Graduate School in Science – Nanoscience and Materials Science

prerequisites of admission:

basic physics,
basics of quantum mechanics,
basics of solid state physics.

1st year

course	activity	hours/ week	hours/ year	form of crediting	credits
General School Seminar	seminar	2	60	participation	4
Analytical Techniques of Nano- and Materials-Science	lecture tutorial	2 1	60 30	exam	12
Quantum Theory of Solids and Nanostructures	lecture tutorial	2 2	60 60	exam	14
2 optional lectures*	lectures	2	30 hour each	essay or test	4 each
Laboratory Project (on individual basis)	laboratory	5	150	project report	10

Required number of credits to complete 1st year: 46

2nd year

course	activity	hours/ week	hours/ year	form of crediting	credits
General School Seminar	Seminar	2	60	participation	4
Computer Modelling of Nanosystems & Materials	lecture + practical classes	2	60	test	7
Fundamentals of Nanotechnology	Lecture	3	45	essay or test	5
2 optional lectures*	Lectures	2	30 hour each	essay or test	4 each
M.Sc. Project		12	360	as arranged with tutor	30

Required number of credits to complete 1st year: 54

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* optional lectures of student's choice from the list of lectures for all School specializations

Quantum Theory of Solids and Nanostructures
Course format: lectures: 2 hours/week
tutorials (two semesters: 30 weeks)

Program: Description of electron states in terms of Bloch wave function and its applications. Elements of second quantization and its applications to cluster and other low dimensional structures. Transition from atomic (or molecular) states into delocalized states, impurity states in a semiconductor. Quantum dots, electron states in nanotubes. Elements of theory of superconductivity and magnetism.

Responsible: Prof. Józef Spałek

Analytical Techniques of Nano- and Materials- Science
Course format: lectures: 2 hours/week
tutorials: 1 hour/week

Program: Description and principles of operation of analytical techniques used in nano- and materials- science. Analytical techniques: ATM/STM, SEM, TEM, ellipsometry, diffraction & scattering techniques, DNA sequencing, ion, electron and photon spectroscopies (SIMS, SNMS, Auger, ISS, ESCA, XPS, UPS). Synthesis techniques of modern semiconductors (Vapor Deposition, Molecular Beam Epitaxy, sputtering, ion-, electron- and photon-lithography, microcontact printing)

Responsible: Assoc. Prof. Zbigniew Postawa

Computer Modelling of Nanosystems
Course format: 2 hours/week (2 semesters – 30 weeks for theorists, 1 semester – 15 weeks for experimentalists)

Program: Exact diagonalization for small clusters (Lanczos method) combined with an *ab initio* method, Monte Carlo Methods, solving one quantum-mechanical problem (*e.g.* Wannier functions for a linear chain, an impurity state, modelling of surface dynamics, *etc*.). Some problems will depend on the choice of the subject for M.Sc. Thesis.

Responsible: Dr. Edward Görlich Jr., Dr. Adam Rycerz

Fundamentals of Nanotechnology
Course format: 3 hours/week (1 semester)

Program: Build a common background, show interconnections between different material classes. Atomic structure, interatomic and intermolecular forces. Processes at surfaces (diffusion, adsorption, desorption, segregation). Phase separation, phase transitions, self-assembly. Modern age materials: ceramics, semiconductors, superconductors, composites, carbon fibers, polymers. Mechanical and electronic properties of nanostructure materials and devices.

Responsible: Prof. Marek Szymoński

Laboratory Project – aims at acquainting students with the basic experimental tool and methods of Surface and Materials Science 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.

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

Some lectures may be proposed to take place together with other specializations depending on the background and the interest of the students.