**MINISTRY OF EDUCATION AND SCIENCE**

**NATIONAL TECHNICAL UNIVERSITY OF UKRAINE**

**"IGOR SIKORSKY KYIV POLYTECHNIC INSTITUTE"**

APPROVED

by Head of Academic Council
Igor Sikorsky Kyiv Polytechnic Institute

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ M. Ilchenko

№3 «\_15\_»\_\_\_03\_\_\_2021 .

Seal

**EDUCATIONAL AND PROFESSIONAL PROGRAM**

**Information-computing means of radio**

 **electronic systems**

**The first (Bachelor) level of higher education**

|  |  |
| --- | --- |
| **Speciality** | **172 Telecommunications and Radioengineering** |
| **Field** | **17 Electronics and telecommunications** |
| **Qualification** | **Bachelor in Electronics and Telecommunications** |

Approved by University Academic Council, from «19» 04\_2021

Meeting protocol № \_НОМ/89/2021

Igor Sikorsky Kyiv Polytechnic Institute

Kyiv – 2021

**PREAMBLE**

**Developed by the working group:**

Head of the working group

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Members of the working group:

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Head of the Design of Electronic Computational Equipment Department

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| --- | --- |
| Lysenko Oleksandr Mykolaevych, Doctor of Technical Sciences, Professor | \_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

Chairman of the scientific and methodological subcommittee on the speciality

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| Ilchenko Mykhailo Yukhymovych, Doctor of Technical Sciences, Professor, Academician of the National Academy of Science of Ukraine, Vice Rector for Scientific Affairs | \_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

The educational program is considered and approved by University Academic Council

(meeting protocol № \_\_3\_\_\_ from «\_15\_» \_\_\_03\_\_\_\_ 2021)

Head of University Academic Council

\_\_\_\_\_\_\_\_\_\_\_\_\_ J.I. Yakymenko

Secretary of University Academic Council

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**1. PROFILE OF THE EDUCATIONAL PROGRAM**

