MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

TERNOPIL IVAN PULUJ NATIONAL TECHNICAL UNIVERSITY

EDUCATIONAL-PROFESSIONAL PROGRAM

«Computer engineering»

of the second level of higher education

on specialty 123 Computer engineering

Branch of knowledge 12 «Information technologies»

Qualification: Master of Science in Computer engineering

Approved by the Academic Council
of Ternopil Ivan Puluj National
Technical University
Head of the Academic Council
_____ / Yasniy P.V. /

(Minutes № 5 of " 23 " 03 2021)

The educational program is launched in
01.09.2021

Rector _____ / Yasniy P.V. /

(Order № 4/226 of " 26 " 03 2021)

Ternopil 2021

LETTER OF APPROVAL

of educational-professional program

«Computer engineering»

The program was discussed and approved by the Academic Council of the Faculty of Computer Information Systems and Software Engineering

Minutes № 8 of « 19 » 03 2021

Dean Baran I.O.

The program was discussed and approved on the Computer Systems and Networks Department meeting

Minutes № 8 of « 19 » 03 2021

Head of the CSN Department Osukhivska H.M.

The educational-professional program has been developed according to the higher education standard on specialty 123 «Computer engineering» for the second (Master of Science) level of higher education (order of the MES of Ukraine №330 of 18.03.2021)

PREFACE

Developed by the project group of the (specialty 123 **«**Computer engineering**»)** consisting of:

– Lupenko Serhii, Doctor of Science (Engineering), Professor, Prof. of the Computer Systems and Networks Department of the Ternopil I.Puluj national technical university

– Osukhivska Halyna, Ph.D. in Engineering Science, Associate Prof., Head of the Computer Systems and Networks Department of the Ternopil I.Puluj national technical university

– Lutskiv Andrii, Ph.D. in Engineering Science, Associate Prof. of the Computer Systems and Networks Department of the Ternopil I.Puluj national technical university

– Semehen Vitalii – student of group CIm-51

– Sorokalit Vitalii – director of the LLC "МЕЛВІС"

Reviews of external stakeholders:

1. Trysnyuk Vasyl – s.sc.r., Doctor of Science (Engineering), head of the environment research department of the Institute of telecommunications and global information space (Kyiv)

2. Dmytryshyn Serhii — owner and founder of LLC "КРАВДІН" (Ternopil)

3. Deren Andrii — co-owner and manager of LLC "Dreams Innovative Technologies" (Ternopil)

1. Master of Science Training Program in Specialty 123 "Computer engineering "

1 – General information	
Full name of the higher educational establishment and a structural subdivision	Ternopil I.Puluj national technical university, Faculty of Computer Information Systems and Software Engineering, Computer Systems and Networks Department
Educational qualification	Master of Science in Computer Engineering
Program official name	Educational-professional program «Computer engineering» of the second (Master of Science) level of higher education on specialty 123 «Computer engineering» branch of knowledge 12 «Information technologies»
Diploma type and number of credits according to the program	Master of Science diploma, Single Honours, 90 credits ECTS, 18 months of study
Accreditation	MES of Ukraine, Certificate of accreditation НД №2087420 valid to 01.07.2022
Cycle/level	FQ-EHEA – second cycle, EQF LLL – 7th level, HPK – 7th level
Admission Requirements	Bachelor degree or educational-qualification level of specialist
Language(s) of instruction	Ukrainian
Educational program validity	Valid to: July 01, 2022
Permanent Internet address of educational program description	http://tntu.edu.ua
2 – Program purpose	
Formation and development of general and professional competencies in the field of informatics and computer hardware aimed at students' acquiring knowledge, skills and abilities enabling them to solve problems of complex systems analysis and synthesis based on the latest information technologies using modern achievements of fundamental and engineering sciences.	
3 – **Educational program characteristics**	
Subject area (branch of knowledge, specialty, specialization) (if it is available)**)**	Branch of knowledge: 12 Information technologies Specialty: 123 Computer engineering **The objects of Master of Science professional activity are:** - software and hardware of computer and computer systems, local, global computer networks and Internet network, cyber physical systems, internet of things, IT-iinfrastructures, interfaces and protocols of their components interaction. - processes, technologies, methods, ways, tools and systems for research, computer-aided and automatic design; adjustment, production and use of software and hardware, design documents, standards, procedures and means of their life cycle control support. - ways of information presentation, receiving, storage, transfer, processing and protection in a computer, mathematical models of computational processes, computation techniques, including highly efficient, parallel, distributed, mobile, web-based and cloud, green (energy saving), safe, autonomous, adaptive, intelligent, smart etc. architecture and organization of functioning of the required software and hardware. **The purpose of study** is to train professionals able to solve complex problems of research and innovative character in the field of computer engineering. **Theoretical contents of the subject area:** concepts, conceptions, principles of research, design, production, use and servicing of computer networks and systems, cyber physical systems, internet of

