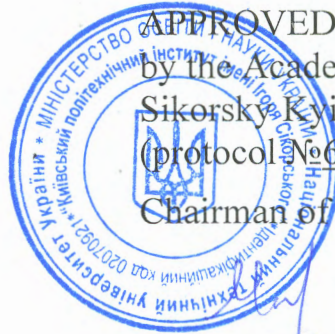


MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE  
NATIONAL TECHNICAL UNIVERSITY OF UKRAINE  
«Igor Sikorsky Kyiv Polytechnic Institute»



APPROVED

by the Academic Council of Igor  
Sikorsky Kyiv Polytechnic Institute  
(protocol №6 dated September 07, 2020)

Chairman of the Academic Council

Mykhailo ILCHENKO

**MICRO- AND NANOSYSTEM ENGINEERING  
(МІКРО- ТА НАНОСИСТЕМА ТЕХНІКА)**

**EDUCATION AND RESEARCH PROGRAMME**

**third level of higher education**

<b>speciality</b>	<b>153 Micro- and nanosystem engineering</b>
<b>field of knowledge</b>	<b>15 Automation and instrument engineering</b>
<b>qualification</b>	<b>Doctor of Philosophy in Micro- and nanosystem engineering</b>

Enacted since 2020/2021 academic year  
(Rector's order №1/282 dated September 17, 2020)

Kyiv – 2020

## PREAMBLE

**DEVELOPED** by the project team:

Project team leader:

Volodymyr Tymofeyev, Dr.Sc, Head of Electronic Engineering Dept.

Project team members:

Anatolii Orlov, Cand.Sc., Head of Microelectronics Dept.

Volodymyr Verbytskii, Dr.Sc, Professor, Microelectronics Dept.

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Tetiana Volkhova, Cand.Sc., Assoc. Prof., Microelectronics Dept.

Victor Kazmirenko, Cand.Sc., Assoc. Prof., Electronic Engineering Dept.

### **AGREED:**

The Scientific and Methodological Commission of the University on speciality 153  
«Micro- and nanosystem engineering»

Chairman of the SMCU 153

Volodymyr TYMOFEYEV

(Protocol №3 dated September 03, 2020)

The Methodological Council of Igor Sikorsky Kyiv Polytechnic Institute

Chairman of the Methodological Council

Yurii YAKYMENKO

(Protocol №1, September 03, 2020)

## **CONSIDERED:**

professional examination of stakeholders:

Yu. L. Zabulonov,  
Director of the Institute of Environmental Geochemistry of the National Academy of Sciences of  
Ukraine,  
Corresponding Member NAS of Ukraine

A. G. Misura,  
Director of the Institute of Applied Problems of Physics and Biophysics,  
Ph.D.

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Ph.D.

Grudanov Mykola Borisovich,  
General Director of GENESIS LLC  
Ph.D.

O. I. Khodchenko,  
General Director of Modul Research and Production Company LLC

D. O. Prangov,  
Director of UkrSemi LLC

N. A. Kovriga,  
Head of the Personnel Department of PJSC Indar Insulin Production

M. V. Kukhar,  
Director of LLC "Research and Production Enterprise" Termix "

reviews of specialists of the Educational and Methodical Department of Igor Sikorsky KPI.

Feedback reviews of stakeholders are attached.

The educational program was discussed after receiving all wishes and suggestions from applicants, stakeholders and approved at extended meetings.

- Department of Electronic Engineering (record № 2 from "2" September 2020);
- Department of Microelectronics (record № 2 from "2" September 2020).

