«… Students have the opportunity to master: modern methods of insurance and financial mathematics, stochastic analysis, probability theory, mathematical statistics,
advanced methods of computer simulation of physical processes; ways and means of the scientific experiments; basics of methods of computational physics, synergetics and catastrophe theory; theory of self-organization of complex systems and the basics of dynamic chaos; theory of nonlinear phenomena ...»
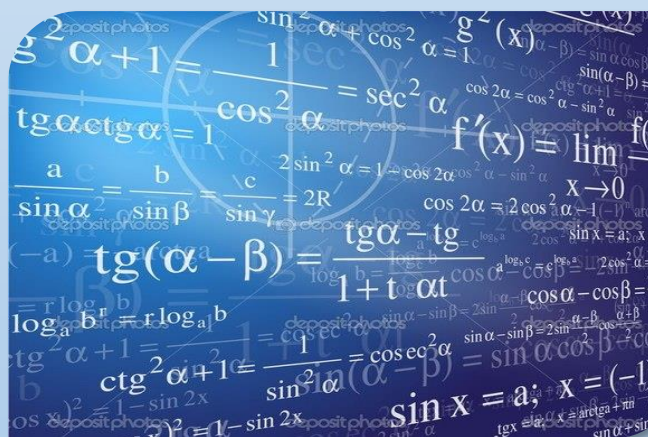
INFORMATION PACKAGE

FACULTY OF PHYSICS AND MATHEMATICS

Kyiv, 2022

CONTENT

*** *Information is current as for the 2022/2023 academic year. Next academic year, there may be minor changes in the list of specialties and educational programs.*
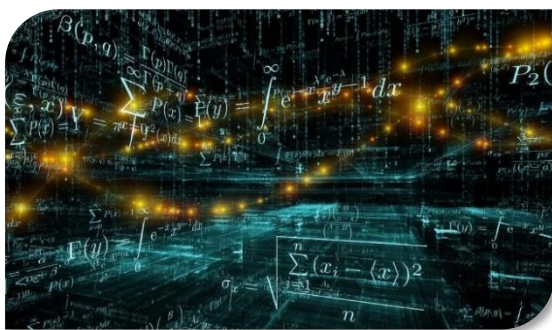
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1. COMMON DESCRIPTION OF THE FACULTY

The **Faculty of Physics and Mathematics (FPM)** trains specialists in fundamental and applied problems in various fields of modern mathematics and physics - from a theory of numbers and function theory to cryptography and computer data analysis using mathematical statistics; from aero- and hydrodynamics to physics of atomic nucleus and elementary particles using methods of mathematical and computer modeling

Students have the opportunity to master: modern methods of insurance and financial mathematics, stochastic analysis, probability theory, mathematical statistics, advanced methods of computer simulation of physical processes; ways and means of the scientific experiment; basics of methods of computational physics, synergetics, and catastrophe theory; theory of self-organization of complex systems and the basics of dynamic chaos; theory of nonlinear phenomena.

Graduates of the **Faculty of Physics and Mathematics** work as specialists in the field of insurance and financial mathematics; stochastic analysis of complex dynamical systems; statistical analysis of empirical data; nanotechnology; solid-state physics; chaos theory, and nonlinear phenomena; astrophysics; information technologies in physics; software developers of biomedical processes description; as the developers of the methods of quantum chemistry, researchers, teachers at higher education institutions, systems analysts in state and commercial institutions.

2. STRUCTURE

The faculty consists of 5 departments:

1. **Department of Differential Equations;**
2. **Department of Mathematical Analysis and Probability Theory;**
3. **Department of General Physics;**
4. **Department of General Physics and Modelling of Physical Processes;**
5. **Department of Descriptive Geometry, Engineering, and Computer-Aided Graphics,**

   as well as

   - **Interfaculty Educational and Scientific Laboratory of Computer Modelling of Physical Processes in Electronics;**
   - **Research Laboratory DIDACTIC;**
   - **Educational and Research Laboratory of Cryogenic Equipment.**

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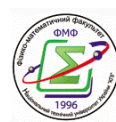
3. EDUCATIONAL PROGRAMS

Levels of higher education. Training of students at the **FPM** is carried out at three levels of higher education. T

At the first level (Bachelor's course, I-IV academic years) students acquire fundamental knowledge in physics, mathematics, mechanics, computing, informatics, and special disciplines. During the fourth year, they prepare and defend the bachelor's thesis and acquire a Bachelor's degree.

