Graduate School in Science – Photonics & Quantum Information

prerequisites of admission:

basic physics (in particular waves, electromagnetism and optics),
basics of quantum mechanics

1st year

course	activity	hours/ week	hours/ year	form of crediting	credits
General School Seminar	seminar	2	60	participation	4
Advanced Quantum Mechanics	lecture, classes (problem solving)	2 2	30 30	exam	8
Lasers and Nonlinear Optical Phenomena	lecture, seminar	2 2	60 60	exam test	14
Introductory Quantum Optics	lecture seminar/problems	2 2	30 30	exam	8
Laboratory Project (experimental or theoretical)	students laboratory or computer laboratory	5	150	project report	10
2 optional lectures*	lecture	2x2	60	essay or test	6
tutorials	tutorial	2	60	as arranged with tutor	4

Required number of credits to complete 1st year: 54

2nd year

course	activity	hours/ week	hours/ year	form of crediting	credits
General School Seminar	seminar	2	60	participation	4
Optoelectronics and Photonics (E)	lecture seminar	2 2	30 30	test	7
Applications of Lasers and Photonics (E)	lecture seminar	2 2	30 30	test	7
Quantum Information and quantum Computers (T)	lecture seminar	2 2	60 60	test	12
Diploma Project	laboratory or theoretical project	12	360	diploma exam	30
2 optional lectures*	lecture	2x2	60	test	6

Required number of credits to complete 2nd year: 58. Students choose either experimental (lectures denoted E) or theoretical (T) profile.

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* optional lectures of student's choice from the list of lectures for all School specializations, as agreed upon with tutor.

General School Seminar – with participation of students and tutors of various specializations.

Seminar Format: two hours per week in two semesters.

Description: General Seminar aims at improving interdisciplinary background of School students and their better integration.

Responsible – School Management

Advanced Quantum Mechanics

Course Format: two hours of lecture and two hours of classes per week in the first semester (30+30 h.).

Description: Dirac equation, Quantum theory of measurement; time dependent perturbation theory; quantum interference; Open systems description

Responsible – Prof. Zakrzewski

Lasers and Nonlinear Optical Phenomena

Course Format: two hours of lecture and two hours of seminar per week in both semesters (60+60 h.). Description: basics of laser physics; design and properties of most popular lasers; short and ultrashort light pulses; principles of nonlinear effects in interactions of laser radiation with material samples.

Responsible – Prof. Gawlik

Introductory Quantum Optics

Course Format: 2h of lecture and 2h of seminar/classes per week in the sec. semester (30+30 h.).

Description: E-M field quantization, quantum field states; photon statistics; quantum theory of coherence; atom-field interaction – hamiltonian, dressed states; cold atoms and Bose-Einsten condensate, elements of laser theory

Responsible –Prof. Zakrzewski

Quantum Information and Quantum Computers

Course Format: 2h of lecture and two hours of seminar per week in both semesters (60+60 h.).

Description: entangled states; classical and quantum cryptography; quantum computer, quantum factorization of integers and other algorithms, logic gates (classical and quantum), one-qubit rotation, physical implementation of discrete Fourier transform, physical realization of quantum computations (ion traps, spin chains), error correction for quantum computers

Responsible –Prof. Życzkowski

Applications of Lasers

Course Format: 2 h of lecture and 2 h of seminar per week in the sec. semester (30+30 h.).

Description: laser spectroscopy; time-resolved laser study; lasers in medicine and biology; optical methods of cooling and trapping neutral atoms; lasers in data analysis and transmission.

Responsible – Prof. Gawlik

Optoelectronics and Photonics

Course Format: two hours of lecture and two hours of seminar per week in the sec. semester (30+30 h.).

Description: light sources and detectors; modulators; fibers and elements of fiber optics (couplers, mixers, multiplexers; etc.); photonic band-gap crystals; nonlinear phenomena in photonic materials.

Responsible – Prof. Gawlik

Laboratory Project – aims at acquainting students with the basic experimental tool and methods of Photonics and Optical Information, such as lasers, light detectors, light analyzers, optical fibers, diffraction optics, etc., as well as main methods of analysis and interpretation of experimental data. It consists of a series of small projects supervised by the teaching staff.

Computer Laboratory – equivalent of experimental laboratory for theoretically oriented students. Small computer projects making a practical use of C and/or Fortran programming as well as mathematical tools such as Maple, Matlab, Mathematica. Possible active participation in working on OpenSource codes.

Diploma Project – the one-year project, supervised by a professor, fulfills requirements for MS Diploma Thesis of the Jagiellonian University and most European Universities.

The seminars associated with lectures aim at a detailed analysis of relevant aspects of the problems presented in the lectures.