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# 1. Profile of the educational program

## specialty: 153 Micro- and nanosystem engineering

<b>1 – General information</b>	
Higher education institution and faculty / institute full name	National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Faculty of Electronics
Higher education degree and qualification title in the original language	Doctor of Philosophy in Micro- and nanosystem engineering
Educational programme official title	“Micro- and nanosystem engineering”
Diploma type and educational programme scope	Doctor of Philosophy diploma, Educational part: 40 credits ECTS, study duration – 4 years
Prior accreditation	Under accreditation for the first time. Accreditation of the educational and scientific program is being held by the National Agency for Higher Education Quality Assurance according to the Law of Ukraine “On Higher Education”.
Education cycle / level of higher education	Ukraine national qualification matrix – 8 level QF-EHEA – third cycle EQF-LLL – 8 level
Prerequisites	Master Degree
Language (s) of instruction	Ukrainian, English
Validity	Till next accreditation
Permanent link to the programme online	<a href="http://ee.kpi.ua/edu/onp_phd_en.pdf">http://ee.kpi.ua/edu/onp_phd_en.pdf</a>
<b>2 – Educational programme purpose</b>	
Training of specialists in micro- and nanosystem engineering, micro- and nanoelectronics, biomedical electronics, able to solve complex problems in the field of professional and research-innovative activities, as well as to solve complex specialized tasks, pedagogical and scientific-innovative activities, involving intercultural interaction with representatives of academic and scientific and technical communities in the context of comprehensive professional, intellectual, social and creative development of the individual in the educational and scientific environment.	
<b>3 – Educational programme characteristics</b>	
Subject area	<i>Object of activity:</i> physical processes and phenomena on which the functioning of micro- and nanosystems is based; technological processes of their production, principles of operation, devices, devices and systems of micro- and nanosystem technology, including micro- and nanosystems of biomedical purpose, models of micro- and nanosystems. <i>The purpose of training</i> is to train specialists capable of solving complex problems in the field of professional and research and innovation activities in the field of development, design, production and modernization of technologies, materials and devices of micro- and nanosystem technology on the basis of scientific methods of cognition. and the creation of new holistic knowledge.

	<p><i>Theoretical content of the subject area:</i> fundamental principles of construction and operation of micro- and nanosystem technology, modelling of objects and processes occurring in them.</p> <p><i>Methods, techniques and technologies:</i> research of processes in devices of micro- and nanosystem technology, measurement and modelling of characteristics of materials, devices, devices and systems; planning experiments and processing their results.</p> <p><i>Tools and equipment:</i> control and measuring equipment, specialized technological equipment and facilities, software for analysis, calculation and modelling of processes, design of devices of micro- and nanosystem technology, including devices and systems for biomedical purposes.</p>
Aspect	Educational and scientific
Main focus	<p>General education in the specialty "Micro- and nanosystem technology".</p> <p>Emphasis on research, development, implementation and application of modern electronic micro- and nanodevices and systems, methods and technologies of their manufacture using modern information technologies, including electronic micro- and nanosystems for biomedical purposes.</p> <p>The program is based on modern scientific principles taking into account the current state of development of micro- and nanoelectronics, micro- and nanosystem technology, focuses on current research areas in which further professional and scientific career is possible: information technology for designing devices and systems of micro- and nanoelectronics , application of modern nanomaterials and technologies in electronics, research of bionanosystems (general, theoretical and applied).</p> <p>Key words: micro- and nanodevices, nanosystems, low-dimensional systems, electronic biomedical systems and technologies.</p>
Features	<p>The educational and scientific program includes basic disciplines and additional disciplines that deepen knowledge in special sections of fundamental and professionally oriented disciplines in nanoelectronics and nanotechnology and provide research competencies for further research, teaching and management activities in the organization of research.</p> <p>The subject area of the program is focused on the ability to solve complex problems and problems in the field of automation and instrumentation and specialty "Micro- and nanosystem technology", which involves the development of educational components and acquisition of software competencies in nanotechnology and nanoelectronics.</p> <p>The program creates conditions that ensure the implementation of international mobility in micro- and nanoelectronics and</p>