	things, IT-iinfrastructures**.** **Methods, techniques and technologies**: research methods of processes in computer networks and systems, methods of computer-aided design and production of software and hardware of computer and computer systems and networks, their components, methods of mathematical and computer modeling, information technologies, technologies of programming.
Educational program orientation	Educational-professional program (academic), oriented on scientific research with a considerable number of communicative and interpersonal skills in native and foreign languages, as well as on the modern scientific achievements of informatics and computing engineering, takes into account the specific features of work in the field of information technologies, computer technologies, systems and networks, their software, hardware, organization support, ways and methods of design, testing, production and use in different fields and at enterprises of various kinds of activity under information society conditions.
The main focus of the educational program and specialization	General higher education in the field of IT with advanced study of development and support technologies of specialized computer systems, networks, and their mathematical, algorithmic, and software support. The main focus is made on the training of specialists of higher qualification able to implement all stages of development and support of specialized computer systems, networks, and their software: determination and analysis of the customer's requirements, development of the project and general architecture of the system according to the standards of computer engineering, development of computer systems and networks components: software and hardware, implementation and support.
Program features	The program provides the professional training of computer systems analysts taking into account the requirements to quality, reliability, production characteristics, and its regular updating allows to take into consideration the tendencies of progressive development of information technologies. The program enables students to participate in the programs of academic mobility (Erasmus+) and study by double diploma training program in the university "Lublin polytechnic" (Poland).
4 – Graduates suitability for employment and further education	
Suitability for employment	Design, production, technological, managerial, scientific-research; innovative, teaching, expert and consulting activity in the field of computer engineering. The main posts according to the National Occupational Classification of Ukraine: Occupational Classification (SC 003:2010) та International Standard Classification of Occupations 2008 (ISCO-08): «Professional in the fields of computing systems» can be employed in organizations, enterprises, institutions of any economic form on the positions: 2131.1. Scientific researchers (computing systems), 2131.2. Developers of computing systems, 2132.1. Scientific researchers (programming), 2132.2. Developers of computer programs, 2139.1. Scientific researchers (other fields of computing), 2139.2. Professionals in other fields of computing.
Further study	Possibility to continue education by the program of the third (educational-scientific) level of higher education and obtain some additional qualification in the system of higher education.
5 – Teaching and Assessment	
Teaching and study	The teaching process involves: lectures, practical classes, laboratory