**Speciality 172 Telecommunications and Radioengineering**

|  |
| --- |
| **1 – General information** |
| Full name of University, Institute/Faculty | National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Faculty of Electronics |
| Level of higher education and the name of qualification in original language  | BachelorQualification: Bachelor in Electronics and Telecommunications |
| Level of the National Qualifications Framework | Level of the National Qualifications Framework of Ukraine– 6th level |
| Official name of educational program | Information computing tools of radioelectronic systems |
| Type of diploma and the amount of educational program | Bachelor diploma, 240 credits, duration of study – 3 years 10 months (4 studying years). |
| Availability of accreditation | Certificate of accreditation, series ND № 1192561 issued by the Ministry of Education and Science of Ukraine, valid for 01.07.2023  |
| Prerequisites | Availability of complete general secondary education |
| Language(s) of study | Ukrainian/English |
| Term of the educational program | Until the next accreditation |
| Internet address of the permanent placement of the educational program | <http://fel.kpi.ua> |
| **2 – The purpose of the educational program** |
| Training of specialists in the field of telecommunications and radio engineering, able to solve specialized problems and practical tasks in the creation and application of information and computing tools in electronic systems for various functional purposes. |
| **3 – Characteristics of the educational program** |
| Subject area (field of knowledge, specialty) | Field of knowledge - 17 Electronics and telecommunicationsSpecialty - 172 Telecommunications and radio engineering |
| Orientation of the educational program | Educational and professional |
| The main focus of the educational program | Special education in the field of electronics and telecommunications, focused on the use of modern innovative technologies in the creation and application of information and computing facilities in electronic systems for various functional purposes.Keywords: radio electronics, telecommunications, digital data processing systems, digital data transmission systems, information and computational means of integration, telecommunication technologies. |
| Features of the program | The program was created in accordance with the requirements of the National Qualifications Framework (NQF) of Ukraine, the European Qualifications Framework for Lifelong Learning (EQF-LLL), the sectoral framework EUR-ACE Framework Standards for Accreditation of Engineering Programs, the requirements of the international organization Engineers Mobility Forum (EMF) to the competencies of self-employed engineers for their certification and registration as an EMF Registered International Professional Engineers, the criteria for accreditation of engineering training programs and the requirements for graduates (Graduate Attributes and Professional Competencies) set out in Washington Accord Declaration.In order to provide conditions for training a specialist in the real environment of future professional activity, a special practice is provided in the Center for Training of FPGA Design Technologies by INTEL FPGA, the training laboratory of TEXAS INSTRUMENTS and the training and research center "Economical Production".Implementation of international mobility and academic cooperation. |
| **4 – Suitability of graduates for employment and further study** |
| Suitability for employment | Employment according to DK 003: 20102144.2 Design Engineer (Electronics) Radio and television engineer Cellular network engineer Electronics engineer3114 Technical specialist in the field of electronics and telecommunications3132 Radioelectronics |
| Further education | Continuation of education at the second (master's) level of higher education. |
| **5 – Teaching and assessment** |
| Teaching and studying | Lectures, practical and seminar classes, computer workshops and laboratory works; course projects and works; technology of blended learning, practice and excursions; design work for diploma |
| Assessment | Rating system, assessment, oral and written exams, knowledge testing, current control, practice reports, defense of the diploma project (works) |
| **6 – Program competencies** |
| Integral competence | Ability to solve complex specialized problems and practical problems in the field of electronics and telecommunications or in the learning process, which involves the application of certain theories and methods of relevant science and is characterized by complexity and uncertainty of conditions. |
| **General Competences (GC)** |
| GC 1 | Ability to abstract thinking, analysis and synthesis |
| GC 2 | Ability to apply knowledge in practical situations |
| GC 3 | Ability to plan and manage time |
| GC 4 | Knowledge and understanding of the subject area and understanding of professional activity |
| GC 5 | Ability to communicate in the state language both orally and in writing |
| GC 6 | Ability to work in a team |
| GC 7 | Ability to learn and master modern knowledge |
| GC 8 | Ability to identify, pose and solve problems |
| GC 9 | Ability to carry out safe activities |
| GC 10 | The desire to preserve the environment |
| GC 11 | The ability to exercise their rights and responsibilities as a member of society, to realize the values ​​of civil (free democratic) society and the need for its sustainable development, the rule of law, human and civil rights and freedoms in Ukraine |
| GC 12 | Ability to preserve and multiply moral, cultural, scientific values ​​and achievements of society based on understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, techniques and technologies. active recreation and a healthy lifestyle |
| **Professional competencies of the specialty (PC)** |
| PC 1 | The ability to understand the essence and significance of information in the development of the modern information society |
| PC 2 | Ability to solve standard tasks of professional activity on the basis of information and bibliographic culture with the use of information and communication technologies and taking into account the basic requirements of information security |
| PC 3 | Ability to use basic methods, methods and means of obtaining, transmitting, processing and storing information |
| PC 4 | Ability to perform computer modeling of devices, systems and processes using universal application packages |
| PC 5 | Ability to use regulatory and legal documentation relating to information and telecommunications networks, telecommunications and radio systems (laws of Ukraine, technical regulations, international and national standards, recommendations of the International Telecommunication Union, etc.) to solve professional problems |
| PC 6 | Ability to perform instrumental measurements in information and telecommunication networks, telecommunication and radio systems |
