MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
LVIV POLYTECHNIC NATIONAL UNIVERSITY

APPROVED BY
Rector of Lviv Polytechnic
National University

_____ /Bobalo Yu.Ya./
«_____» _____ 2021

EDUCATIONAL AND SCIENTIFIC PROGRAM

third (educational and scientific) level of higher education

in specialty 153 “Micro and Nanosystem Techics”

field of knolwledge 15 “Automation and instrumentation”

Qualification: Doctor of Philosophy in specialty

“Micro and Nanosystem Techics”

Considered and approved
at a meeting of the Academic Council of
Lviv Polytechnic National University
«___» _____ 2021
Protocol №____

Lviv 2021

The Program was developed by the next working group for the specialty 153 “Micro and Nanosystem Techics”:

Project Team Leader(Guarantor):

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Members:

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Guarantor _____ D.Sc., Prof. Druzhinin A.A.
(signnature)

APPROVED AND PROVIDED
by the order of Rector of Lviv Polytechnic National University Lviv
«____» _____ 2021 № ___.

LETTER OF AGREEMENT
educational and scientific program

Level of higher education	Third (educational and scientific)
Field of knowledge	15 “Automation and instrumentation”
Specialty	153 “Micro and Nanosystem Techics”
Qualification	Doctor of Philosophy

APPROVED

Scientific and methodical commission of specialty 153 “Micro and Nanosystem Techics”
Protocol No._____
«____» _____ 2021

Head of the NMC of the specialty
153 “Micro and Nanosystem Techics”
_____Ostrovskii I.P.
«____» _____ 2021

Head of the Institute of Telecommunications, Radioelectronics and Electronic Engineering
_____B.M. Strykhaliuk
«____» _____ 2021

AGREED

Head of the educational and methodical department
_____ Sviridov V.M.
«____» _____ 2021

Vice-rector for scientific work

_____ Demidov I.V.
«____» _____ 2021

Vice-rector for scientific and pedagogical work
_____ Davydchak O.R.
«____» _____ 2021

RECOMMENDED
Scientific and methodological council of Lviv Polytechnic National University
Protocol No._____
«____» _____ 2021

_____ A.H. Zahorodnyi

I. Educational component of educational-scientific programme

1. Profile of the Doctor of Philosophy program in Speciality of «Micro and nanosystem technics»

1 – General information	
1	2
Full name of the higher education institution and structural unit	**Lviv Polytechnical National University**
The full title of the qualification in the original language	**Doctor of Philosophy in Natural Sciences by Speciality of «Micro and nanosystem technics»**
The official name of the educational program	Micro- and nanosystem technics
Type of diploma and scope of the educational program	Diploma of Doctor of Philosophy, single, 43 ECTS credits, term of the educational component of the educational and scientific program 2 years
Cycle/level	NFQ –level 8, FQ-EHEA – third cycle, EQF-LLL – level 8
Prerequisites	Master's level
Language(s)	Ukrainian
Basic concepts and their definitions	The educational and scientific program uses the main concepts and their definitions in accordance with the Law of Ukraine "On Higher Education" dated 07/01/2014 No. 1556-VII with amendments and additions, the Law of Ukraine "On Education" dated 09/05/2017 No. 2145-VIII with amendments and additions to the Law of Ukraine "On Scientific and Scientific-Technical Activities" dated 26.11.2015 No. 848-VIII as amended, Procedures for the Training of Higher Education Candidates for Doctor of Philosophy and Doctor of Science Degrees in Higher Education Institutions (Scientific Institutions), approved by Resolution of the Cabinet of Ministers of Ukraine dated 23.03.2016 No. 261 with changes and additions, the Procedure for conducting an experiment on awarding the degree of Doctor of Philosophy, approved by Resolution of the Cabinet of Ministers of Ukraine dated 03.06.2019 No. 167, Methodological recommendations for the development of higher education standards, approved by the Order of the Ministry of Education and Science of Ukraine dated June 1, 2017 No. 600 with changes and additions
2 – The purpose of the educational program	
	To provide theoretical knowledge and practical skills for solving complex problems in the field of "Micro- and nanosystem technics", conducting scientific, research and innovation activities, as well as implementing the obtained results.
3 - Characteristics of the educational program	
Subject area (field of knowledge, specialty)	***Automation and instrumentation:*** **Micro and nanosystem technics**
Orientation of the educational program	The educational and scientific program is aimed at relevant aspects of the specialty, within which a further scientific and teaching career is possible.
Features and differences	The scientific component of the educational and scientific program is determined by the individual study plan of the graduate student
4 – Suitability of graduates of the educational program to employment and further education	
Suitability for employment	Jobs in research institutes of the National Academy of Sciences of Ukraine, higher educational institutions of the Ministry of Education and Science of Ukraine, scientific centers and high-tech companies producing micro- and nanosystem equipment.
Further education	Certification training in research institutes of the National Academy of Sciences of Ukraine, leading universities and research centers of micro- and nanotechnologies.
5 – Teaching and assessment	
Teaching and learning	Lectures, practical classes, experimental research in laboratories, elaboration of publications in leading scientific publications, consultations with teachers, writing essays, preparation of a dissertation.
Assessment	Written and oral exams, assessments, oral presentations
6 – Program competencies	
Integral competence	The ability to solve complex problems in the field of micro- and nanosystem engineering, to conduct research and innovation activities that involve a deep rethinking of existing and the creation of new integral knowledge, as well as the practical implementation of the obtained results.