	<p>nanotechnology in the world's leading universities, internships and double degrees at universities in France, Belgium, Germany, Spain, Japan, South Korea under agreed programs. The implementation of the program involves the involvement of practitioners, industry experts and internships in foreign partner universities with the teaching of special subjects in English.</p> <p>The program provides for the selection of certificates in CADENCE licensed systems of automated design of micro- and nanoschemes.</p>
<b>4 – Eligibility of graduates for employment and further study</b>	
Eligibility for employment	<p>Graduates can work at enterprises of any organizational and legal form in positions (according to the classifier of professions of Ukraine DK 003: 2010):</p> <p>2149 - Professionals in other fields of engineering.</p> <p>2149.1 Researchers</p> <p>2310 - Teachers of universities and higher educational institutions.</p> <p>2351 - Professionals in teaching methods.</p> <p>2359.1 - Researcher, researcher-consultant.</p> <p>The program provides an opportunity, in addition to a doctorate, to obtain certificates from international companies, software and hardware developers, in particular, CADENCE and ORCAD.</p>
Further study	<p>Continuing education in doctoral studies and / or participation in postdoctoral programs;</p> <p>The right to obtain the degree of Doctor of Science and to obtain additional qualifications in the system of adult education.</p>
<b>5 – Teaching and assessment</b>	
Teaching and studying	<p>The program implements problem-oriented learning, with a focus on the topic of the student's own research, with the possibility of mobility programs with foreign partner universities to use a modern laboratory and experimental base on nanotechnology. There is a wide use of information and communication technologies (e-learning, online lectures, distance learning courses) for certain educational components. Full-fledged preparation for research and teaching activities in the specialty is provided by involving graduate students in research and educational process of the departments of microelectronics and electronic engineering. Approbation of research results is carried out in the framework of conferences, seminars, in particular, the annual international conference "Electronics and Nanotechnology" (ELNANO) with the publication of articles indexed in the SCOPUS database.</p>
Assessment	<p>The educational process of the program includes current control in the form of laboratory reports, abstracts and presentations and semester control in the form of tests and exams. Evaluation is performed using a rating system.</p>
<b>6 – Programme competencies</b>	
<i>Integral competence</i>	<p>Ability to solve complex problems in the professional field, including research and innovation, which involves a deep rethinking of existing and creation of new holistic knowledge</p>

	and/or professional practice in the field of automation and instrumentation in the specialty "Micro- and nanosystem technology".
<i>General competencies (GC)</i>	
GC1	Ability to abstract thinking, analysis and synthesis.
GC2	Ability to search, process and analyse information from various sources.
GC3	Ability to work in an international context.
GC4	Ability to apply modern information technologies.
GC5	Ability to carry out scientific and innovative activities.
GC6	Ability to communicate in a foreign language to an extent sufficient to present and discuss the results of their scientific work orally and in writing, as well as for a full understanding of foreign scientific texts in the specialty.
<i>Professional competencies (PC)</i>	
PC1	Ability to perform original research, achieve scientific results that create new knowledge in micro- and nanosystem technology and related interdisciplinary areas and can be published in leading scientific journals in electronics and related fields.
PC2	Ability to adhere to research ethics, as well as the rules of academic integrity in research and scientific and pedagogical activities.
PC3	Ability to evaluate and increase the innovative and commercial attractiveness of the development, production and operation of parts, assemblies and devices of micro- and nanosystem technology.
PC4	Ability to use technical equipment and equipment, decision-making systems, software and tools for conducting a scientific experiment and processing the results of experimental research.
PC5	Ability to initiate, develop and implement comprehensive innovative and interdisciplinary projects in the field of micro- and nanosystem technology, leadership in their implementation.
PC6	Ability to carry out scientific and pedagogical activities in higher education using the latest pedagogical approaches and practices, including information technology, multimedia in the educational process for Ukrainian and foreign audiences, to diversify teaching methods for better perception of the material.
PC7	Ability to organize, provide and control the maintenance of scientific and professional qualifications of the team at the world level of scientific and engineering achievements in the field of development and operation of devices and devices of micro- and nanosystem technology.
PC8	Ability to apply methods of analysis, mathematical modelling, perform physical and mathematical experiments in research in the field of micro- and nanosystem technology.
PC9	Ability to improve existing and develop new methods and technologies, software and hardware for micro- and nanosystem technology of biomedical purposes.
PC10	Ability to research promising areas of industry development, creatively use new methods and technologies for creating devices and devices of micro- and nanoelectronics, modern microelectronic information systems.
<b>7 – Programme learning outcomes (PLO)</b>	
PLO1	Have advanced conceptual and methodological knowledge in micro- and nanosystem technology and at the boundaries of subject areas, as



