Graduate School in Science – Biological Physics & Soft Matter

prerequisites of admission:

basic physics ,
basics of quantum mechanics and statistical mechanics
courses in university algebra and analysis
basics of programming languages: Fortran or C

1st year

title	kind of activity	hours/ week	hours/ year	form of crediting	credits
General School Seminar	seminar	2	60	participation	4
Statistical Physics (*)	lecture, classes (problem solving)	3 2	45 30	exam test	10
Elements of Quantum Mechanics (*)	lecture, classes (problem solving)	2 2	30 30	Exam test	8
Introduction to Soft Matter	lecture, seminar	2 2	30 30	exam test	8
Doing Science with Mathematica and Maple (I)	lecture	2	30	project	3
Computer Aided Modeling & Computational Lab (*)	lecture Students Lab	3 6	45 90	project report	10
From Random Walks to Polymers	lecture	2	30	essay or seminar	4
2 optional lectures from the list of lectures for all School specializations	lecture	2x2	60	essay or test	7
tutorials	tutorial	2	60	as arranged with tutor	4

Required number of credits to complete 1st year: 46

2nd year

title	kind of activity	hours/ week	hours/ year	form of crediting	credits
General School Seminar	seminar	2	60	participation	4
Selforganization in Liquid Crystals and polymers	lecture seminar	2 2	30 30	oral exam	7
Brownian Motors in Biology	lecture	2	30	essay	4
Stochastic Processes and Modelling	lecture	2	30	essay	4
Membranes and Channels: principles of Biotransport	lecture	2	30	essay	4

Phase transitions and Critical Phenomena (*)	Lecture classes	2 1	30 15	exam test	5
Doing Science with Mathematica and Maple (II) (*)	computer Lab	2	30	project	3
Molecular and Quantum Dynamics Modelling of Biomolecules	software lab	3	45	project	5
Diploma Project	Laboratory or theoretical project	12	360	diploma exam	30

Required number of credits to complete 2nd year: 58

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* common lectures with other School specializations

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

Statistical Physics

Course Format: three hours of lecture and two hours of classes per week in the sec. semester (45+30 h.).

Description: Fundamentals of probability theory and statistics, classical statistical mechanics, Time-dependent random variables, quantum-mechanical description of statistical systems, stochastic modeling of experimental observations.

Responsible - Prof. Longa/dr P. Góra

Elements of Quantum Mechanics

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

Description: Elements of quantum theory of many body systems; quantum theory of chemical binding.

Responsible – Assoc. Prof. E. Gudowska-Nowak/Prof. Longa

Introduction to Soft Matter Physics

Course Format: two hours of lecture and two hours of seminar per week in the first semester (30+30 h.). Description: Forces, energies and time scales in soft matter, phase transitions, colloidal systems,

Polymers, gels, foams, molecular ordering of soft matter systems, self-assembling of amphiphilics and polymers, soft matter in nature

Responsible – Prof. Longa/Prof. Mościcki/ Assoc. Prof. A. Budkowski

From Random Walks to Polymers

Course Format: two hours of lecture per week in the first semester (30 h.).
Description: random walks in one to 3 dim., recurrence and self-avoiding walks, CTRW models
of random polymers, super- and sub-diffusion, models of DNA and other organic polymers
Responsible – Assoc. Prof. E. Gudowska-Nowak/ Prof. Longa

Selforganization in Liquid Crystals and Polymers

Course Format: two hours of lecture and two hours of seminar per week in the first semester
(30+30 h.). Description: symmetry and phase transitions, nematics and smectics, defects and textures,
cholesterics, columnar phases, lyotropic systems. Polymers and nanoscale organization.
Responsible – Prof. Longa/ Assoc. Prof. A. Budkowski

Brownian Motors in Biology

Course Format: two hours of lecture per week in the first semester (30 h.).
Description: Feynman ratchet problem, tilted potentials, origin of nonzero fluxes in nonequilibrium systems, theory of linear response, motor proteins, chemical models of
ratchets, molecular wires.
Responsible – Assoc. Prof. E. Gudowska-Nowak

Stochastic Processes and Modelling

Course Format: two hours of lecture per week in the first semester (30 h.).
Description: theory of Markov and non-Markov stochastic processes, limit theorems and Levy
Distributions, fractal Brownian motion, stochastic diffusion and applications.
Responsible – Assoc. Prof. E. Gudowska-Nowak/ dr Paweł Góra

Membranes and Channels: principles of Biotransport

Course Format: two hours of lecture per week in the sec. semester (30+30 h.).
Description: channel proteins, conformations and gating, models of artificial channels, Kinetics of ion passage, molecular dynamics studies of membranes and channels
Responsible – Assoc. Prof. E. Gudowska-Nowak/ Prof. M. Pasenkiewicz-Gierula

Doing Science with Mathematica and Maple (I + II)

Course Format: two hours of lecture and two hours of classes per week in both semesters (60+60 h.).
Description:. Modeling in physics, biology, medicine and chemistry with Wolfram Software *Mathematica*. Unification of computing, simulation and visualization.
Examples: Chaos with a heart, synchronization processes in biology, discrete maps and chaos, binary collisions, dimensional analysis. Duffing equation, chemical oscillators, frequency analysis of time series, etc.
Responsible – Prof. Longa

Molecular and Quantum Dynamics Modelling of Biomolecules

Course Format: thre hours of software lab per week in the first semester (30+30 h.).
Description: use of the MSI software: CHARMM, Quanta, InsightII, principles of quantum mechanical molecular orbital calculations : Gaussian98, INDO, CNDO,MNDO
Responsible – Assoc. Prof. E. Gudowska-Nowak/ Prof. M. Pasenkiewicz-Gierula

Computer Aided Modelling & Computational Lab – aims at acquainting students with the basic

programming and problem solving with. It consists of lectures on selected computer techniques

and a series of small projects supervised by the teaching staff.
Responsible - Prof. Wit/ Dr P. Góra

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 detailed analysis of relevant experimental aspects of the problems presented in the lectures.