**MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE**

**NATIONAL TECHNICAL UNIVERSITY OF UKRAINE**

**“IGOR SIKORSKY KYIV POLYTECHNIC INSTITUTE”**

APPROVED

By Scientific Council of Igor Sikorsky Kyiv Polytechnic Institute

(protocol № \_\_\_ from «\_\_\_» \_\_\_\_\_\_ 2021)

Chairman of the Academic Council

 **\_\_\_\_\_\_\_\_\_ Mykhailo ILCHENKO**

**MATHEMATICAL METHODS OF COMPUTER MODELING,**

**PATTERN RECOGNITION**

**AND COMPUTER VISION**

**EDUCATIONAL AND SCIENTIFIC PROGRAM**

**of the second (master) level of higher education**

|  |  |
| --- | --- |
| **Specialty** | **113 Applied Mathematics** |
| **Field of knowledge** | **11 Mathematics and statistics** |
| **Qualification** | **Master of Applied Mathematics** |

AGREED BY

Scientific and Methodological Board

of Igor Sikorsky Kyiv Polytechnic Institute

In specialty 113 Applied Mathematics

 (Protocol No. \_\_ dated «\_\_» \_\_\_\_\_ 20\_)

Kyiv – 2021

**PREAMBLE**

**DESIGNED by the group consisting of:**

*Head of the project group:*

|  |  |
| --- | --- |
| Smirnov Serhiy Anatoliyovych, Deputy Director of the Institute of Physics and Technology, Associate Professor of Information Security, Senior Research Fellow, Candidate of Physical and Mathematical Sciences |  |

*Members of the project group:*

|  |  |
| --- | --- |
| Novikov Oleksiy Mykolayovych, Director of the Institute of Physics and Technology, Professor, Doctor of Technical Sciences |  |
|  |  |
| Tereshchenko Ivan Mykolayovych, Deputy Director of the Institute of Physics and Technology, Candidate of Physical and Mathematical Sciences, Associate Professor of Information Security |  |
|  |  |
| Kravtsov Oleg Vasilyevich, Associate Professor of the Department of Information Security, Associate Professor, Candidate of Physical and Mathematical Sciences |  |
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| Kaczynski Anatoliy Bronislavovych, Professor of the Department of Information Security, Professor, Doctor of Technical Sciences |  |
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| Lavreniuk Alla Mykolayivna, Associate Professor of the Information Security Department, Candidate of Technical Sciences |  |
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| Stepochkina Irina Valerievna, Associate Professor of Information Security, Candidate of Technical Sciences |  |
|  |  |
| Graivoronsky Mykola Vladlenovych, acting Head of the Department of Information Security, Associate Professor of the Department of Information Security, Associate Professor, Candidate of Physical and Mathematical Sciences |  |

**APPROVED BY:**

Scientific and Methodological Board of Igor Sikorsky Kyiv Polytechnic Institute, speciality 113 Applied Mathematics

Head of SMBU 113 Applied Mathematics

\_\_\_\_\_\_\_\_\_\_\_ Mikhail SAVCHUK

(Protocol № \_\_\_ dated «\_\_\_» \_\_\_\_\_\_\_\_ 2021)

Methodical Council of Igor Sikorsky Kyiv Polytechnic Institute

Chairman of the Methodical Board

\_\_\_\_\_\_\_\_\_\_\_\_\_ Yuriy YAKYMENKO

(Protocol № \_\_\_ dated «\_\_\_» \_\_\_\_\_\_\_\_ 2021)

**PROFESSIONAL ASSESSMENT**

Executed by the following stakeholders:

Andriy Fisunenko, Vice President of Development and Research

Samsung Electronics Ukraine Ltd.,

Center for Development and Research

Schlesinger Mikhail Ivanovich, Ph.D. n., prof.,

Chief Researcher, International

scientific and educational center of information technologies

and systems of the NAS of Ukraine

and the Ministry of Education and Science of Ukraine

Panchenko Ivan Vladimirovich, director

Apersept Ltd., representative of Apostera GmbH in Ukraine

Khomenko Ruslan, 5th year undergraduate student

in the specialty 113 Applied Mathematics

Bondar Maria, 4th year undergraduate student

in the specialty 113 Applied Mathematics

Feedback reviews of stakeholders are attached.