Continuation of Table

1	2
	1) advanced knowledge in one's academic field and mastering the philosophy of science in the field; 2) critical analysis, evaluation and synthesis of new ideas; 3) the ability to effectively communicate with the wider scientific community and the public on topical issues of micro- and nanosystem technology; 4) the ability to self-develop and self-improve during life, responsibility for teaching others 5) social responsibility for the results of strategic decision-making; 6) initiation of original research and innovation complex projects, 7) leadership and the ability to work both autonomously and in a team during project implementation.
Professional competencies	1) knowledge of modern development trends and the most important new scientific achievements in the field of micro- and nanosystem technology; 2) systematic knowledge and understanding of modern scientific theories and methods, and the ability to effectively apply them for the synthesis and analysis of micro- and nanosystem technology; 3) the ability to initiate, plan, implement and adjust a consistent process of thorough scientific research with due academic integrity; 4) the ability to integrate knowledge from other disciplines, apply a systematic approach and take into account non-technical aspects when solving engineering problems and conducting research; 5) the ability to design systems and their elements taking into account all aspects of the task, including creation, debugging, operation, maintenance and disposal; 6) the ability to argue the choice of methods for solving specialized problems, critically evaluate the obtained results and defend the decisions made
7 – Programme learning outcomes	
Knowledge	1) ability to demonstrate systematic knowledge of current research methods in the field of micro- and nanosystem engineering; 2) the ability to demonstrate advanced knowledge in the chosen field of research; 3) ability to demonstrate an understanding of the impact of technical solutions in the social, economic and social context.
Abilities	1) search, analyze and critically evaluate information from various sources; 2) apply knowledge and understanding to solve the problems of synthesis and analysis of elements and systems specific to the chosen field of research; 3) to study and simulate phenomena and processes in devices and devices of micro- and nanosystem technology; 4) apply a systematic approach, integrating knowledge from other disciplines and taking into account non-technical aspects, while solving theoretical and applied problems of the chosen field of research; 5) combine theory and practice, as well as make decisions and develop a strategy for solving scientific and applied problems taking into account human values, public, state and industrial interests; 6) work effectively both individually and as part of a team; 7) independently carry out experimental research and apply research skills; 8) evaluate the feasibility and feasibility of applying new methods and technologies in the problems of synthesis of devices and devices of micro- and nanosystem technology; 9) justify the choice of methods for solving the scientific-applied problem, critically evaluate the results obtained and defend the decisions made