	well as research skills sufficient for conducting scientific and applied research at the level of the latest world achievements in the relevant field, gaining new knowledge practice.
PLO2	Freely present and discuss with specialists and non-specialists the results of research, scientific and applied problems of micro- and nanosystem technology in state and foreign languages, qualified to reflect the results of research in scientific publications in leading international scientific journals.
PLO3	Formulate and test hypotheses; use appropriate evidence to substantiate the conclusions, in particular, the results of theoretical analysis, experimental research, mathematical and computer modelling, available literature data.
PLO4	Systematically think and apply creative abilities to form fundamentally new ideas, build and study physical, mathematical and computer models of objects and processes of micro- and nanoelectronics, offer ways to solve problems when methods of solving them are not known.
PLO5	Plan and perform experimental and / or theoretical research in the field of micro- and nanosystem technology, related interdisciplinary areas using modern theories, methods, specialized equipment and facilities, information and communication technologies, critically analyse the results of own research and the results of other researchers in the context of the whole complex modern knowledge about the researched problem.
PLO6	Plan, organize and coordinate work on the design, development, analysis, calculation, modelling, production and testing of micro- and nanosystem technology.
PLO7	Organize and manage research, innovation and investment activities, business projects and production processes, taking into account technological indicators, market requirements, existing standards, competitiveness of scientific and engineering products, rules of professional ethics and academic integrity.
PLO8	Use and research new methods and technologies for creating nanocomponents and systems, biomedical electronic systems.
PLO9	Develop new methods and technologies, software and hardware of micro- and nanosystem technology, microelectronic information systems.
PLO10	Be able to use modern methods and technologies of scientific communication in Ukrainian and foreign languages, read and understand foreign texts in the specialty.
PLO11	Be able to apply knowledge of the basics of analysis and synthesis in various subject areas, critical thinking and solving research problems; understand the philosophical concepts of the scientific worldview, the role of science, explain its impact on social processes; be able to formulate and test hypotheses; use appropriate evidence, available literature data to substantiate the conclusions; know the methodology of scientific research in the subject area; follow the rules of academic integrity; know and adhere to the basic principles of academic integrity in scientific and educational (pedagogical) activities.
<b>8 – Resource provision for programme implementation</b>	
Staffing	In accordance with the personnel requirements to ensure the implementation of educational activities for the relevant level of