At the second level, (Master's course, I-II academic years) students acquire relevant professional skills including laboratory practice. Applicants prepare to defend a master's thesis and acquire a Master's degree.

The third educational-scientific level – postgraduate studies, I-IV academic years. Applicants defend their dissertations and they are awarded the educational qualification of Doctor of Philosophy (Ph.D.).

Terms of training: Bachelor – 4 years; Master (education-professional program) – 1.5 years; Master (education-scientific program) – 2 years; Ph.D. – 4 yearsю.

1. Department of Differential Equations provides teaching of mathematical disciplines at the Faculty of Physics and Mathematics and the engineering faculties of the Igor Sikorsky KPI/.

2. Department of Mathematical Analysis and Probability Theory provides training under the following Educational Programs:

Specialty	Educational Program	Levels of higher education		
		First	**Second**	**Third**
111 Mathematics	Actuarial and Financial Mathematics	Bachelor *EPP*	Master *EPP*	–
			Master *ESP*	
	Mathematics	–	–	Ph.D. *ESP*

Comment: *EPP* – Educational-Professional Program
ESP – Educational-Scientific Program

The department prepares experts in fundamental and applied aspects of the probabilistic analysis of complex stochastic systems. Knowledge acquired by students during training can be used for constructing mathematical models in the face of uncertainty and risks, and for evaluating the structural characteristics of the models for prediction and identification.

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Graduates work in higher educational institutions, research institutes, schools, insurance companies, banks, analytical units of investment funds and consulting firms, high-tech departments of firms for the development of software, etc.

3. Department of General Physics
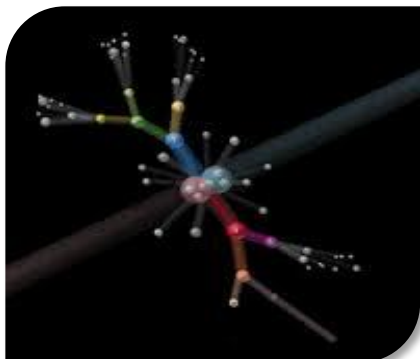
The main task of the department is the training of students in the field of physics. Teachers of the department conduct training in general and theoretical physics at the Faculty of Physics and Mathematics, Faculty of Electric Power Engineering and Automation, Institute of Energy Saving and Energy Management, Institute of Materials Science and Welding, and Institute of Nuclear and Heat Power.

The department also trains doctors of philosophy (Ph.D.) in the specialty **104** "Physics and Astronomy" (educational and scientific program "Physics").

4. Department of General Physics and Modelling of Physical Processes

Teachers of the department (professors and associate professors) are specialists in various fields of general and theoretical physics, and they help the students to master the difficult but wonderful world of physics by use of their inspiration and creative attitude to work.

Department provides training under the following Educational Programs:

Specialty	Educational Program	Levels of higher education		
		First	**Second**	**Third**
104 Physics and Astronomy	Computer Modeling of Physical Processes	Bachelor *EPP*	Master *EPP*	–
			Master *ESP*	
	Physics	–	–	PhD *ESP*

Comment: *EPP* – Educational-Professional Program
ESP – Educational-Scientific Program

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5. Department of Descriptive Geometry, Engineering, and Computer-Aided Graphics

The main objective of the department is the teaching of engineering graphics disciplines, fostering the skills of students in:

- geometric modeling of technical objects and their parameterization;
- the design of typical elements of technical objects.
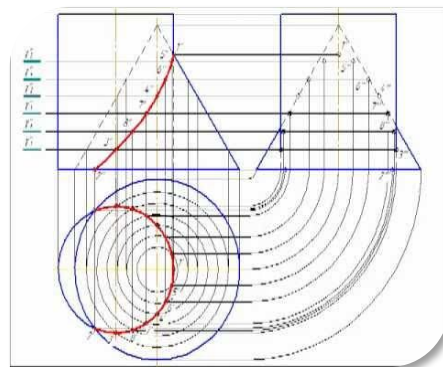
Department provides training under the following Educational Programs:

Specialty	Educational Program	Levels of higher education		
		First	Second	Third
122 Computer Sciences	Computer Sciences	–	–	Ph.D. *ESP*
131 Applied Mechanics	Applied Mechanics	–	Master *ESP*	Ph.D. *ESP*

Research Laboratory DIDACTIC is engaged in the development, manufacturing, and introduction of the educational process of modern visual teaching aids based on microprocessor technology, computer-based training programs, and distance learning tools.

4. TRAINING AND LABORATORY BASE

Classes are held in university classrooms, as well as the premises of the Faculty of Physics and Mathematics.

Training is carried out with the use of modern equipment from the university and the National Academy of Sciences of Ukraine.
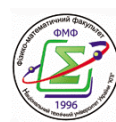
5. RESEARCH ACTIVITY

The Faculty of Physics and Mathematics conducts research in the following areas**:**

- Development of mathematical methods for the study of stochastic systems and boundary value problems of mathematical physics;
- Study of asymptotic properties of random point processes;

- Analysis of real objects in the generalized renewal processes;
- Geometrical modeling of objects, processes, and phenomena;
- Nanotechnology;
- Solid-state physics;
- Chaos theory, nonlinear phenomena;
- Differential and integral equations;
- Physics of magnetic phenomena;
- Theoretical physics.

Department of Mathematical Analysis and Probability Theory

The main focus of research is the study and development of new mathematical methods for the analysis of linear and nonlinear stochastic systems, statistical procedures, further development of the theory of special functions, and its application to problems of mathematical physics.

Methods for research of empirical full convergence are developed jointly with the scientists of the University of Ulm (Germany), and investigations are funded by the Foundation for Basic Research of Ukraine and the DFG (Germany). The Ministry of Education and Science of Ukraine and CNRF (France) fund joint work with the university experts from Cergy-Pontoise (France) on the statistical dependence.

The department also conducts joint research with the specialists from

- University of Bern (Switzerland) on the multi-dimensional random point processes in the framework of the program, which is funded by the SNCF (Switzerland);
- University of Cologne (Germany) on the analysis of dual objects, which are funded by the DFG (Germany).

Department of General Physics and Modelling of Physical Processes

The main areas of research at the department:

- Quantum chemistry methods to calculate the dynamics of complex molecules;
- Numerical methods for determining optimal regimes controlled synthesis of nanoparticles and surfaces with the desired morphology;
- Methods of signal stabilization in optical communications in a turbulent zone;
- Spectroscopy of films and nanoscale composites based on silicon-organic polymers.
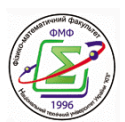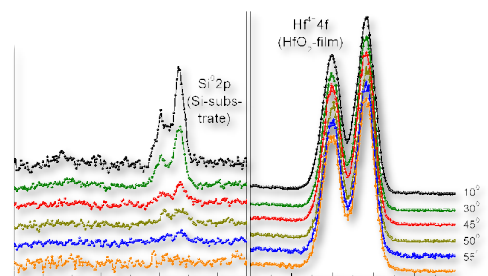
- Theoretical and experimental studies of optical, electro-physical properties and surface phenomena of semiconductor materials, modeling of self-organization processes of nanoparticles;
- Development of theoretical fundamentals, creation of a series of optoelectronic devices based on semiconductor materials;
- The latest technology of training, distance learning;
- Magnetic properties of ferromagnets and antiferromagnets;
- Electrochemical and hydrodynamic processes in a magnetic field;
- Study of the behavior of domain structures in an external magnetic field;
- Thermomagnetic phenomena in ferromagnetic bodies;
- Study of the propagation of spin waves in a magnetic medium;
- Study of surface properties of solids using scanning electron microscopy and tunneling and atomic force microscopy.

