NATIONAL TECHNICAL UNIVERSITY OF UKRAINE
"Igor Sikorsky Kiev Polytechnic Institute"

PHYSICO-MATHEMATICAL FACULTY

APPROVED
Academic Council
Physics and Mathematics Faculty
Minutes No. _1_ of February 23, 2017
Chairman of the Academic Council _____V.V. Vanin

PROGRAM

Basic entrance exam to postgraduate study

From the specialty 104 Physics and Astronomy

The program is recommended
Educational and methodical commission
Faculty of Physics and Mathematics
Minutes No. from. .2017_

Kyiv – 2017

I. INTRODUCTION

In our time, the higher school should solve Enhance the task the fundamental nature of the education of scholars. Physics is in the first series of fundamental disciplines along with mathematics, chemistry, and others.
Along with the fundamentals of education for a specialist is important the ability to effectively use the results of physical research for accelerating scientific and technological progress. Disciplines, the content of which is included in the exam, belong to the cycle disciplines of general and theoretical physics and solid state physics. Purpose this exam is a test of the skills and abilities of entrants regarding definition of physical characteristics of processes, knowledge of basic principles and laws of physics and their mathematical form, methods of observation and experimental study of the basic physical phenomena; availability ideas about the limits of the application of physical models and theories.
Applicants must fully understand the fundamental laws Physics and methods of their research, be able to apply this knowledge when considering separate phenomena, to combine their physical substance with analytical ones correlations, ability to combine macroscopic phenomena with them microscopic mechanism; Be able to use knowledge of general courses and theoretical physics, as well as solid state physics when studying others disciplines in the specialty.
An introductory test takes place in the form of a written exam.
Each entrant receives a ticket, which contains three theoretical questions on physics.
Preparation of the response is given 90 minutes.

II. KEYWORD

The introductory test program contains the following sections:

Section 1. IDEAL CRYSTAL STRUCTURES

1.1. Perfect crystal. Crystal lattice, basis, elementary cell,
Primitive cell, Wigner-Seitz cell.
1.2. Operations of symmetry of crystalline structures. Broadcast, point operations
Symmetry, point group of symmetry.
1.3. Classification of Brave lattice and crystalline structures. Syngony
1.4. Miller's Indices. Position and designation of planes, directions and nodes
Elementary lattice in a crystal.
1.5. Reflection of X-rays from atomic planes. Bragg's law.
1.6. Methods of investigation of crystalline structures. Use of electrons
Neutrons, X-rays for the study of crystals. Method
Laue, crystal rotation method, oscillation method, powder method.
1.7. Turntable lattice. The volume of an elementary cell. The first zone of Brilien.
1.8. Periodic potential. Bloch's theorem. Bohr-Karman Boundary Conditions.
Number of permitted states.

Section 2. LATTICE OSCILLATIONS

2.1. Types of communication in crystals. Metals, ionic crystals, covalent crystals,
Molecular crystals. Classical theory of harmonic oscillations.
Heat capacity of the classical crystal. Law of Dulong-Pti. Elastic properties of crystals.
2.2. Phonons and fluctuations of the lattice. Phonon spectrum. Heat capacity of crystals by

Different temperatures. Models of Einstein and Debye. Debye temperature.
Debye-Waller Factor.
2.3. Phonons in metals. The law of dispersion of phonons. Experimental
Definition of the law of dispersion.
2.4. Anharmonic effects. Became Gruneisen Thermal conductivity of the lattice.

Section 3. ELECTRONS IN CRYSTALS

3.1. Electron in periodic crystalline lattice. Free electronic gas
Fermi Fermi's surface.
3.2. Methods of calculation of band structure. Approximation of weak link.
Energy zones.
3.3. Approximation of strong coupling for electrons. Functions Wanier.
3.4. An overview of additional methods for calculating the band structure (methods
Connected flat waves, orthogonalized plane waves method,
Pseudo-potential method).
3.5. Semiconducting theory of conductivity in metals. The effect of De Haaz-Wang-
Alfena Determination of the Fermi surface.

Section 4. SEMICONDUCTOR CRYSTALS

4.1. Own conductivity of semiconductors. Concentration of own carriers.
4.2. Impurity conductivity of semiconductors. Impurity states.
4.3. Semiconductor devices. Principle of action Scope of application.

Section 5. SUPERCONDUCTORS

5.1. Phenomenology of the phenomenon of superconductivity. The London equation. Length
Coherence.
5.2. Electron-phonon interaction in superconductors. Josephson's effect.

Section 6. MAGNETIC PROPERTIES OF CRYSTALS

6.1. Exchange interaction. Paramagnetism of atomic skeletons. Formula
Langevin
6.2. Ferromagnetism. Antiferromagnetism Curie temperature. Temperature
Neelia
6.3. Magnetism of localized moments (Heisenberg magnetics).
6.4. Magnetism of delocalized electrons.

Section 7. OPTICAL PROPERTIES OF DIELECTRIC

7.1. Excitons Weakly bound and strongly bound excitons.
7.2. Photovoltaic. Dependence of photoconductivity on photon flux.
Gain factor.
7.3. Luminescence Fluor

Section 8. PHASE TRANSFORMATIONS IN SOLIDS

8.1. Features of heat capacity at phase transitions. □point
8.2. Diffusion phase transformations. Examples
8.3. Structural phase transformations: ferroelectric, ferromagnetic,
etc.
8.4. Martensitic phase transformations.

Section 9. DEFECTS IN CRYSTALS

9.1. Spot defects - substitution atoms, penetration atoms, vacancies.
9.2. Dislocations, double borders, packaging defects. Burgers vector.
9.3. Borders of grains with a small angle of rooting. Burgers model.

Section 10. EXPERIMENTAL METHODS OF PHYSICS OF SOLID BODY

10.1.Research of the structure of crystals by X-ray and
Electronic microscopy.
10.2. Investigation of magnetic structures and phonon spectra by the method
Neutronography.
10.3.Optical methods for the investigation of solids (spectroscopy).

III. FINAL PROVISIONS

1. Support materials.
The exams do not allow the use of additional literature.
2. Evaluation criteria.
Examination ticket consists of three theoretical questions in physics.
The assessment system evaluates the ability of the entrant:
- generalize the knowledge acquired to solve specific problems, problems;
- apply rules, methods, principles, laws in specific situations;
- analyze and evaluate the facts, events and make substantiated conclusions;
- interpret circuits, graphs, diagrams;
- to present the material logically, consistently, in accordance with the requirements of the standards
The answer for an entrant is estimated on a 100-point scale (33-34 points for each question). The correct answer is a complete and adequate coverage of the issue
According to the Supplemental Entrance Testing Program
After that, the transfer of these marks into ECTS assessment according to the table is carried out:

Amount of points scored	Score
95…100	A
85…94	B
75…84	C
65…74	D
60…64	E
Less 60	F