1	2
Communication	- the ability to communicate effectively at the professional and social levels; - the ability to present and discuss the results obtained and transfer knowledge;
Autonomy and responsibility	- the ability to adapt to new conditions, make decisions independently and initiate original research and innovation complex projects; - the ability to be aware of the need for lifelong learning in order to deepen acquired and acquire new professional knowledge; - the ability to be responsible for the work being performed and to achieve the stated

	goal in compliance with the requirements of professional ethics.
8 – Resource support for program implementation	
Specific characteristics of personnel support	100% of the teaching staff involved in teaching professionally oriented disciplines have scientific degrees in their specialty
Specific characteristics of material and technical support	Use of modern equipment of leading microelectronics companies, in particular Ameteck, Intel, Hewlett-Packard, Siemens.
Specific characteristics of informational and methodological support	The use of the virtual learning environment of the Lviv Polytechnic National University and author's developments of the teaching staff
9 – The main components of the educational program	
List of educational components (disciplines, practices, coursework and qualification papers)	The matrix of correspondence of program competencies to educational disciplines and the structure of the educational program are given in the Appendix
10 – Academic Mobility (regulated by CMU Resolution No. 579 "On Approval of the Regulation on the Procedure for Realizing the Right to Academic Mobility" dated August 12, 2015)	
National credit mobility	Based on bilateral agreements between Lviv Polytechnic National University and the Technical University of Ukraine.
International credit mobility	In the framework of Erasmus+ program based on bilateral agreements between Lviv Polytechnic National University and schools partner countries
Education of foreign students of higher education	is possible

2. Distribution of content of the educational component of the educational and scientific program by component groups and preparation cycles

№ п/п	Training cycle	The amount of study load of a graduate student (credits / %)		
		Mandatory components of the educational program	**Elective components of the educational program**	In total for the entire term teaching
1	*Cycle of disciplines that form general scientific competences and universal skills of the researcher*	*21 / 48,8*	*3 / 7,0*	*24 / 55,8*
2	*Cycle of disciplines forming professional competences*	*10/23,2*	*9 / 21,0*	*19 / 44,2*
In total or the entire term teaching		***31/ 72***	***12 / 28***	***43 / 100***

The structure of the educational component of the educational and scientific program

Code of academic discipline	Components of educational programm	Number of credits	Final control form	Competences provided for by Resolution 261 dated 03.23.2016 (as amended from 04.03.2019)
1	2	3	4	5
1. Mandatory components of the educational program				
Cycle of disciplines that form general scientific competences and universal skills of the researcher				
OK1.1.	Philosophy and Methodology of Science	3	exam	Mastering general scientific (philosophical) competences aimed at forming a systematic scientific outlook, professional ethics and a general cultural outlook; application of modern information technologies in scientific activities (work with NMBD, automatic

				formation of links to literary sources)
ОК1.2.	English Language For Academic Purposes, part 1	4	test exam	Acquisition of linguistic competences sufficient to present and discuss the results of one's scientific work in a foreign language in oral and written form, as well as to fully understand foreign language scientific texts in the relevant specialty, use of modern information technologies (presentation of scientific results).
ОК1.3.	English Language For Academic Purposes, part 2	4	exam	
ОК1.4.	Professional Pedagogy	3	test exam	Acquisition of universal skills of a researcher, in particular, organization and conduct of training sessions, use of modern information technologies (work with VNS, Microsoft Teams, Zoom, etc.)
ОК1.5	Academic Entrepreneurship	4	test exam	Acquisition of universal researcher skills, in particular oral and written presentation of the results of one's own research in Ukrainian, management of scientific projects and/or preparation of proposals for financing scientific research, registration of intellectual property rights, application of modern information technologies.
ОК1.6.	Teaching Practice	3	test exam	Acquisition of universal skills of a researcher, in particular, organization and conduct of training sessions, use of modern information technologies (work with VNS, Microsoft Teams, Zoom, etc.)
Total per cycle:		**21**		
Cycle of disciplines forming professional competences				
ОК2.1.	Devices Based on MOS Structure in Micro- and Nanoelectronics	4	exam	Acquiring in-depth knowledge of the specialty in which the graduate student conducts research, in particular, mastering the main concepts, understanding theoretical and practical problems, the history of development and the current state of scientific knowledge in the chosen specialty, mastering the terminology of the researched scientific direction in the amount of ECTS credits in accordance with the standard of higher education
ОК2.2.	Optical Engineering and Photonic Technologies	3	test exam	
ОК2.3.	Characterization of Materials of Micro- and Nanosystem Technics	3	test exam	
Всього за цикл:		**10**		
Elective components of the educational program				
Cycle of disciplines that form general scientific competences and universal skills of the researcher				
ВБ1.1	Business Foreign Language	3	test exam	Acquisition of universal researcher skills, in particular oral and written presentation of the results of one's own research in Ukrainian, management of scientific projects and/or preparation of proposals for financing scientific research, registration of intellectual property rights, application of modern information technologies Acquisition of linguistic competences sufficient to present and discuss the results of one's scientific work in a foreign language in oral and written form, as well as to fully understand foreign language scientific texts in the relevant specialty, use of modern information technologies (presentation of scientific results).
ВБ1.2	Psychology of Creativity and Invention	3	test exam	
ВБ1.3	Management of Scientific Projects	3	test exam	
ВБ1.4	Technology of Processing Grant Applications and Patents	3	test exam	
ВБ1.5	Rhetoric	3	test exam	
ВБ1.6	Modern Inventical Management in Scientific and Research Activities	3	test exam	
ВБ1.7	Open Science Practices	3	test exam	
ВБ1.8	Academic Integrity and Education Quality	3	test exam	
ВБ1.9	Methodology of Scientific Paper Publishing	3	test exam	
ВБ1.10	Quality of Higher Education (Internal Quality Assurance	3	test exam	

