

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

APPROVE

Rector of
Lviv Polytechnic National University

_____ /Bobalo Yu./
«_____» _____ 2021

EDUCATIONAL AND SCIENTIFIC PROGRAM

**third (educational and scientific) level of higher education
by specialty 152 Metrology and information and measurement technics
field of knowledge 15 Automation and instrumentation
Qualification: Doctor of Philosophy in metrology and information and
measurement technology**

Considered and approved
Academic Council of the University

(protocol № ____
«__» _____ 2021)

Lviv 2021

It was developed by the working group in specialty 152 "Metrology and information and measurement technology" consisting of:

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(guarantor):

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Dr.Sc, Prof., Head of IVT Department

Members of working group:

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PhD., As.-Prof., Director of DP NDI «Systema»

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Guarantor

Dr.Sc, Prof., Stadnyk B.

Approved and put into effect by the Order of the Rector of Lviv Polytechnic National University «__» _____ 2021. № _____.

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LETTER OF AGREEMENT

of educational and scientific program

Level of higher education	third (educational and scientific)
Field of knowledge	15 Automation and instrumentation
Specialty	152 Metrology and information and measurement technics
Qualification	Doctor of Philosophy

APPROVED	AGREED
Scientific and methodical commission (SMC) of specialty 152 Metrology and information and measurement technics	Head of the educational and methodical department
Protocol № 02	_____ Sviridov V.
«21» January 2021	«__» _____ 2021
Head of SMC specialty 152 Metrology and information-measuring technics	Vice-rector for scientific work
_____ Stadnyk B.	_____ Demydov I.
«21» січня 2021 р.	«__» _____ 2021 р.
Director of ICTA	Проректор з науково-педагогічної роботи
_____ Mykyichuk M.	_____ Davydchak O.
«28» January 2021	«__» _____ 2021
RECOMMENDED	
Scientific and methodological council of the university	
Protocol №	
«__» _____ 2021	
Head of SMC	
_____ Zahorodnij A.	

1. Introduction

According to art. 1 "Basic terms and their definitions" of the Law of Ukraine "On Higher Education", an educational program is a system of educational components at the appropriate level of higher education within the specialty, which determines the requirements for the level of education of persons who can start studying under this program, a list of academic disciplines and the logical sequence of their study, the number of ECTS credits required to complete this program, as well as the expected learning outcomes (competencies) that the recipient of the corresponding degree of higher education should master.

The educational program is used during:

- accreditation of the educational program, inspection of educational activities by specialty and specialization;
- development of the curriculum, programs of educational disciplines and practices;
- development of tools for diagnosing the quality of higher education;
- determination of the content of training in the system of retraining and advanced training;
- professional orientation of applicants.

The educational program takes into account the requirements of the Law of Ukraine "On Higher Education", the National Framework of Qualifications, approved by the Resolution of the Cabinet of Ministers of Ukraine of November 23, 2011 No. 1341, "The Procedure for Training Candidates for Higher Education Degrees of Doctor of Philosophy and Doctor of Science in Higher Educational Institutions (Scientific Institutions)", approved by the resolution of the Cabinet of Ministers of Ukraine dated March 23, 2016 No. 261 and establishes:

- scope and terms of the educational component of the educational-scientific program of preparing a doctor of philosophy;
- general competencies;
- professional competences;
- program learning outcomes;
- the list and scope of educational disciplines for mastering the competencies of the educational program;
- requirements for the structure of educational disciplines.

The educational program is used for:

- compilation of study plans and work study plans;
- formation of individual plans of PhD degree holders;
- formation of programs of educational disciplines;
- determination of the information base for the formation of diagnostic tools;
- accreditation of the educational program;
- internal and external quality control of specialist training;
- semester examinations of candidates for the degree of Doctor of Philosophy, specialty 152 "Metrology and information-measuring technics".

Users of the educational program:

- higher education holders of the degree of Doctor of Philosophy studying at the National University "Lviv Polytechnic";

– scientific and pedagogical workers who train candidates for the degree of doctor of philosophy in specialty 152 "Metrology and information-measuring technology";

– Admissions Committee of Lviv Polytechnic National University.