The educational program was discussed after receiving all the wishes and suggestions from applicants for higher education and graduates of the educational program and approved at an extended meeting of the Department of Information Security (Protocol № \_\_\_ dated «\_\_\_» \_\_\_\_\_\_\_\_ 2021)

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# 1. PROFILE OF THE EDUCATIONAL PROGRAM

**in the specialty 113 Applied Mathematics**

**for the educational program "Mathematical methods of modeling, pattern recognition and computer vision"**

|  |
| --- |
| **1 – General information** |
| Full title of higher educational institution and institution/faculty | National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”, Institute of Physics and Technology |
| The degree of higher education and the title of the qualification | Degree of higher education - MasterQualification - Master of Applied Mathematics |
| Level in the national qualifications framework | The level of the national qualifications framework of Ukraine - 7 level, FQ-EHEA - second cycle, EQF-LLL - 7 level |
| The official title of the educational program | Mathematical methods of modeling, pattern recognition and computer vision |
| Type of diploma and scope of the educational program | Master's degree, unitary, 120 credits, the term of study – 1 year 9 months |
| Availability of accreditation | Ministry of Education and Science of Ukraine Certificate of accreditation series № 1192616. Accreditation period until 01.07.2023. |
| Prerequisites | The bachelor degree |
| Teaching language(s) | Ukrainian |
| The duration of the educational program | Until the next accreditation |
| Internet address of the permanent placement of the educational program | <https://osvita.kpi.ua/node/103>ipt.kpi.ua |
| **2 – The purpose of the educational program** |
| **Purpose of the EP**: Training of specialist capable of solving a wide range of mathematical problems in the field of modern applications of computer technology, to carry out research and teaching activities in the specialty; use and implement mathematical methods and the latest technologies in the field of decision support, pattern recognition and computer vision, to carry out research and teaching activities in the specialty; providing basic training and life-long learning skills; harmony, multidimensionality of education; integration of research and practical activities and educational process; focus on international requirements in the field (ACM Curriculum Committee); dual education, focus on labor market requirements, promising research. |
| **3 – Characteristics of the educational program** |
| Subject area (field of knowledge, specialty) | Field of knowledge - 11 Mathematics and statisticsSpecialty - 113 Applied MathematicsEducational program - **Mathematical methods of modeling, pattern recognition and computer vision**Objects of study and activities: mathematical methods, models, algorithms and software designed for research, analysis, design of processes and systems in various specific subject areas, including modeling, pattern recognition and computer vision. |
| Orientation of the educational program | Educational and scientific |
| The main focus of the educational program | *The basic focus of EP* is mathematical modeling, computer solution of a wide range of applied problems, including in the areas of decision support, pattern recognition and computer vision*Keywords*: mathematical methods, algorithms, mathematical modeling, pattern recognition, machine learning, data analysis, computer vision |
| Peculiarities of the program | Passing research practice and implementation of joint projects commissioned by state, research institutions and leading IT companies of Ukraine in the specialty, dual education. Unique in Ukraine orientation of education on actual tasks of pattern recognition and computer vision. |
| **4 – Eligibility of graduates for employment and further training** |
| Eligibility for employment | According to the State Classification of Occupations ДК 003:2010 graduates can work in positions corresponding to the classification groups:2121.2 Mathematician (applied mathematics)2132.2 Applied programmer2139.1 Researcher (computing industry)2121.1 Researcher-consultant (mathematics)EP graduates can work as consultants in the application of mathematics and statistics to solve a wide range of applied problems, IT specialists, systems analysts, application programmers, researchers. |
| Further training | Continuation of education at the third (educational and scientific) level of higher education |
| **5 – Teaching and assessment** |
| Teaching and studying | The program provides student-centered learning. Teaching takes the following forms: lectures, practical and seminar classes, computer workshops and laboratory work; course projects and works; technology of blended learning in some educational components, practices; execution and defense of a master's theses |
| Assessment | Assessment of students' knowledge is carried out in accordance with the Regulations on the rating system for assessing the learning outcomes of students of the Igor Sikorsky Kyiv Polytechnic Institute for all types of classroom and extracurricular work (incoming, current, boundary, final control); oral and written exams, tests) |
| **6 – Program competencies** |
| Integral competency | Ability to solve specialized scientific problems and practical problems in mathematics and statistics |
| **General competency (GC)** |
| GC1 | Ability to abstract thinking, analysis and synthesis |
| GC2 | Ability to self-study, search, process and analyze information from various sources |
| GC3 | Ability to develop solutions in accordance with intellectual property standards |
| GC4 | Ability to manage projects, provide solutions to problems in accordance with the principles of sustainable development of society |
| GC5 | Interpersonal skills and abilities, ability to scientific communication in a foreign language |
| GC 6 | Ability to make informed decisions, present and convey knowledge and ideas to the general public, the implementation of educational activities |
| GC 7 | Ability to carry out research activities |
| **Professional competencies (PC)** |
| PC1 | Ability to use mathematical apparatus, develop models for solving a wide range of problems, modeling complex systems. |
| PC 2 | Ability to use methods and technologies of pattern recognition, knowledge management and data mining |
| PC 3 | Ability to use theory-game methods, decision-making methods in conditions of uncertainty |
| PC 4 | Ability to develop new methods and algorithms for solving applied problems of modeling, pattern recognition and computer vision |
| PC 5 | Ability to research scientific problems in the specialty |
| PC 6 | Ability to offer practical solutions in the specialty taking into account modern advances in science |
| **7 - Program outcomes of studing** |
| POS 1 | Use and adapt mathematical theories and models to provide a theoretical basis for solving scientific and practical problems. |
| POS 2 | Select, apply and develop new methods and algorithms for pattern recognition and computer vision to solve scientific and applied problems |
| POS 3 | Select, apply and develop new methods and algorithms for modeling, analysis, decision making to solve scientific and applied problems. |
| POS 4 | Conduct mathematical and computer modeling, analysis and data processing, computational experiment, solving formalized problems using modern methods of data analysis and knowledge management models. |
| POS 5 | Formulate a mathematical statement of the problem, based on the statement in the language of the subject area, and choose a method for solving it that provides the required accuracy and reliability of the result. |
| POS 6 | Use the norms of intellectual property in professional activities, communicate at a professional level (including in a foreign language), carry out educational activities |
| POS 7 | Find, study and analyze scientific and technical information, domestic and foreign experience related to professional issues. |
| POS 8 | Compile scientific reports on the performed research work and implement in practice the results of research and development, report and publish research results. |
| POS 9 | Manage projects, organize their own professional activities in accordance with the principles of sustainable development of society |
| **8 – Resource provision of the program’s implementation** |
| Staffing | In accordance with the staff requirements for ensuring the educational activities’ implementation at the relevant level of HE (annex 12 to the License Terms), approved by Decree of the Cabinet of Ministers of Ukraine No. 1187 dated December 30, 2015, (prevailing) updated by Decree No. 347, May 10, 2018. |
| Material-and-technical supplying | In accordance with the technological requirements for material-and-technical supplying of educational activities’ implementation at the relevant level of HE (annex 13 to the License Terms), approved by Decree of the Cabinet of Ministers of Ukraine No. 1187 dated December 30, 2015, updated by Decree No. 347, May 10, 2018, 3 computer classes, Cybersecurity ground.Use of equipment for lectures in the format of presentations, network technologies, in particular on the Sikorsky distance learning platform. |
| Informational and methodological supplying | In accordance with the technological requirements for informational and methodological supplying of educational activities’ implementation at the relevant level of HE, (annex 14 and 15 to the License Terms) approved by Decree of the Cabinet of Ministers of Ukraine No. 1187 dated December 30, 2015, (prevailing) updated by Decree No. 347, May 10, 2018.Resources of the Igor Sikorsky KPI Scientific and Technical Library |
| **9 – Academic Mobility** |
| National credit mobility | Participation of students in academic mobility programs, the possibility of concluding agreements on academic mobility. |
| International Credit Mobility | Possibility of concluding agreements on international academic mobility, on long-term international projects. |
| Training of foreign applicants acquiring higher education | Possibility of teaching in Ukrainian in general training groups or in English with the provision of learning Ukrainian as a foreign language |

