List of topics (subjects) for candidates willing to pass the entry examination to become the Ph.D. student at the Faculty of Physics and Applied Computer Science

SUBJECTS OF THE FIRST, MORE GENERAL PART OF THE EXAM

1. Fundamentals of classical and relativistic mechanics

Momentum conservation principle
Angular momentum conservation principle
Energy conservation principle
Galileo and Lorentz transformations
Time dilatation (also: experimental evidence)
Mass-energy equivalence (also: experimental evidence)

2. Electromagnetism

- Charge conservation principle (also: experimental evidence)
- Electrostatic field, scalar potential
- Gauss Law for electrostatic and magnetic fields
- Vector potential of magnetic field
- Electric charge in magnetic field (examples of applications)
- Magnetic field – mechanism of creation
- Electromagnetic induction
- Wave equation
- Plane wave

3. Experimental foundations of quantum mechanics

- Photoelectric effect
- Compton effect
- Black-body radiation
- Line atomic spectra
- Electron diffraction on crystal (Davisson-Germer experiment)
- Stern-Gerlach experiment

4. Structure of matter

- Standard model of elementary particles
- Atomic nucleus – model of its structure
- Atom and its structure
- Poly-atomic molecules – mechanism of bonds
- Crystal structure of solids

5. Thermodynamics and statistical physics

- Maxwell distribution
- Boltzmann distribution
- Temperature
- I principle of thermodynamics
- Entropy and II principle of thermodynamics

SUBJECTS OF THE ELECTIVE, MORE DETAILED PART OF THE EXAM

Candidate should choose **one** of the following fields of physics (and its applications)

1. Fundamentals of medical physics:

- Ultrasounds – generators and detectors of
- Ultrasounds interaction with matter
- Physical foundations of X-ray diagnostics
- Physical foundations of EPR spectrometry
- Physical foundations of NMR spectrometry
- Interaction of electromagnetic radiation (different wavelength range) with matter
- Radioisotopes in medical diagnosis– scintigraphy, gamma camera, SPECT and PET methods X-ray, radioisotopes and heavy paticles in therapy- teletherapy, brachytherapy, radiopharmaceutical therapy, hadron therapy, BNCT (boron neutron capture therapy), gamma knife, x-ray knife, cyberknife
- MIRD – Medical Internal Radiation Dose
- Influence of constant and variable electromagnetic fields on live organisms
- Thermoluminescence dosimetry

2. Fundamentals of biophysics and bionanotechnology:

- Ultrasounds interaction with matter (plus generators and detectors of ultrasounds)
- Interaction of electromagnetic radiation with matter (microwaves, infrared-radiation, visible light, ultraviolet, X-ray)
- Interaction of charged ionizing radiation with matter (electrons, protons, alpha particles, heavy irons)
- Crystallography – basic definitions, X-ray diffraction
- Synchrotron radiation – generation, properties and examples of application
- Methods in surface science (AES – Auger electron spectroscopy, XPS – X-ray photoelectron spectroscopy, SIMS – secondary ion mass spectrometry)
- Thermoluminescence – physical foundations and examples of application in biology
- Spectroscopic methods in biological and medical investigations (for example: EPR, NMR, Mössbauer spectroscopy, Infrared and Raman spectroscopy)
- Microscopies (STM – scanning tunneling microscopy, AFM – atomic force microscopy, confocal microscopy)