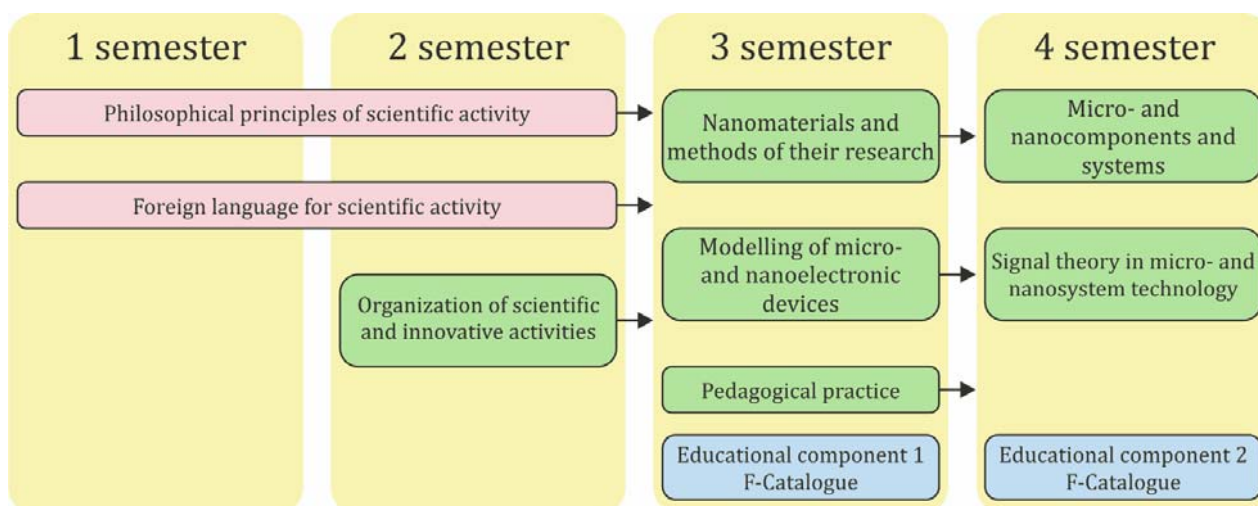
	<p>HE (Annex 2 to the License Terms), approved by the Resolution of the Cabinet of Ministers of Ukraine dated 30.12.2015 № 1187 as amended in accordance with the Resolution of the Cabinet of Ministers of Ukraine №347 dated 10.05.2018 p.</p> <p>The program in terms of cycles of general and professional training is implemented by research and teaching staff of the departments of microelectronics and electronic engineering consisting of 6 doctors of sciences, professors and 4 associate professors, candidates of sciences, and involves experts from partner universities for mobility and double degree programs.</p>
Material-and-technical supplying	<p>In accordance with the technological requirements for material and technical support of educational activities of the appropriate level of HE (Annex 4 to the License Terms), approved by the Resolution of the Cabinet of Ministers of Ukraine dated 30.12.2015 № 1187 as amended in accordance with the Resolution of the Cabinet of Ministers of Ukraine №347 dated 10.05. 2018</p> <p>The use of equipment, laboratory, and experimental base of the departments of microelectronics and electronic engineering for the design of micro- and nanoelectronic devices and systems and technologies for their manufacture.</p>
Information, training and methodological supplying	<p>In accordance with the technological requirements for educational and methodological and informational support of educational activities of the relevant level of HE (Annex 5 to the License Conditions), approved by the Resolution of the Cabinet of Ministers of Ukraine dated 30.12.2015 № 1187 as amended in accordance with the Resolution of the Cabinet of Ministers of Ukraine №347 10.05.2018</p> <p>Use of the Scientific and Technical Library of KPI named after Igor Sikorsky, an electronic resource of the university, which contains teaching materials from the disciplines of the curriculum, including in the distance learning system, as well as access to databases of scientific periodicals in English of the relevant or related profile.</p>
<b>9 – Academic mobility</b>	
National credit mobility	<p>National mobility is realized by involving graduate students of other higher education institutions in joint scientific conferences, seminars, summer schools under the program of Doctor of Philosophy for the formation of general and special (professional) competencies.</p>
International credit mobility	<p>Agreements on double degrees of doctors of philosophy in international programs, including the Erasmus + program, have been concluded with partner universities:</p> <p>KU Leuven, Leuven (Belgium), Double Ph.D. Degree, the doctoral program in Engineering Science</p> <p>The University of Lorraine (France), Double Ph.D. Degree, Doctoral School IAEM (Informatics, Automation, Electronics, Electrotechnics, Mathematics)</p> <p>The University of Granada, (Spain), Double Ph.D. Degree, PhD</p>

	<p>program on Information and Communication Technologies (ICT) at the University of Granada</p> <p>4. Graduate School of Engineering Science, Osaka University (Japan), Double Ph.D. Degree, «Advanced Research in Mechanical Science and Bioengineering»</p> <p>5. Technische Universität Dresden (TUD), Germany, double degree programs based on the “Electronic devices and equipment” and “Technologies and Means of Telecommunication”</p>
Foreign applicants education	For foreign citizens, training can be carried out in joint groups with Ukrainian graduate students or in separate groups with English as the language of instruction.