	Systems)			Mastering general scientific (philosophical) competences aimed at forming a systematic scientific outlook, professional ethics and a general cultural outlook; application of modern information technologies in scientific activities (work with NMBD, automatic formation of links to literary sources) Acquisition of universal skills of a researcher, in particular, organization and conduct of training sessions, use of modern information technologies (work with VNS, Microsoft Teams, Zoom, etc.)
Total per cycle:		**3**		
Cycle of disciplines forming professional competences				
ВБ2.1	Transformation Devices on the Basis of Semiconductor and Dielectric Materials	3	exam	Acquiring in-depth knowledge of the specialty in which the graduate student conducts research, in particular, mastering the main concepts, understanding theoretical and practical problems, the history of development and the current state of scientific knowledge in the chosen specialty, mastering the terminology of the researched scientific direction
ВБ2.2	Methods of Synthesis of Electronics Functional Materials	3	exam	
ВБ2.3	Fundamentals of Photonics	3	exam	
ВБ2.4	Plasmonics	3	exam	
ВБ2.5	Models of Transfer Effects	3	exam	
ВБ2.6	Micro- and Nanoelectromechanical Systems	3	exam	
ВБ2.7	Micro sensors and actuators	3	exam	
ВБ2.8	Analytical and Numerical Methods of Research	3	exam	
ВБ2.9	Software for micro- and nanosystem technics	3	exam	
ВБ2.10	Nanotechnology	3	exam	
Всього за цикл:		**6**		
Disciplines of the free choice of graduate students				
ВБ3.1	Discipline of the free choice of graduate students	3	test exam	
Total per cycle		**3**		
TOTAL		**43**		

II. The scientific component of the educational and scientific program

The scientific component of the educational-scientific program involves the post-graduate student conducting his own scientific research under the guidance of one or two academic supervisors and the preparation of his results in the form of a thesis.

The thesis for obtaining the degree of Doctor of Philosophy is an independent comprehensive study that offers a solution to an actual scientific and applied task in the specialty 153 Micro- and nanosystem technics, the results of which are characterized by scientific novelty and practical value and are published in relevant publications.

The scientific component of the educational-scientific program is drawn up in the form of an individual plan of scientific work of a postgraduate student and is an integral part of the postgraduate study plan.

An integral part of the scientific component of the postgraduate educational and scientific program is the preparation and publication of scientific articles, speeches at scientific conferences, scientific professional seminars, round tables, and symposia.

Topics of scientific research in the specialty "153. Micro- and nanosystem technics»:

1. Creation of sensors based on semiconductor micro- and nanocrystals.
2. Development of measuring systems of micro- and nanosystem technology based on sensors of physical quantities.
3. Development of methods for obtaining and researching magnetic nanoparticles for biomedical applications.
4. Study of parameters of thin layers for integrated optics and plasmonics.
5. Development of laser and photon technologies based on the interaction of electromagnetic radiation with heterogeneous systems and nanostructures.