	work, course papers and projects, independent work with possible tutorials, research laboratory work, Master's diploma paper writing. The process is based on the problem-oriented study, self-study, e-learning, projects in teams, internship programs participation in establishments and at enterprises.
Assessment	Oral and written examinations on the courses, current tests, checking of practical assignments, defense of laboratory paper reports, presentations, defense of course papers (projects) and reports on practice, diploma thesis public defense as the final attestation.
6 – Program competencies	
Integral competence	Be able to solve complex problems and tasks in the field of computer engineering or in the study process involving some research and/or innovations conducting and is characterized by uncertain conditions and requirements.
General competencies (GC)	GC1. Adaptability to new environments and situations. GC 2. Ability of abstract thinking, analysis and synthesis. GC 3. Be able to conduct research at appropriate level. GC 4. Be able to search, process and analyze information from different sources. GC 5. Be able to generate new ideas (creativity). GC 6. Be able to see, set and solve problems. GC 7. Be able to make reasonable decisions. GC 8. Be able to communicate in a foreign language.
Professional competencies of the specialty (SC)	CK1. Be able to determine technical characteristics, design specific features, use and specification of software, software-hardware, computer systems and networks of various use. CK2. Be able to develop algorithms and software, computer systems and networks components, Internet of applications, cyber physical systems using the latest methods and languages of programming, as well as means and systems of design automation. CK3. Be able to design computer systems and networks taking into account goals, restrictions, technical, economic and legal aspects. CK4. Be able to develop and study the models of computer systems and networks. CK5. Be able to build architecture and develop system and applied software of computer systems and networks. CK6. Be able to use and implement new technologies including the technologies of smart, mobile, green and safe computation, take part in modernization and reconstruction of computer systems and networks, different embedded and distributed applications to rise their efficiency in particular. CK7. Be able to study, develop and choose technologies of large and very large systems creation. CK8. Be able to assure the quality of IT products and services throughout their life cycle. CK9. Be able to present the results of research and/or developments as presentations, scientific-technical reports, articles and reports on scientific-technical conferences. CK10. Be able to identify, classify and describe hardware-software operation, computer systems and networks, and their components; CK11. Be able to choose efficient methods of complex problems solving of computer engineering, estimate the obtained results and substantiate the decisions made.

	СК12. Be able to used methods of analysis, identification and synthesis of computer systems and networks, cyber physical systems, Internet-of-things and IT-infrastructure.
7 – Program learning outcomes	
	PH1. Apply general approaches of cognition, methods of mathematics, natural and engineering sciences to solving complex problems of computer engineering. PH2. Find the required data, analyze and estimate them. PH3. Develop and study models of computer systems and networks, estimate their adequacy, determine their application boundaries. PH4. Apply specialized conceptual knowledge involving the latest scientific achievements in the field of computer engineering, necessary for their professional activity, not standard thinking and research conducting, critical attitude towards the problems of information technologies and at the intersection of knowledge branches. PH5. Develop and implement projects in the field of computer engineering and relevant interdisciplinary projects taking into account engineering, social, economic, legal and other aspects. PH6. Analyze problems, identify and state certain problems required the immediate solution, choose the efficient ways of their solving. PH7. Solve problems of analysis and synthesis of computer systems and networks. PH8. Apply knowledge of engineering characteristics, design specific features, use and specification of hardware-software of computer systems and networks to solve complex problems of computer engineering and relevant problems. PH9. Develop software for embedded and distributed applications, mobile and hybrid systems. PH10. Provide information search in different sources to solve problems of computer engineering, analyze and assess this information. PH11. Make efficient decisions on the matters of development, implementation and use of computer systems and networks, analyze the alternatives, estimate risk and probable consequences. PH12. Be able to communicate, speak and write, in Ukrainian and one of the foreign languages (English, German, French, Italian, Spanish) while discussing professional issues, research or innovations in the field of IT. PH13. Be clear in explaining the required knowledge, conclusions and proofs to professionals and non- professionals, in particular to those who are studying. PH14. Plan and carry out scientific research in the field of computer engineering, state and check any hypothesis, choose the required techniques and tools, analyze the results, substantiate the conclusions.
8 – Program implementation resources	
Staff assistance	All academic staff members providing the educational-professional program meet the requirements of the courses' specialization, has the required teaching and practical experience. Some professionals experienced in research, management, innovative, creative and occupational activities are involved into the teaching process.
Materials and equipment	Learning process according to the educational program takes place on classrooms and laboratory rooms equipped with multimedia apparatuses and proper hardware. The appropriate hardware is used in teaching-scientific work according to the educational program: computers, laptops, scanners, multimedia projectors. **Tools and equipment:** software, tools and computer equipment,

