Gaussian beam and the way to characterize it. Linear and nonlinear optical components for beam shaping, phase/amplitude. Modulation, frequency conversion, pulse compression. Materials' design tools for tailoring optical properties. **Applying knowledge and understanding.** How to measure laser beam physical parameters. How to modify laser beam physical parameters. How to calculate propagation of laser beams in linear and nonlinear optical materials. **Making judgements.** Criteria for choosing optical materials and components. Criteria for choosing instrumentation for light beams characterization. Criteria for optimizing optical setups. **Transferable Communication skills.** Writing extended laboratory reports. Preparing and presenting tutorial-type presentations..

	Lifelong learning skills. Critical review of laboratory results. Autonomous search and assessment of scientific state-of-art.
Course contents summary	Optical materials. Principles and instrumentation for beam characterization and shaping. Beam propagation methods.
detailed syllabus	**Lectures** **Optical materials**: glasses, molecular crystals, dielectrics, semiconductors, photonic crystals, metamaterials. **Wave propagation in transparent media**: Beam Ray Tracing, Coupled Differential Wave Equations, Radiative Transfer Equation, Nonlinear Schroedinger Equation. **Linear optical components**: lenses, lens systems, mirrors, coatings, polarization optics, 1D and 2D modulators. **Nonlinear optical properties of materials**: 2nd and 3rd order polarization, nonlinear frequency generation, nonlinear absorption and nonlinear phase-shift, saturable nonlinearities. **Laser beam characterization**: the Gaussian beam, the Gaussian pulse, Bessel and vortex beams, pulse width and spectral width measurement, ellipsometry. **Laser beam shaping**: amplitude modulation, frequency modulation, polarization modulation, focusing, filtering, steering, broadening, shortening, structuring. **Laboratory practice** - Beam characterization: polarization, M2, spectrum - Beam modulation by EOM, AOM, SLM - Applications of Optical Tweezers - Applications of Optical Feedback Interferometry
Books	Saleh, Teich, *Fundamentals of Photonics*, 2nd ed, Wiley, 2007. Powers, Haus, *Fundamentals of Nonlinear Optics*, 2nd ed, CRC Press, 2017. Jones, Maragò, Volpe, *Optical Tweezers, Principles and Applications*, CUP, 2015. Donati, *Electro-Optical Instrumentation*, Prentice Hall PRT, 2004.
Notes	Selected chapters
Teaching methods	Lectures in the teaching room with the aid of a laptop and a projector. Laboratory activities supervised.
Assessment % of final mark	Written reports (50%), oral presentation including Q&A (50%)
Evaluation criteria	- **Knowledge and understanding** *Minimum*: the properties of Gaussian beam and the way to characterize it, classification and usage of optical materials. *Intermediate:* materials' design tools for tailoring optical properties, nonlinear optical effects and applications. *Optimal:* maths of wave propagation in transparent media.

	- **Knowledge and comprehension skills applied** *Minimum:* critical analysis and accurate presentation of laboratory activity. *Intermediate:* comprehensive review of state-of-art *Optimal:* comparison of experimental data with numerical simulations. - **Autonomy of judgment** *Minimum:* correct estimation of experimental uncertainties. *Intermediate:* motivated choice of materials and components for the purpose. *Optimal:* identification of the optimal setup for a given measurement. - **Communication skills** *Minimum:* compliance with timing and template of reports and presentation. *Intermediate:* cogency of argumentation. *Optimal:* skillful presentation of state-of-art and perspective studies.