| PC 7 | Willingness to monitor compliance and ensure environmental safety |
| PC 8 | Willingness to promote the introduction of advanced technologies and standards |
| PC 9 | Ability to accept and develop new equipment in accordance with current regulations |
| PC 10 | Ability to carry out installation, adjustment, adjustment, adjustment, experimental check of working capacity, tests and commissioning of constructions, means and the equipment of telecommunications and radio engineering |
| PC 11 | Ability to compile regulatory documentation (instructions) for operational and maintenance of information and telecommunications networks, telecommunications and radio systems, as well as test programs |
| PC 12 | Ability to perform work to manage the flow of information and telecommunications networks |
| PC 13 | Ability to organize and implement measures for labor protection and safety in the operation, maintenance and repair of equipment for information and telecommunications networks, telecommunications and radio systems |
| PC 14 | Willingness to study scientific and technical information, domestic and foreign experience on the subject of investment (or other) project of telecommunications and radio engineering |
| PC 15 | Ability to perform calculations in the process of designing structures and means of information and telecommunication networks, telecommunication and radio systems, in accordance with the terms of reference using both standard and self-created methods, techniques and software automation of design |
| PC 16 | Ability to analyze and synthesize digital logic devices, apply modern methods of their design and testing, design and debug hardware and software components of electronic computer systems (EOS), in particular, built into radio and telecommunications equipment using modern tools and CAD that support them |
| PC 17 | Ability to reasonably choose the element base of REA, to apply methods of calculation and design of parts, assemblies and structures of REA in accordance with technical tasks using modern CAD / CAM / CAE systems, to conduct experimental studies to determine the basic characteristics of REA materials, to apply standard calculation methods to determine their operational parameters |
| PC 18 | Ability to reasonably select electronic components and circuit solutions for the construction of analog and pulse CEA units, calculate the nominal values ​​of circuit components and printed circuit boards, consciously at the physical-theoretical level to determine the requirements for CEA designs taking into account external factors. |
| PC 19  | Ability to apply the necessary set of mathematical methods for modeling, analysis, optimization of information and computing facilities of electronic systems and technological processes of their production in order to improve existing and create new technical solutions. |
| PC 20  | Ability to perform the task of building new hardware and software systems EOS in accordance with the technical conditions with the use of modern hardware and software platforms, including digital signal processing. |
| **7 – Program learning outcomes** |
| **KNOWLEDGE** |
| KW 1 | modern scientific ideas about the surrounding physical world, philosophical foundations of knowledge of natural and technical objects and processes, psychological and ethical foundations of scientific, technical and industrial activities. |
| KW 2 | the main provisions of the disciplines of the natural science unit of training in the specialty, sufficient to solve professional problems. |
| KW 3 | generally accepted norms of social behavior and public morality; |
| KW 4 | general principles of management decisions, norms of professional and business communication |
| KW 5 | foreign language in the amount of topics due to professional needs |
| KW 6 | basics of application of physical and mathematical apparatus for analysis of processes in telecommunication and radio engineering devices and systems; |
| KW 7 | theoretical bases of processes occurring in electronic circuits and devices, basic properties of electromagnetic oscillations as information carriers; |
| KW 8 | basic properties of the component base of telecommunication and radio devices and systems |
| KW 9 | basics of design and testing of telecommunication and radio devices and systems, means of automation of design of telecommunication objects and radio engineering, systems of representation of algorithms, programs, data, etc. |
| KW 10 | basic information about the means of design and technological processes of creating means of telecommunications and radio engineering |
| KW 11 | basic information on the organization of production, operation and marketing of telecommunications and radio equipment |
| KW 12 | principles of organization and regulatory documentation on occupational safety in the industry, environmental consequences of activities in the industry and measures to prevent possible consequences of accidents |
| KW 13 | legal, psychological and normative bases of organizational and managerial activity; |
| KW 14 | basics of metrology of the subject area and the principles of standardization, unification and certification of telecommunications and radio equipment. |
| KW 15 | methodical bases of performance of research works in the subject branch; |
| KW 16 | modern means of computer modeling and calculation of parameters of telecommunication devices and radio engineering; |
| KW 17 | Knowledge of the basics of representation and transformation of digital information, Boolean algebra, methods of analysis, synthesis and optimization of logic functions, applied theory of digital automata and digital description language Verilog, methods of design, manufacture and debugging of EOS hardware and software, system organization and basics of hardware and EOS software components, physical properties of CEA components and their formal models for the synthesis of electronic circuits. |
| KW 18  | Knowledge of criteria for reasonable choice of REA element base, methods of calculation and design of parts, units and structures of REA, basics of physical processes and phenomena accompanying conversion of physical quantity into electric signal and dependences of properties of conductive, magnetic, semiconductor, dielectric materials technological implementation. |
| KW 19 | Knowledge of the basics of construction and application of industrial and domestic REA, physical bases of electronic devices, physical and theoretical bases of REA design, which are used in creating schemes of electrical REA, calculation and modeling. Knowledge of modern methods of construction of REA at the level of integrated circuit technology of DC / DC converters for power supplies, amplifiers and signal generators. |