## *Department of Descriptive Geometry, Engineering, and Computer-Aided Graphics*

The main research directions of the department:
- Geometric modeling of product surfaces; design, processes, and equipment in the aircraft industry and mechanical engineering;
- Geometric modeling of multicriteria problems of science and technology;
- Simulation of agricultural production processes to optimize the construction of agricultural tools and equipment;
- The latest technologies of learning, distance learning.

Department of Differential Equations

The scientific work of the department covers the fundamental research in the following areas:

- Development of analytical methods for studies of the theory of parabolic equations;
- Theoretical study of deterministic chaos in dynamic systems;
- Development of a theory of decision operators and the theory of optimal mathematical models;
- Development of the theory of nonlinear dynamics of magnetization distributions in crystals of the external variables fields;
- Implementation of international projects on computer modeling of basic physical and mechanical processes in materials science.
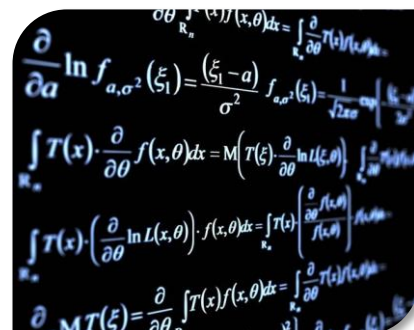
- Differential equalizations and their applications;
- Application of differential equalizations is in mechanics and thermodynamics;
- Differential equalizations are with stochastic coefficients;
- Problems of theory of functional rows;
- Problems of functional analysis.

Department of General Physics

The main directions of scientific work of the department:
- Physics of superconductivity; physics of magnetic phenomena;
- Physics of imperfect crystals;
- Physics of composite media;
- The theory of complex systems;
- Development of diagnostic sensors for aircraft systems.

6. INTERNATIONAL PROJECTS AND COLLABORATION

In recent years, mathematicians of **FPM** carry out joint projects with colleagues from Bern (Switzerland) and Paderborn (Germany) to analyze the asymptotic properties of the point random processes and limit theorems of probability theory. Within the frameworks of cooperation, joint conferences were held in Kyiv, as well as in Germany, France, and Sweden.

Physicists of the FPM carry out the joint work with colleagues from the Los Alamos National Laboratory, USA (LANL). The LANL was founded in 1943 for the implementation of the Manhattan Project to build atomic weapons. Now at the base of LANL, the fundamental investigations are conducted in many areas of physics involving scientists from all around the world.

During the past three years, active cooperation is carried out with the Center for Advanced Material Processing (Clarkson University, NY), which is supported by the joint agreement.

Department of Mathematical Analysis and Probability Theory has agreements with the Ulm University (Germany) and the Cergy-Pontoise University (France) on joint

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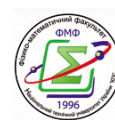
activities in the training of bachelors, masters, and Ph.D. Under these agreements, master's and post-graduate students are trained in Ulm and Paris.

Joint work is carried out with colleagues from the University of Oslo (Norway), Cardiff University (UK), University of Debrecen (Hungary), Lublin University of Technology (Poland), University of Florida Gainesville, and Lakehead University (Canada).

Department of General Physics and Modelling of Physical Processes collaborates with

- Clarkson University, NY. Centre of Advanced Material Processing - Development of highly active catalysts based on platinum nanopillars and sintering problems in nanosystems, under the agreement on cooperation between the Igor Sikorsky KPI and the Clarkson University, which operates from March 1, 2012, until February 29, 2016

- Los Alamos National Laboratory USA, NM – development of methods of calculation of the dynamics of nanosystems with an account for no-daibatics, research in the field of optical communications in a turbulent atmosphere.

- Imperial College London – development of theoretical fundamentals of the creation of metamaterials in acoustics.

Department of General Physics collaborates in the field of the physics of magnetic phenomena with the:

- Adam Mickiewicz University in Poznań (Poland);

- University of Exeter (Exeter, United Kingdom);

- University of the Basque Country (Spain);

- Royal Institute of Technology (Stockholm, Sweden).

7. CONTACT INFORMATION

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