	control-measuring devices, software and hardware of automation and systems of design automation, production, operation, control, monitoring, network, mobile, cloud technologies etc..
Information support and teaching – learning materials	Official web-site www.tntu.edu.ua contains information of the educational programs, educational, scientific and teaching activities, structural subdivisions, admission requirements, contacts. All resources of scientific-technical library are available on the university site: http://library.tntu.edu.ua/. The TNTU e-learning system Atutor provides with the access to materials both in English and Ukrainian on educational program disciplines, presentations, tests, video material and other e-learning components.
9 – Academic mobility	
National credit mobility	Some agreements are signed of academic mobility and double diplomas.
International credit mobility	The agreements are signed of international academic mobility (Erasmus+) and study according to the double diploma training program in the university “Lublin polytechnic” (Poland).
Foreign students training	There are favorable conditions for foreign students learning both in English and Ukrainian.

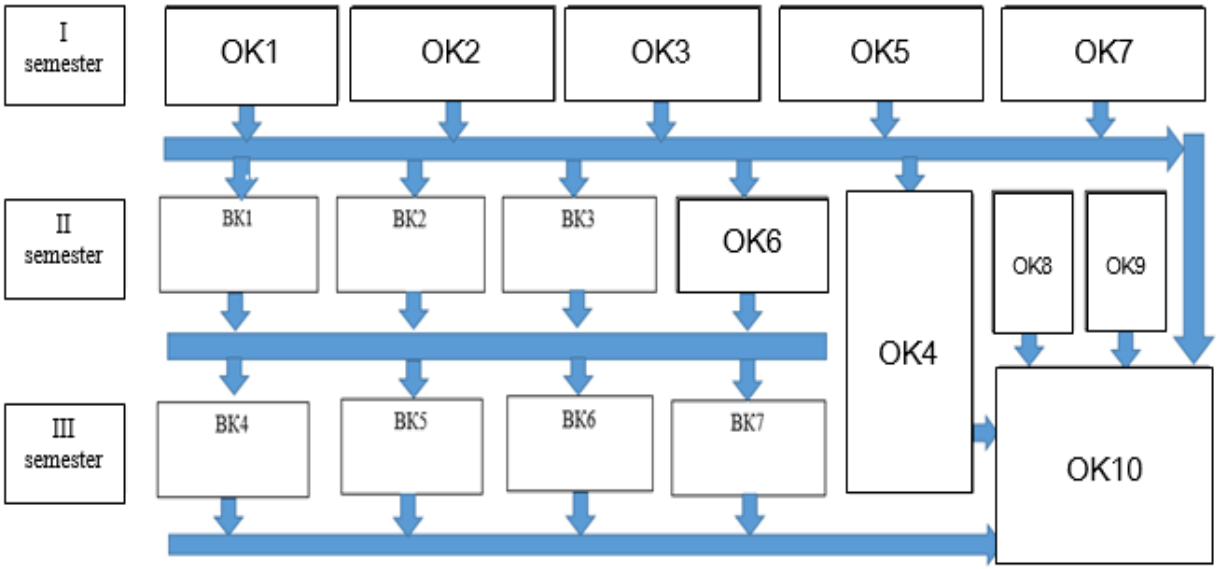
2. List of components of the educational-professional program and their logical sequence