# 2. List of components of the educational and scientific program

|  |  |  |  |
| --- | --- | --- | --- |
| E/D code | Components of the educational program (disciplines, course projects (works), practices, qualification work) | Number of credits | Final assessment form |

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | 2 | 3 | 4 |
| **1. Compulsory Educational Components** |
| **1.1 General Training Cycle** |
| GC 1 | Intellectual Property and Patent Science | 3 | Credit |
| GC 2 | Sustainable Innovation Development | 2 | Credit |
| GC 3 | Practical course of foreign language scientific communication | 4,5 | Credit |
| GC 4 | Startup Projects Development | 3 | Credit |
| GC 5 | Pedagogical Skills | 2 | Credit |
| GC 6 | Intellectual Data Analysis  | 4 | Exam |
| GC 7 | Modelling of Complex Systems | 4 | Exam |
| **1.2 Vocational Training Cycle** |
| PC 1 | General Game Theory | 5 | Exam |
| PC 2 | Construction of Mathematical Models in Natural Science | 5,5 | Credit |
| PC 3 | Statistical Methods of Recognition | 6 | Exam |
| PC 4 | Models and Decision Making under Uncertainty | 3,5 | Credit |
| PC 5 | Models of Knowledge Management | 4 | Exam |
| PC 6 | Models of Cyber-Physical Systems | 5 | Exam |
|  **Research (scientific) component** |
| PC 7 | Scientific Work on the Topic of Master's Thesis |  |  |
| PC 7.1 | 1. Fundamentals of Scientific Research | 2 | Credit |
| PC 7.2 | 2. Research Work on the Topic of Master's Thesis | 9,5 | Credit |
| PC 8 | Scientific -Research Practice | 9 | Credit |
| PC 9 | Master's Thesis Implementation and Defence | 17 | Graduation |
| **2. Оptional educational components** |
| **2.1. Vocational training cycle** **(Оptional subjetcs from Faculty catalogue)** |
| PO 1 | Educational Component I of Faculty Catalog | 4 | Credit |
| PO 2 | Educational Component II of Faculty Catalog | 5 | Exam |
| PO 3 | Educational Component III of Faculty Catalog | 5 | Exam |
| PO 4 | Educational Component IV of Faculty Catalog | 5 | Exam |
| PO 5 | Educational Component V of Faculty Catalog | 4 | Credit |
| PO 6 | Educational Component VI of Faculty Catalog | 4 | Credit |
| PO 7 | Educational Component VII of Faculty Catalog | 4 | Credit |
|  |
| **The total scope of the general training cycle:** | **89** |
| **TOTAL IN SELECTIVE educational components:** | **31** |
| **TOTAL** | **120** |