The educational program extends to the departments of the Institute of Computer Technologies, Automation and Metrology, which are graduations for the preparation of specialists for the degree of Doctor of Philosophy, specialty 152 "Metrology and information-measuring technics".

2. REGULATORY REFERENCES

The educational program is developed on the basis of the following regulatory documents and recommendations:

2.1. Law of Ukraine "On Higher Education". No. 1556-UII from 01.07.2014 // Bulletin of the Verkhovna Rada. – 2014. – No. 37, 38.

2.2. National Qualifications Framework. Appendix to the Resolution of the Cabinet of Ministers of Ukraine dated November 23, 2011 No. 1341.

2.3. Decree of the Cabinet of Ministers of Ukraine dated April 26, 2015 No. 266 "List of fields of knowledge and specialties for which higher education applicants are trained."

2.4. Resolution of the Cabinet of Ministers of Ukraine dated March 23, 2016 No. 261 "On approval of the Procedure for the training of higher education applicants for the degree of Doctor of Philosophy and Doctor of Sciences in higher educational institutions (scientific institutions)"

2.5. Regulation "On the organization of the educational process at the Lviv Polytechnic National University", approved by the order of the Rector of the University No. 235-10 dated 10.12.2015.

2.6. Methodological recommendations for the development of higher education standards, approved by the higher education sector of the Scientific and Methodological Council of the Ministry of Education and Science of Ukraine, protocol dated 03/29/2016 No. 3.

2.7. A Tuning Guide to Formulating Degree Programme Profiles Including Programme Competences and Programme Learning Outcomes. -Bilbao, Groningen and The Hague, 2010

2.8. A TUNING-AHELO conceptual framework of expected/desired learning outcomes in engineering. OECD Education Working Papers, No. 60, OECD Publishing 2011. <http://dx.doi.org/10.1787/5kghtchn8mbn-en>

Profile of the Doctor of Philosophy program in the specialty 152 "Metrology and information and measurement technics "

1 – General information

Full name of the higher education institution and structural division	Lviv Polytechnic National University
The full title of the qualification in the original language	Doctor of Philosophy in the specialty "Metrology and information and measurement technics " Philosophy Doctor degree
Qualification in diploma	Higher Education Degree - Doctor of Philosophy Specialty - "Metrology and information-measuring technics"
The official name of the educational program	Metrology and information-measuring technics
Restrictions on forms of education	Intramural form of education
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
Availability of accreditation	Accredited by the National Agency for Quality Assurance of Higher Education
Cycle/level	National Qualifications Framework – 8 level, FQ-EHEA – the third cycle, EQF-LLL – 8 level
Prerequisites	Master's level
Language(s) of instruction	Ukrainian and English
Basic concepts and their definitions	The program uses the main concepts and their definitions in accordance with the standard of higher education in the specialty "Metrology and information and measurement technics "

2 – The purpose of the educational program

To provide theoretical knowledge and practical skills and abilities to carry out scientific research activities.