| KW 20  | Knowledge of methods of modeling complex processes and modes of operation that characterize the functioning of electronic systems, features of mathematical models of basic electronic components, methods, algorithms and software for analysis, optimization and design decisions. |
| KW 21  | Knowledge of the main architectural features and properties of hardware components of modern EOS, namely: universal or specialized (signal, communication, multimedia) microprocessors (MP) and their families, families of single-chip microcontrollers (OMC) built into CEA (S) and systems on crystal ), basics of theory and methods of digital signal processing and algorithms for their implementation in the design of EOS. |
| **SKILLS** |
| SK 1 | analyze, argue, make decisions in solving specialized problems and practical problems of telecommunications and radio engineering, which are characterized by complexity and incomplete definition of conditions |
| SK 2 | apply the results of personal search and analysis of information to solve qualitative and quantitative problems of a similar nature in information and communication networks, telecommunications and radio systems; |
| SK 3 | to determine and apply in professional activity methods of testing information and telecommunication networks, telecommunication and radio engineering systems for compliance with the requirements of domestic and international regulations; |
| SK 4 | explain the results of the measurements in terms of their significance and relate them to the relevant theory; |
| SK 5 | to adapt to the conditions of changing technologies of information and communication networks, telecommunication and radio systems; |
| SK 6 | competently apply the terminology of telecommunications and radio engineering; |
| SK 7 | describe the principles and procedures used in telecommunication systems, information and telecommunication networks and radio engineering; |
| SK 8 | analyze and evaluate the effectiveness of methods for designing information and telecommunications networks, telecommunications and radio systems; |
| SK 9 | communicate on professional issues, including oral and written communication in the state language and one of the common European languages ​​(English, German, Italian, French, Spanish); |
| SK 10 | apply interpersonal skills to interact with other people and involve them in teamwork; |
| SK 11 | tolerantly accept and apply ethical norms of behavior towards other people; |
| SK 12 | application of basic and applied sciences for analysis and development of processes occurring in telecommunication and radio systems; |
| SK 13 | application of understanding of the main properties of the component base to ensure the quality and reliability of telecommunications, radio systems and devices; |
| SK 14 | application of understanding of means of automation of design and technical operation of telecommunication systems and radio engineering in professional activity; |
| SK 15 | application of understanding of basics of metrology and standardization in the field of telecommunications and radio engineering in professional activity; |
| SK 16 | understanding and compliance with domestic and international regulations on the development, implementation and maintenance of information and telecommunications networks, telecommunications and radio systems; |
| SK 17 | find, evaluate and use information from various sources necessary for solving professional tasks, including reproduction of information through electronic search; |
| SK 18 | carry out standard tests of information and communication networks, telecommunication and radio systems for compliance with the requirements of domestic and international regulations; |
| SK 19 | explain the principles of construction and operation of hardware and software systems of control and maintenance systems for the development, analysis and operation of information and telecommunications networks, telecommunications and radio systems; |
| SK 20 | to ensure reliable and high-quality operation of information and communication networks, telecommunication and radio systems; |
| SK 21 | to control the technical condition of information and communication networks, telecommunication and radio systems in the process of their technical operation in order to detect deterioration of the quality of operation or failures, and its systematic fixation by documentation. |
| SK 22 | use different types and forms of sexual activity for active recreation and a healthy lifestyle |
| SK 23 | Develop digital devices in integrated ModelSim modeling and Quartus II design environments, including using HDL hardware description language, implement logical devices using FPGA-based debugging boards, design printed circuit boards using Altium Designer CAD or other similar functionality. package, design EOS hardware and software using modern integrated design environments and tools. |
| SK 24 | Calculate the main performance parameters of materials, analyze their characteristics for optimal selection in the development of CEA, calculate the main indicators of stability of printed assemblies and typical structural elements of high levels, as well as the reliability of simple and complex structures, use standard libraries of electronic components and their technological seats taking into account the existing limitations in the development of design documentation to model the metrological characteristics of measuring transducers, to assess their sensitivity in the selected measuring range, as well as to calculate the measurement errors of the physical quantity. |
| SK 25 | Develop analog devices of industrial and domestic REA using ORCAD design environments, analyze topological blocks of integrated DC / DC converters containing reference power supplies, feedback signal amplifiers sawtooth voltage generators, pulse width modulators, internal stabilizers of self-chips for chips chips, analyze transients in time, amplitude and frequency characteristics of amplifiers, determine the phase margin to ensure stable operation of CEA, determine the possibility of activation of parasitic elements of the integrated circuit, prevention of such phenomena and minimization of parasitic elements when such phenomena become impossible |
| SK 26 | Carry out physical, mathematical modeling and optimization, analyze alternatives for reasonable choice of numerical method for solving an applied problem, correctly interpret the obtained modeling result and evaluate its adequacy, build and analyze equivalent circuits of basic electronic components and ICs using modern CADENCE-PSpice software formalized model of the states of the technical system based on the results of production experiments, process and analyze the results of the experiment. |
| SK 27 | Independently make the right engineering and technical decisions, apply modern system and information technologies, justify the choice of rational options for the construction of EOS, as well as electronic systems for various functional purposes and principles of operation. |

