

**MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
LVIV POLYTECHNIC NATIONAL UNIVERSITY**

APPROVED by
Rector of
Lviv Polytechnic
National University

_____ Yurii Bobalo
« ___ » _____ 2020

EDUCATIONAL AND RESEARCH PROGRAM

**third (educational and research) level of higher education
in specialty 113 “Applied Mathematics”
field of knowledge 11 Mathematics and Statistics
Qualification: Doctor of Philosophy in specialty
113 “Applied Mathematics”**

Considered and approved by
Academic Board of
Lviv Polytechnic
National University
(protocol No.
dated « ___ » _____ 2020)

Lviv 2020

Educational and Research Program in specialty 113 “Applied Mathematics” for training seekers of the third (educational and research) level of higher education was developed by the working team for ensuring the quality of the educational and research program in specialty “Applied Mathematics” consisting of:

Head of the working team (guarantor of Educational and Research Program 113 “Applied Mathematics”):

Kostrobii Petro Petrovych

Dr. Phys.-Math. Sc., Prof., Head of the Applied Mathematics Department

Members of the working team:

- | | |
|-----------------------------------|--|
| 1. Bun Rostyslav Adamovych | DScTech, Prof., Professor of the AMD |
| 2. Kushnir Roman Mykhailovych | Academician of the NAS of Ukraine, Head of Pidstryhach Institute for Applied Problems of Mechanics and Mathematics |
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| 7. Polovyi Vitaliy Yevhenovych | the 3rd year postgraduate student |

Considered and recommended at the meeting of the specialty 113 “Applied Mathematics” EMC

Protocol No. dated 2020

Head of the specialty EMC
113 “Applied Mathematics”

Dr. Phys.-Math. Sc., Prof. Kostrobii P.P.

Approved at the meeting of the Applied Mathematics Department

Protocol No. dated 2020

Head of the AMD
Secretary of the AMD
Haiduchok O.V.

Dr. Phys.-Math. Sc., Prof. Kostrobii P.P.
Cand. Econ. Sc., Assoc. Prof.

Considered and recommended at the meeting of the University Council EMC

Protocol No. dated 2020

Head of the University EMC

Cand. Econ. Sc., Prof. Zahorodniy A.H.

Approved and brought into force

by Order of the Rector of Lviv Polytechnic National University

dated “___” _____ 2020 No. ___

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I. EDUCATIONAL PART OF THE EDUCATIONAL AND RESEARCH PROGRAM

1. Profile of the Doctor of Philosophy program in the field of knowledge 11 *Mathematics and Statistics* in specialty 113 “*Applied mathematics*”

| 1 – General information | |
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| 1 | 2 |
| Full name of higher education institution and structural unit | Lviv Polytechnic National University |
| Full name of qualification in original language | Доктор філософії за спеціальністю 113 «Прикладна математика» Doctor of Philosophy in specialty 113 “Applied mathematics” |
| Official name of educational program | Прикладна математика Applied Mathematics |
| Type of diploma and scope of educational program | Diploma of Doctor of Philosophy, single, 60 ECTS credits, term of the educational part of the Educational and Research Program 1.5 years |
| Cycle/level | NQF of Ukraine – 9th level, FQ-EHEA – 3rd cycle, EQF-LLL – 8th level |
| Prerequisites | Masters level of higher education |
| Language(s) of teaching | Ukrainian language |
| Basic concepts and their definitions | The Educational and Research Program uses the main concepts and their definitions in accordance with the Law of Ukraine “On Higher Education” (dated 01.07.2014 No. 1556-VII) with amendments and additions, the Law of Ukraine “On Research and Technical Activity” (dated 26.11.2015 No. 848-VIII) with amendments and additions, the Procedure for training seekers of a higher education degree of Doctor of Philosophy and Doctor of Science in higher educational institutions (research institutions), approved by the Resolution of the Cabinet of Ministers of Ukraine (dated 23.03.2016 No. 261) |
| 2 – Aim of educational program | |
| | To provide in-depth theoretical knowledge and practical skills and abilities for the successful performance of original scientific research in the specialty 113 “ <i>Applied Mathematics</i> ” aimed at obtaining new knowledge, carrying out research activities, further professional and scientific activities, preparing and defending a dissertation. |
| 3 – Educational program characteristics | |
| Subject area (field of knowledge, specialty) | Field of knowledge – 11 <i>Mathematics and Statistics</i> , specialty – 113 “ <i>Applied Mathematics</i> ”. |
| Educational program orientation | Fundamental and applied knowledge in the field of mathematical modeling of complex natural and artificial systems; methods of developing analytical and computer research of new mathematical models of complex systems. A further scientific and/or teaching career is possible. |
| Main focus of educational program | Research in the field of “Applied Mathematics”. Acquisition of basic necessary skills for further scientific career and teaching skills of special disciplines in the field of applied mathematics. |