# 3. STRUCTURAL AND LOGICAL DIAGRAM OF THE EDUCATIONAL PROGRAM



# 4. THE FORM OF GRADUATION CERTIFICATION FOR THE RECIPIENTS OF HIGHER EDUCATION

Certification of applicants for higher education in the educational program of the specialty 113 Applied Mathematics is carried out in the form of defense of a master's thesis and ends with the issuance of a standard document on awarding him a master's degree with the educational qualification "Master of Applied Mathematics" with a specialization in "Mathematical Methods of Modeling, Pattern Recognition and Computer Vision".

Graduation certification is open and public. Master's theses are checked for signs of violation of academic integrity and after defense are published in the repository of NTB University for free access.

# 5. MATRIX OF CORRESPONDENCE OF PROGRAM COMPETENCES TO EDUCATIONAL PROGRAM COMPONENTS

|  |  |  |
| --- | --- | --- |
|  | GC | PC |
|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 1 | 2 | 3 | 4 | 5 | 6 |
| GC 1 |  |  | + |  |  |  |  |  |  |  |  |  |  |
| GC 2 |  |  |  | + |  |  |  |  |  |  |  |  |  |
| GC 3 |  |  |  |  | + |  |  |  |  |  |  |  |  |
| GC 4 |  |  |  | + |  | + |  |  |  |  |  |  |  |
| GC 5 |  | + |  |  |  | + |  |  |  |  |  |  |  |
| GC 6 | + | + |  |  |  |  | + | + |  |  |  |  |  |
| GC 7 | + |  |  |  |  |  | + | + | + |  | + |  |  |
| PC 1 | + |  |  |  |  |  | + | + |  | + | + |  |  |
| PC 2 | + |  |  |  |  |  | + | + | + |  | + |  |  |
| PC 3 | + |  |  |  |  |  | + | + | + |  | + |  |  |
| PC 4 | + |  |  |  |  |  | + | + |  | + | + |  |  |
| PC 5 | + |  |  |  |  |  | + | + | + |  | + |  |  |
| PC 6 | + |  |  |  |  |  | + | + | + |  | + |  |  |
| PC 7.1 | + |  |  |  |  |  | + | + |  |  |  | + | + |
| PC 7.2 | + |  |  |  |  |  | + | + |  |  |  |  | + |
| PC 8 | + | + | + | + | + | + | + | + | + | + | + | + | + |
| PC 9 | + | + | + | + | + | + | + | + | + | + | + | + | + |

# 6. MATRIX OF PROVIDING PROGRAM LEARNING OUTCOMES WITH RELEVANT COMPONENTS OF THE EDUCATIONAL PROGRAM

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| POS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| GC 1 |  |  |  |  |  | + |  |  |  |
| GC 2 |  |  |  |  |  |  |  |  | + |
| GC 3 |  |  |  |  |  | + |  |  |  |
| GC 4 |  |  |  |  |  |  |  |  | + |
| GC 5 |  |  |  |  |  | + |  |  |  |
| GC 6 |  |  |  | + | + |  |  |  |  |
| GC 7 | + |  | + | + | + |  |  |  |  |
| PC 1 | + |  | + |  | + |  |  |  |  |
| PC 2 | + |  | + | + | + |  |  |  |  |
| PC 3 | + | + |  |  | + |  |  |  |  |
| PC 4 | + |  | + |  | + |  |  |  |  |
| PC 5 | + |  | + | + |  |  |  |  |  |
| PC 6 | + |  | + | + | + |  |  |  |  |
| PC 7.1 |  |  |  |  |  |  | + | + |  |
| PC 7.2 | + |  | + | + | + |  | + | + |  |
| PC 8 | + | + | + | + | + | + | + | + | + |
| PC 9 | + | + | + | + | + | + | + | + | + |