3 - Characteristics of the educational program

Subject area (field of knowledge, specialty)	<p><i>Metrology and information-measuring technics</i></p> <p><i>Object of activity:</i> methods and means of information and measurement technologies, which include methods of measurements, control, tests and diagnostics; unity and traceability of measurements, their metrological support, standardization, qualimetry and conformity assessment, as well as cognitive technologies of experimental research.</p> <p><i>Training goals:</i> training of specialists in information and measurement technologies capable of solving complex problems in the field of development and improvement of measurement procedures.</p>
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	<p><i>Theoretical content of the subject area:</i> study of the basics, principles and concepts in the field of information and measurement technologies in order to ensure the unity and traceability of measurements; optimization of experimental research processes using the latest computer-integrated technologies, development of the basics of metrological activity aimed at improving the quality of products and services.</p> <p><i>Methods, techniques and technologies:</i> scientific research, creation and improvement of information and measurement technologies and their software to achieve metrological goals, teaching skills and training of specialists; management of teams when solving information and measurement technology tasks.</p> <p><i>Tools and equipment:</i> software and technical means for designing, modeling, creating, researching and operating tools for ensuring the unity and traceability of measurements.</p>
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.
The main focus of the educational program and specialization	Acquiring the necessary research skills for a scientific career, teaching special disciplines in the field of metrology, information and measuring devices, complexes and systems, as well as commercialization of the results of research activities and technology transfer. Keywords: metrology, information-measuring devices, complexes, systems, standards, technical regulations, subsystems of cyber-physical systems.
Features and differences	
4 – Suitability of graduates of the educational program to employment and further education	
Suitability for employment	Jobs in scientific research institutes of the National Academy of Sciences and universities of the Ministry of Education and Science of Ukraine, scientific centers and high-tech companies of the manufacturing sector and agriculture, aeronautics and cosmonautics, health care.
Further education	Advanced training in research institutes of the National Academy of Sciences of Ukraine, leading universities and research metrology, energy and other companies.
5 – Teaching and assessment	
Teaching and learning	Lectures, practical classes, research in laboratories, processing of publications in leading publications of the metrological profile, consultations with teachers, writing essays, preparation of a dissertation.
Assessment	Written and oral exams, oral presentations, dissertation defense.
6 – Program competencies	
Integral competence	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 drafting of proposals for financing scientific research, registration of intellectual property rights.
General competences	SC01. Acquisition of universal skills of a researcher, in particular, the organization and conduct of training sessions, the use of modern information technologies (work with the Virtual Learning

	Environment, Microsoft Teams, Zoom).
	<p>SC02. The ability to perform original research, achieve scientific results that create new knowledge in the field of developing new and improving existing methods and techniques of measurements and tests and related interdisciplinary areas and can be published in leading scientific publications on metrology and information- measuring equipment and related industries.</p> <p>SC03. The ability to orally and in writing present and discuss the results of scientific research and/or innovative developments in Ukrainian and English, a deep understanding of English-language scientific texts in the field of research.</p> <p>SC04. Ability to use modern information technologies, databases and other electronic resources, specialized software in scientific and educational activities.</p> <p>SC05. he ability to carry out scientific and pedagogical activities in higher education.</p> <p>SC06. The ability to apply a systematic approach to solving scientific and technical tasks of metrology and information and measurement technology.</p>
Special (professional) competences	SC07. Acquiring in-depth knowledge of the specialty 152 Metrology and information and measurement technics, in particular mastering the main concepts, understanding theoretical and practical problems, the history of development and the current state of scientific knowledge, mastering scientific terminology.
7 – Program learning outcomes	
Knowledge	<ul style="list-style-type: none"> - the ability to demonstrate knowledge of modern research methods in the field of metrology and information and measurement technology; - the ability to demonstrate in-depth knowledge in the chosen field of scientific research; - the ability to demonstrate an understanding of the impact of technical solutions in a public, economic and social context.
Skills	<ul style="list-style-type: none"> - search, analyze and critically evaluate information from various sources; - apply knowledge and understanding to solve problems of synthesis and analysis of sensors, devices, complexes and systems characteristic of the chosen field of scientific research; - research and model phenomena and processes in complex dynamic temperature, electrical and magnetic systems; - apply a systematic approach, integrating knowledge from other disciplines and taking into account non-technical aspects, when solving theoretical and applied problems of the chosen field of scientific research; - combine theory and practice, as well as make decisions and develop a strategy for solving scientific and applied problems, taking into account universal human values, public, state and industrial interests; - work effectively both individually and as part of a team; - independently perform experimental studies and apply research skills; - evaluate the expediency and possibility of applying new methods and technologies in the tasks of designing smart sensors, smart metrological tools, creating measuring devices, devices, complexes and systems; - justify the choice of methods for solving a scientific and applied problem, critically evaluate the obtained results and defend the