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| | Keywords: mathematical modeling of complex systems and processes; computer modeling and computational methods; computer simulation software. |
| Features and differences | Educational and Research Program was developed taking into account the practice of training PhDs in applied mathematics at leading universities in Europe and the USA and the experience of training post-graduate students in the following specialties: mathematical modeling and computational methods, computational mathematics, mechanics of deformable solids in research institutions of the NAS of Ukraine. The scientific part of the Educational and Research Program is determined by the direction of scientific research conducted at the department and the individual seeker curriculum. |
| 4 – Suitability of educational program graduates for employment and further education | |
| Suitability for employment | Jobs in research institutions of the NAS of Ukraine and branch ministries, higher educational institutions of the Ministry of Education and Science of Ukraine, research centers of high-tech companies. |
| Further education | Lifelong learning for improvement in research and other activities (for example, highly specialized high-tech areas). Further training in doctoral studies or post-doctoral research programs is possible; as well as advanced training at leading universities, scientific centers of the NAS of Ukraine and high-tech companies. |
| 5 – Teaching and evaluation | |
| Teaching and learning | Studying various interactive courses of mandatory Educational and Research Program component. Special courses and special seminars, consultations and individual work of selective Educational and Research Program component. Close scientific supervision, support and consultancy from post-docs, scientific supervisor and his team. Scientific research on the dissertation subject. |
| Evaluation | Tests and written exams in the disciplines of the mandatory component; seminars, scientific reports with an evaluation of achievements, and dissertation defense. |
| 6 – Program competencies | |
| Integral competence (INT) | The ability to solve complex, specialized scientific tasks and practical problems of mathematical and computer modeling of complex systems and phenomena; to carry out research and innovation activity, which involves a profound rethinking of existing and creation of new integral knowledge, as well as the practical implementation of the obtained results through scientific publications, patents and author's certificates, speeches at international and all-Ukrainian conferences. |
| General competences (GC) | <ol style="list-style-type: none"> 1) Knowledge of modern research methods in the field of mathematical and computer modeling of complex systems and phenomena, and in related fields of science; 2) critical analysis, evaluation and synthesis of new and complex ideas; 3) the ability to effectively communicate with the broad scientific community and the public in matters of applied mathematics; 4) persistence in achieving the goal, development of creativity; |

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| | <ol style="list-style-type: none"> 5) ability to self-develop and self-improve during life, responsibility for teaching others; 6) social responsibility for the results of strategic decision-making; 7) initiation of original research and innovation complex projects; 8) leadership and ability to work autonomously and in a team during project implementation. |
| Special (professional) competences (SC) | <ol style="list-style-type: none"> 1) Knowledge of development trends and the most important new developments in the field of mathematical and computer modeling of complex systems, as well as related areas; 2) knowledge and understanding of modern scientific theories and methods, the ability to effectively apply them for the synthesis and analysis of mathematical models of complex systems and phenomena; 3) ability to effectively apply analytical methods of analysis and mathematical modeling of complex systems, to perform computer experiments when conducting scientific research; 4) ability to integrate knowledge from other disciplines, apply a systematic approach and take into account non-technical aspects when solving scientific and applied problems and conducting research; 5) ability to develop and implement projects, including own research, which make it possible to rethink existing or create new knowledge, as well as to solve complex problems in the field of mathematical and computer modeling; 6) ability to justify the choice of a method of solving a specialized problem, critically evaluate the obtained results, and defend the decisions made; 7) ability to transfer acquired knowledge and research results to persons who want to study; 8) ability to comply with ethical obligations in scientific research. |
| 7 – Program learning outcomes | |
| Knowledge (KN) | <ol style="list-style-type: none"> 1) Knowledge of modern research methods in the field of mathematical and computer modeling of complex systems and phenomena; 2) ability to demonstrate in-depth knowledge in the chosen specialization; 3) ability to demonstrate an understanding of the impact of technical solutions in the public, economic and social context. |
| Skills (SK) | <ol style="list-style-type: none"> 1) To search, analyze and critically evaluate information from various sources; 2) apply knowledge and understanding to solve problems of synthesis and analysis of elements and systems characteristic for the chosen specialization; 3) to model and investigate phenomena and processes in complex systems; 4) to independently plan and carry out research, evaluate the obtained results; 5) apply information and communication technologies and skills in programming to solve the problems of mathematical modeling of complex systems and phenomena; 6) to work effectively both individually and as part of a team; |