III. Certification of applicants

Certification of applicants for higher education with the degree of doctor of philosophy is carried out by a specialized scientific council, permanently active or formed for a one-time defense, on the basis of a public defense of scientific achievements in the form of a thesis.

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

Candidates of higher education for the degree of Doctor of Philosophy defend their thesis, as a rule, in a permanent specialized academic council for the relevant specialty, which functions in the higher educational institution where the graduate student was trained. The academic council of a higher educational institution has the right to submit documents to the National Agency for Higher Education Quality Assurance for the accreditation of a specialized academic council formed for a one-time defense, or to apply to another higher educational institution where a permanent specialized academic council in the relevant specialty operates. .

5. The matrix of correspondence of program competencies to educational disciplines

	SK1.1	SK1.2	SK1.3	SK1.4	SK1.5	SK1.6	SK2.1	SK2.2	SK2.3	B1.1	B1.2	B1.3	B1.4	B1.5	B1.6	B1.7	B1.8	B1.9	B1.10	B2.1	B2.2	B2.3	B2.4	B2.5	B2.6	B2.7	B2.8	B2.9	B2.10
INT	●	●		●	●		●		●	●		●		●	●	●		●	●	●		●		●	●	●		●	●
GC1				●			●	●	●	●		●			●	●				●		●			●	●			
GC2	●									●			●	●			●			●			●	●			●		
GC3	●	●	●													●	●									●	●		
GC4	●		●		●	●											●										●		
GC5					●	●											●										●		
GC6					●		●							●	●	●		●	●					●	●	●		●	●
GC7					●												●	●									●	●	
FC1		●						●		●			●			●				●			●			●			
FC2				●			●	●	●	●	●	●	●	●	●	●				●	●	●	●	●	●	●			
FC3				●			●				●	●		●	●						●	●		●	●				
FC4			●		●																								
FC5							●		●	●	●	●		●	●					●	●	●		●	●				
FC6		●						●			●		●	●							●		●	●					

Conventional designations: SK_i – compulsory discipline, B_i – selective discipline, i – discipline number in the list of components of the educational component, INT – integral competence, GC_j – general competence, FC_j – professional (special) competence, j – competence number in the list of competences educational component.

5. Matrix of provision of programmatic learning outcomes with relevant components of the educational program

	SK1.1	SK1.2	SK1.3	SK1.4	SK1.5	SK1.6	SK2.1	SK2.2	SK2.3	B1.1	B1.2	B1.3	B1.4	B1.5	B1.6	B1.7	B1.8	B1.9	B1.10	B2.1	B2.2	B2.3	B2.4	B2.5	B2.6	B2.7	B2.8	B2.9	B2.10
Kn 1	●	●		●	●		●		●	●		●		●	●	●		●	●	●		●		●	●	●		●	●
Kn 2				●			●	●	●	●		●			●	●				●		●			●	●			
Kn 3	●									●			●	●			●			●			●	●			●		
Sk 1	●	●	●													●	●									●	●		
Sk 2	●		●		●	●											●										●		
Sk 3					●	●											●										●		
Sk 4					●		●							●	●	●		●	●					●	●	●		●	●
Sk 5					●												●	●									●	●	
Sk 6		●						●		●			●			●				●			●			●			
Sk 7				●			●	●	●	●	●	●	●	●	●	●				●	●	●	●	●	●	●			
Sk 8				●			●				●	●		●	●						●	●		●	●				
Sk 9			●		●																								
Com1							●		●	●	●	●		●	●					●	●	●		●	●				
Com2		●						●			●		●	●							●		●	●					
AiB 1				●			●				●	●		●	●						●	●		●	●				
AiB 2			●		●																								
AiB 3							●		●	●	●	●		●	●					●	●	●		●	●				

Conventional designations: SK_i – mandatory discipline, B_i – selective discipline, i – number of the discipline in the list of components of the educational component, Kn_m – program results (knowledge), Sk_m – program results (skills), m – number of the program result in the list of program results educational component.

Structural and logical scheme of the educational and scientific program of the third (doctor of philosophy) level of higher education in the specialty 153 "Micro- and nanosystem technics"