	decisions made.
Communication	<ul style="list-style-type: none"> - the ability to communicate effectively at the professional and social levels, including in a foreign language; - the ability to present and discuss the obtained results and transfer the acquired knowledge;
Autonomy and responsibility	<ul style="list-style-type: none"> - the ability to adapt to new conditions, make decisions independently and initiate original research and innovation complex projects; - the ability to realize the need for lifelong learning in order to deepen acquired and acquire new professional knowledge; - the 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 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	The use of modern equipment of leading instrument-making companies, in particular National Instruments, Physical Instruments, Flir, Siemens, IFM, SIOS ect.
Specific characteristics of informational and methodical support	The use of the virtual learning environment of 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 Appendices.
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	On the basis of bilateral agreements between Lviv Polytechnic National University and technical universities of Ukraine.
International credit mobility	Within the EU Erasmus+ program, as well as outside it on the basis of bilateral agreements between Lviv Polytechnic National University and educational institutions of partner countries.
Education of foreign students of higher education	Separate lectures of several disciplines are provided in English and German

I. DISTRIBUTION OF THE CONTENT OF THE EDUCATIONAL AND SCIENTIFIC PROGRAM BY GROUPS OF COMPONENTS AND CYCLES OF TRAINING

№ п/п	Training cycle	The volume of the educational load of the student of higher education (credits / %)		
		Common components of the educational and professional program	Elective components of the educational and professional program	Всього за весь термін навчання
1	Cycle of general training	21/49	3/7	24/56
2	Cycle of professional training	10/23	6/14	16/37
3	The cycle of free choice of a graduate student	-	3/7	3/7
Total for the study period		31/72	12/28	43 / 100

COMPONENT LIST

EDUCATIONAL PROGRAMS FOR DOCTOR OF PHILOSOPHY OF SPECIALTY 152 "Metrology and information and measurement technics"

Code of discipline	Semester	Components of the educational program	Number of credits	The structure of the study load			Form of final control	Departments
				lectures	labs	practices		
1. Mandatory components (MC) of the educational component								
2. Cycle of disciplines that form general scientific competences and universal skills of the researcher								
MC1.1	1	Philosophy and methodology of science	3	1	-	1	exam	IHSS, FL
MC1.2	1	Foreign language for academic purposes	4	-	-	4	test	IHSS, FL
MC1.3	2	Foreign language for academic purposes. Part 2	4	-	-	4	exam	IHSS, FL
MC1.4	2	Professional pedagogy	4	1	-	1	test	IHSS, dep. of philos.
MC1.6	3	Academic entrepreneurship	4	1	-	1	test	IEM
MC1.7	2	Pedagogical practice	3	2	-	1	test	IJPS, dep. PIE
		Total per cycle	21					
Cycle of disciplines forming professional competences								
MC2.1	3	Seminar in metrology	4	3	-	1	exam	IMT

MC2.2	3	Scientific bases and practice of improvement of metrological support means	3	2	-	1	exam	IMT
MC2.3	4	Analytical and numerical research methods	3				exam	IMT
Total per cycle			10					
Elective components of the educational component								
Cycle of disciplines that form general scientific competences and universal skills of the researcher								
EL1.1	3	Business Foreign Language	3	-	3	-	test	IHSS, FL
EL1.2	3	Psychology of creativity and invention	3	1	-	1	test	IJPS, TAP
EL1.3	3	Management of scientific projects	3	1	-	1	test	ICSIT
EL1.4	3	Technologies for the registration of grant applications and patent rights	3	1	-	1	test	IEM
EL1.5	3	Rhetoric	3	1	-	1	test	
EL1.6	3	Modern inventions in research activities	3	1	-	1	test	
EL1.7	3	Open scientific practices	3	1	-	1	test	
EL1.8	3	Academic integrity and quality of education	3	1	-	1	test	
EL1.9	3	Methodology of preparation of scientific publications	3	1	-	1	test	
EL1.10	3	Quality of higher education (formation of internal quality assurance systems)	3	1	-	1	test	
Total per cycle			3					
Cycle of disciplines forming professional competences								
EL2.1	4	Precision mechatronics and additive technologies	3	2	-	-	test	IMR
EL2.2	4	Virtual metrology laboratory	3	2	-	-	test	IMR
EL2.3	4	Fundamentals of micro- and nano-system technology	3	2	-	-	test	IMR
EL2.4	4	Technology of writing and design of scientific papers and dissertations	2	1	-	1	exam	IMT
EL2.5	4	Selected issues of processing measurement results and measurement signals	2	1	-	1	exam	IMT
EL2.6	4	Cyber-physical systems	2	1	-	1	exam	IMT
EL2.7	4	Wireless sensor networks and data transfer protocols	2	1	-	1	exam	IMT
EL2.8	4	Problems of technical regulation and conformity assessment	2	1	-	1	exam	IMT
EL2.9	4	Trends in the development of management systems	2	1	-	1	exam	IMT
EL2.10	4	The platform and environment for the development of computing and measuring equipment within the limits of the visual programming language LabVIEW	2	1	-	1	exam	IMT
EL2.11	4	Mathematical modeling in the field of quality engineering	2	1	-	1	exam	IMT
EL2.12	4	Gasodynamic phenomena in flowmeters and their influence on the results of flow and quantity measurement	2	1	-	1	exam	ACIT
EL2.13	4	Metrological support of means of measuring the flow and volume of liquid media	2	1	1	-	exam	ACIT