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| | <ol style="list-style-type: none"> 7) to combine theory and practice, as well as make decisions and develop an activity strategy to solve the tasks of specialization, taking into account universal human values, public, state and industrial interests; 8) to independently carry out scientific research and apply research skills on professional issues; 9) to independently model the system (phenomenon) and their elements, taking into account all aspects of the task; 10) to justify the choice of methods for solving a specialized problem, critically evaluate the obtained results and defend the decisions made; 11) to evaluate the practicality and possibility of applying new methods and technologies in mathematical and computer modeling tasks. |
| Communication (COM) | <ol style="list-style-type: none"> 1) Ability to communicate effectively at the professional and social levels; 2) ability to present and discuss the obtained results and transfer the acquired knowledge. |
| Autonomy and responsibility | <ol style="list-style-type: none"> 1) Ability to adapt to new conditions, make decisions independently and initiate original research and innovation complex projects; 2) ability to realize the need for lifelong learning in order to deepen acquired and acquire new professional knowledge; 3) ability to take responsibility for the work performed and achieve the set goal in compliance with the requirements of professional ethics. |
| 8 – Resource support for program implementation | |
| Specific characteristics of staffing | 100% of scientific and pedagogical workers involved in teaching professionally oriented disciplines have scientific degrees in their specialty. |
| Specific characteristics of material and technical support | Usage of modern research software in the field of mathematical modeling of complex processes and phenomena. |
| Specific characteristics of informational and methodological support | Usage of Virtual Learning Environment of Lviv Polytechnic National University and teaching staff author's developments. |
| 9 – Main components of educational program | |
| List of educational components (disciplines, practices, coursework and qualification papers) | The matrix of program competencies correspondence to educational disciplines and the structure of the educational program are given in the Appendices. |
| 10 – Academic mobility (regulated by the Resolution of the CMU No. 579 “On Approval of the Regulation on the Procedure for Implementing the Right to Academic Mobility” dated August 12, 2015) | |
| National credit mobility | On the basis of bilateral agreements between Lviv Polytechnic National University and technical universities of Ukraine. |
| International credit mobility | Within the EU Erasmus+ program on the basis of bilateral agreements between Lviv Polytechnic National University and educational institutions of partner countries. |
| Teaching of foreign seekers of higher education | Possible. |

**2. Distribution of the content
of Educational and Research Program educational part
by component groups and training cycles**

| No. | Training cycle | Amount of postgraduate teaching load (credits / %) | | |
|--------------------------------------|--|---|--|--------------------------------------|
| | | Mandatory components of educational part | Selective components of the educational part | Total for the entire period of study |
| 1. | The cycle of disciplines that form general scientific competences and universal skills of a researcher | 27/45 | 4/6.7 | 31/51.7 |
| 2. | The cycle of disciplines that form the professional competencies of a researcher | 6/10 | 20/33.3 | 26/43.3 |
| 3. | The cycle of subjects of free choice for a postgraduate student | - | 3/5 | 3/5 |
| Total for the entire period of study | | 33/55 | 27/45 | 60/100 |