## 2. List of educational programme components

Code	Components of the education program	# ECTS credits	Assessment
<b>Normative components</b>			
N1	Philosophical principles of scientific activity	6	Exam
N2	Foreign language for scientific activity	6	Exam
N3	Nanomaterials and methods of their research	3	Final test
N4	Micro- and nanocomponents and systems	3	Final test
N5	Modelling of micro- and nanoelectronics devices	3	Final test
N6	Signal theory in micro- and nanosystem technology	3	Final test
N7	Organization of scientific and innovative activities	4	Exam
N8	Pedagogical practice	2	Final test
<b>Elective components</b>			
E1	Educational component 1 F-Catalogue	5	Exam
E2	Educational component 2 F-Catalogue	5	Exam
Total of <b>normative components</b> :			30
Total of <b>elective components</b> :			10
<b>TOTAL OF THE EDUCATION PROGRAM</b>			<b>40</b>

## 3. Structural-and-logical scheme of the educational programme



## 4. Scientific program

Year of training	Content of the work of PhD student	Assessment
<b>1 year</b>	The choice of the topic of the graduate student's dissertation, the formation of an individual work plan of the graduate student; execution of the dissertation work under the guidance of the scientific supervisor; preparation and submission for publication of at least 1 publication on the topic of the dissertation in accordance with current requirements.	Approval by the Academic Council of the Institute / Faculty by 30.11, reporting on the progress of the individual plan of the graduate student twice a year.
<b>2 year</b>	Execution under the guidance of the supervisor of the dissertation; preparation and submission for publication of at least 1 publication on the topic of the dissertation in accordance with current requirements.	Reporting on the progress of the individual graduate student's plan twice a year
<b>3 year</b>	Execution under the guidance of the supervisor of the dissertation; preparation and submission for publication of at least 1 publication on the topic of the dissertation in accordance with current requirements.	Reporting on the progress of the individual graduate student's plan twice a year
<b>4 year</b>	Completion of the dissertation, summarizing the results of publications (at least three) on the topic of the dissertation in accordance with current requirements. Submission of documents for the preliminary examination of the dissertation. Graduation certification	Reporting on the progress of the individual plan of the graduate student twice a year Providing a conclusion on the scientific novelty, theoretical and practical significance of the results of the dissertation. PhD thesis defence.

## 5. The form of graduation attestation for degree pursuers

The graduation attestation of degree pursuers under the educational programme in 153 "Micro- and nanosystem engineering" is carried out in the form of dissertation and is finalised with the issue of a document of a standard form on conferring a Doctor of Philosophy degree and qualification of "Micro- and nanosystem engineering".

The dissertation is subjected to mandatory assessment for plagiarism. After the defence the dissertation is stored in the repository of the University Scientific and Technical Library to be accessed freely.

The graduation attestation is conducted openly and publicly.

## 6. Matrix of program competencies matching with components of the educational program

	GC1	GC2	GC3	GC4	GC5	GC6	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10
PLO1	+	+					+		+	+		+	+			
PLO2	+		+				+	+								
PLO3		+					+						+	+	+	+
PLO4	+						+		+	+				+	+	+
PLO5	+	+			+		+			+						
PLO6	+							+			+	+	+			
PLO7			+		+			+			+		+			
PLO8	+			+						+				+	+	
PLO9	+			+						+				+		+
PLO10			+			+										
PLO11	+							+				+				

## 7. Compliance matrix of programme competencies with programme components

	N1	N2	N3	N4	N5	N6	N7	N8
GC1	+		+	+	+	+		
GC2			+	+	+	+	+	+
GC3		+					+	
GC4			+	+	+	+		
GC5	+			+			+	
GC6		+						
PC1			+	+	+	+		
PC2	+						+	+
PC3				+			+	
PC4			+	+	+	+		
PC5					+		+	
PC6							+	+
PC7			+		+			+
PC8			+	+	+	+		
PC9					+	+		
PC10			+	+				

## 8. Compliance matrix of programme learning outcomes with programme components

	N1	N2	N3	N4	N5	N6	N7	N8
PLO1			+	+	+	+		+
PLO2		+					+	+
PLO3			+		+			
PLO4				+	+			
PLO5			+	+				
PLO6			+		+	+	+	+
PLO7	+						+	+
PLO8					+	+		
PLO9			+	+				
PLO10		+					+	
PLO11	+							+