EL2.14	4	Metrological support of means of gas analysis	2	1	-	1	exam	ACIT
EL2.15	4	Gas dynamic methods of analysis and synthesis of gas mixtures	2	1	-	1	exam	ACIT
Total per cycle			6 = 3+3					
DISCIPLINES OF THE GRADUATE STUDENT'S FREE CHOICE								
FC1	4		3	-	-	-	test	
Total per cycle			3					
Total			43					

MATRIX OF SUITABILITY OF SOFTWARE COMPETENCES TO EDUCATIONAL DISCIPLINES

	MC11	MC12	MC13	MC14	MC16	MC17	MC21	MC22	MC23	EL11	EL12	EL13	EL14	EL15-	EL21	EL22	EL23	EL24	EL25	EL26	EL27	EL28	EL29	EL210	EL211	EL212	
IK												•			•		•		•	•			•	•			
CK01				•					•					•		•					•	•			•	•	
CK02	•												•		•												
CK03	•									•		•	•	•			•	•	•	•							
CK04	•	•						•																			
CK05		•					•				•																
CK06			•		•			•				•	•	•	•	•					•	•	•	•	•	•	•
CK07		•				•		•							•	•	•	•	•	•	•	•	•	•	•	•	•

acquired competence;

MC ij - the number of the mandatory discipline in the list of disciplines of the training program of the specialty;

EL ij – the number of the elective discipline in the list of disciplines of the training program of the specialty;

IK, CKij – competency number in the competency list of the program profile.

II. The scientific component of the educational and scientific program

The scientific component of the educational-scientific program involves the postgraduate 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 dissertation.

The dissertation for obtaining the degree of Doctor of Philosophy is an independent comprehensive study that offers a solution to an actual scientific task in the specialty "152. Metrology and information-measuring technics", the results of which are an original contribution to the sum of knowledge in the specialty "152. Metrology and information-measuring technics" and 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. Preparation and publication of scientific articles, presentations at scientific conferences and seminars, symposia are an integral part of the scientific component of the postgraduate educational and scientific program.

Topics of scientific research in the specialty "152. Metrology and information-measuring technics»:

1. Research and development of sensitive elements, sensors, devices and systems for the field of information and measurement technologies.
2. Research, design and use of smart sensors, devices and their networks with built-in and installed software.
3. Development and certification, including virtual and remote, of standards, devices and elements of cyber-physical systems.
4. Metrological support, quality, standardization and certification of measuring devices, complexes and systems.
5. Robotic means of measurement and regulation.

III. Attestation of graduate students

Attestation of applicants for higher education with the degree of Doctor of Philosophy is carried out by 3 permanent specialized scientific councils, or by a council formed for a one-time defense on the basis of a public defense of scientific achievements in the form of a dissertation.

A mandatory condition for admission to the defense is the successful completion by the graduate student of his individual study plan in the presence of academic integrity (According to the current Regulations on Academic Integrity of the Lviv Polytechnic National University).

Candidates of higher education for the degree of Doctor of Philosophy defend their dissertations, 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 Quality Assurance of Higher Education 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 .