3. List of components of Educational and Research Program educational part

| E/d code | Semester | Components of educational part | Number of credits | Weekly class. load (lect./pr.) | Form of control |
|---|----------|---|-------------------|--------------------------------|-----------------|
| 1 | 2 | 3 | 4 | 5 | 6 |
| 1. Mandatory components of educational part | | | | | |
| 1.1. The cycle of disciplines that form general scientific competences and universal skills of a researcher | | | | | |
| OK1.1. | 1 | Foreign Language for Academic Purposes 1 | 4 | 0/2 | test |
| OK1.2. | 1 | Professional Pedagogy | 4 | 1/1 | exam |
| OK1.3. | 1 | Philosophy and Methodology of Science | 4 | 2/1 | exam |
| OK1.4. | 1 | Additional Sections of Computational Mathematics | 5 | 1/1 | exam |
| OK1.5. | 1 | Academic Entrepreneurship | 3 | 1/1 | exam |
| OK1.6. | 2 | Foreign Language for Academic Purposes 2 | 4 | 0/2 | test |
| OK1.7. | 3 | Pedagogical Practice | 3 | 0/0,5 | test |
| Total per cycle: | | | 27 | | |
| 1.2. The cycle of disciplines that form the professional competencies of a researcher | | | | | |
| OK2.1. | 2 | Foreign Language as Language of Scientific Communication | 3 | 0/1 | test |
| OK2.2. | 2 | Communicability and Ethics of Scientific Research | 3 | 1/0 | test |
| OK2.3. | 1 | Technologies for Issuing Grants, Scientific Projects and Their Management | 4 | 1/1 | test |
| Total per cycle: | | | 10 | | |
| 2. Selective components of the educational part | | | | | |
| 2.1. The cycle of disciplines that form general scientific competences and universal skills of a researcher | | | | | |
| VB1.1. | 2 | Modern Methods in the Theory of Boundary Value Problems | 4 | 1/1 | exam |
| VB1.2. | 2 | Numerical Methods of Studying Nonlinear Models | 4 | 1/1 | exam |
| VB1.3. | 3 | Special Courses on the Subject of Dissertation Work | 6 | 0,5/0 | exam |
| VB1.4. | 3 | Special Seminar on the Subject of Dissertation Work | 6 | 0/0,5 | test |
| VB1.5. | 2 | Mathematical Models of Ecological Processes | 4 | 1/1 | exam |
| VB1.6. | 2 | Numerical Methods of Research and Optimization of Discrete Models | 4 | 1/1 | exam |
| Total per cycle: | | | 20 | | |
| 2.2. The cycle of subjects of free choice for a postgraduate student | | | | | |
| VB1.7 | | | 3 | 0/0,5 | test |

II. SCIENTIFIC PART OF THE EDUCATIONAL AND RESEARCH PROGRAM

The scientific part of the Educational and Research Program allows the post-graduate student to conduct his own scientific research under the supervision of a scientific supervisor and write the results obtained in the research process in the form of a dissertation.

The dissertation work for obtaining the degree of Doctor of Philosophy is an independent detailed study of an actual scientific problem in specialty 113 “*Applied Mathematics*”, the results of which are characterized by scientific novelty and are published in relevant publications.

The scientific part of the Educational and Research Program is drawn up as an individual plan of scientific work and is an integral part of the curriculum.

An obligatory element of the scientific part of the Educational and Research Program is the preparation and publication of scientific articles in journals that are included in the abstract and citation databases of Scopus or WEB of Science, specialized publications, speeches at scientific conferences, specialized seminars, schools, and symposia.

Subjects of scientific research by specialty 113 “*Applied Mathematics*”:

1. Mathematical modeling of reaction-diffusion processes in low-dimensional systems;
2. Mathematical modeling of plasmonics systems, including modulated nanostructures;
3. Mathematical modeling of thermodynamic and non-equilibrium characteristics of low-dimensional metallic systems;
4. Mathematical modeling of equilibrium characteristics of deformable solids;
5. Mathematical modeling in problems of thermomechanics of deformed solids;
6. Mathematical modeling of socio-economic processes;
7. Mathematical modeling of ecological processes and greenhouse gas accounting processes;
8. Mathematical modeling of information systems through the development of the theory and application of neural networks;

which corresponds to the departmental topic “Mathematical Modeling of Complex Systems” registered in UKRNTI (PM-6, state registration number 0118UOO1547).

Scientific and pedagogical practice

The scientific practice consists of the postgraduate student participation in: the implementation of the state-budget, state-contracted scientific research works of structural units (laboratories) of the university, international and state projects, programs and grants, other scientific activities that correspond to the subject of the postgraduate student's research work.

The pedagogical practice is a component of practical professional training for research and pedagogical activity in a higher educational institution and is aimed at acquiring skills in the implementation of the educational process in a higher educational institution and the formation of teaching skills, in particular, teaching special disciplines that correspond to the subject of a graduate student's research work, organization of students educational activities, relevant scientific and methodical work.

III. ATTESTATION

Attestation of seekers of higher education degree of Doctor of Philosophy is carried out by a specialized academic board, permanently active or formed for a one-time defense based on a public presentation of scientific research in the form of a dissertation.

A mandatory condition for admission to the defense is the successful completion of the postgraduate student's study plan.

Seekers of higher education degrees of Doctor of Philosophy present their dissertations, as a rule, in a permanent specialized academic board on the relevant specialty, which functions in the higher educational institution in which the postgraduate student training took place. The academic board of a higher education institution has the right to submit to the National Agency for Quality Assurance of Higher Education documents for the accreditation of a specialized academic board formed for a one-time defense, or to apply to another higher education institution where a permanent specialized academic board operates on the relevant specialty.

The minimum volume of the main part of the dissertation is within 3.25-4 authors' pages for this Educational and Research Program.