2.1 List of components

No. In sequence	Discipline title	Number of credits ECTS	Form of final control
1	2	3	4
COMPULSORY COURSES			
Cycle of general training			
OK 1.	Professional Ethics and Fundamentals of Pedagogy	4,0	Credit tests
OK 2.	Foreign Language for Professional Purposes	4,0	Credit tests
OK 3.	Scientific Research Management and Methodology	4,0	Credit tests
Cycle of professional training			
OK 4.	Investigation and Design of Computer Systems and Networks+ Course projects	8,0	Exam
OK 5.	Mathematical Software for Computer Systems and Networks+ Course projects	7,0	Exam
OK 6.	Distributed Computer System and Cloud Technologies of Big Data Engineering	5,0	Exam
OK 7.	Computer Systems and Networks Components' Development Using Programmable Logic Integrated Circuits+ Course projects	5,5	Exam
Practical training			
OK 8.	Specialty Practice	9,0	Grading tests
OK 9.	Qualifying Paper-related Internship	7,5	Grading tests
OK 10.	Master's Graduation Thesis Writing	7,5	
OK 11.	Master's Graduation Thesis Defense	1,5	
Total according to compulsory part:		**63,0**	
Optional courses			
Cycle of general training			
BK 1.1.	Intellectual Property	3,0	Credit tests
BK 1.2.	Technical Feasibility of Engineering Decisions	3,0	Credit tests
Cycle of professional training			
BK 2.1.	Distributed Computer Systems and Cloud Services' Administration and DevOps Practices	**5,5**	Exam

BK 2.2.	Cyberphysical Systems	**4,0**	Credit tests
BK 2.3.	Artificial Intelligence (Methods and Systems)	**4,0**	Credit tests
SC 2.4.	Occupational Health and Safety in the Branch	**3,5**	Exam
SC 2.5.	Specialized Computer Systems	**4,0**	Credit tests
Total optional courses:		**27,0**	
TOTAL FOR MASTER TRAINING		**90,0**	

2.2. Structural and logical scheme



3. Forms of Attestation

Form of attestation	Public defense of the Qualification paper.
Requirements to the Qualification paper	The Qualification papers must involve solving a complex problem of computer engineering requiring some experimental or empirical study or some innovative activity. The qualification paper must not contain any academic plagiarism, fabrication, cheating. The Qualification papers should be made public on the official site of the higher educational establishment or its subdivision (faculty, department) or in the repository of the higher educational establishment. The Qualification papers with restricted access must be made public according to the legal requirements.

4. Matrix of correspondence of program competencies to the components of the educational program

	ОК1	ОК2	ОК3	ОК4	ОК5	ОК6	ОК7	ОК8	ОК9	ОК10
GC1	+	+	+	+	+	+	+	+	+	+
GC2			+	+	+	+	+	+	+	+
GC3		+	+	+		+			+	+
GC4	+		+	+	+	+	+	+	+	+
GC5			+	+	+	+	+	+	+	+
GC6			+	+	+	+	+	+	+	+
GC7		+	+	+	+	+		+	+	+
GC8	+									
SC1				+	+				+	+
SC2				+		+	+	+	+	+
SC3		+		+	+				+	+
SC4			+			+	+	+	+	+
SC5				+		+	+		+	+
SC6				+	+			+	+	+
SC7			+	+		+	+	+	+	+
SC8				+	+		+		+	+
SC9			+	+	+	+		+	+	+
SC10			+	+	+		+		+	+
SC11			+			+	+			+
SC12				+	+	+	+		+	+

5.The matrix of providing program learning outcomes with the relevant components of the educational program

	ОК1	ОК2	ОК3	ОК4	ОК5	ОК6	ОК7	ОК8	ОК9	ОК10
PH1			+			+	+			+
PH2			+	+	+	+	+	+	+	+
PH3				+		+			+	+
PH4				+	+	+	+		+	+
PH5		+	+	+	+	+	+	+	+	+
PH6			+	+	+	+	+	+	+	+
PH7				+		+		+	+	+
PH8				+	+	+			+	+
PH9				+	+	+	+		+	+
PH10			+	+	+	+	+	+	+	+
PH11				+	+			+	+	+
PH12	+	+	+	+	+	+	+	+	+	+
PH13		+	+	+	+	+		+	+	+