**2. LIST OF COMPONENTS OF THE EDUCATIONAL PROGRAM**

|  |  |  |  |
| --- | --- | --- | --- |
| Number in order | Components of the educational program | ECTS credits | Form of final control |

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | 2 | 3 | 4 |
| **1. COMPULSORY EDUCATIONAL COMPONENTS** |
| **1.1. General training (GT) cycle** |
| GT 1 | Ukrainian language for professional purposes | 2 | set-off |
| GT 2 | History of science and technology | 2 | set-off |
| GT 3 | Sports | 5 | set-off |
| GT 4 | Foreign Language | 6 | set-off |
| GT 5 | Economics and organization of production | 4 | set-off |
| GT 6 | Labor Safety and civil defense | 4 | set-off |
| GT 7 | Higher Mathematics | 20 | exam |
| GT 8 | Physics | 12 | exam |
| GT 9 | Engineering and Computer Graphics | 5 | exam |
| GT 10 | Introduction to Specialty | 2 | set-off |
| GT 11 | Fundamentals of Metrology | 3 | set-off |
| GT 12 | Informatics | 10 | exam |
| GT 13 | Fundamentals of Circuits Theory | 8 | exam |
| GT 14 | Electrodynamics and the propagation of radio waves | 7,5 | exam |
| GT 15 | Circuitry | 6 | exam |
| GT 16 | Fundamentals of Telecommunication Theory and Radioengineering | 6,5 | exam |
| GT 17 | Digital Signal Processing | 5,0 | exam |
| **Total compulsory educational components for GT cycle** | 108,0 |  |
| **1.2. Vocational training (VT) cycle** |
| VT 1 | Fundamentals of Probabilistic Data Processing | 3,5 | set-off |
| VT 2 | Materials Science of Radioelectronic Devices | 4 | set-off |
| VT 3 | Electronic Component Base of Radioelectronic Equipment | 4 | exam |
| VT 4 | Design and Manufacturing Technology of Radioelectronic Devices | 6,5 | exam |
| VT 5 | Design of digital devices using Verilog language | 4 | set-off |
| VT 6 | Fundamentals of Microprocessor-based Devices | 5 | exam |
| VT 7 | Architecture of computer systems | 4 | set-off |
| VT 8 | Design engineering of Radioelectronic Equipment | 6,5 | exam |
| VT 9 | Microprocessor systems based on microcontrollers ARM Cortex-M | 7 | exam |
| VT 10 | Modeling of Technical Systems and Technological Processes | 7 | exam |
| VT 11 | Optimization and Decision in Project Design Solution | 3,5 | set-off |
| VT 12 | Course work on Electronic Component Base of Radioelectronic Equipment | 1 | course work, set-off |
| VT 13 | Course project on Design and Manufacturing Technology of Radioelectronic Devices | 1,5 | course project, set-off |
| VT 14 | Course work on Design engineering of Radioelectronic Equipment | 1 | course work, set-off |
| VT 15 | Course project on Microprocessor systems based on microcontrollers ARM Cortex-M | 1,5 | course project, set-off |
| VT 16 | Pre-diploma Practice | 6 | set-off |
| VT 17 | Bachelor's Thesis Implementation | 6 |  |
| **Total compulsory educational components for VT cycle** | 72,0 |  |
| **Total in compulsory educational components**  | 180,0 |  |
| **2. OPTIONAL EDUCATIONAL COMPONENTS** |
| **2.1. General training (OGT) cycle** **(Оptional subjects from University catalogue)**  |
| OGT 1 | Educational component 1 University catalogue | 2 | set-off |
| OGT 2 | Educational component 2 University catalogue | 2 | set-off |
| OGT 3 | Educational component 3 University catalogue | 2 | set-off |
| OGT 4 | Educational component 4 University catalogue | 2 | set-off |
| OGT 6 | Foreign Language for professional Purposes | 6 | exam |
| **Total optional educational components for OGT cycle** | 14,0 |  |
| **2.1. Vocational training (OVT) cycle** **(Оptional subjects from Faculty/Department catalogue)** |
| OVT 1 – OVT 11 | Educational components 1-11 from Faculty catalogue | 46 | exam, set-off |
| **Total optional educational components for OVT cycle** | 46 |  |
| **Total for optional educational components** | 60,0 |  |
|  |
| **Total for general training cycle:** | 108,0 |
| **Total for vocational training cycle:** | 72,0 |
| **Total for compulsory educational components:** | 180 |
| **Total for optional educational components:** | 60 |
| **TOTAL FOR EDUCATIONAL PROGRAM** | 240 |

**3. STRUCTURAL SCHEME OF THE** **EDUCATIONAL PROGRAM**



**4. FORM OF FINAL ASSESSMENT OF HIGHER EDUCATION APPLICANTS**

Final assessment of higher education applicants for an educational and professional program «Information-computing means of radio electronic systems» of specialty 172 - «Telecommunications and Radioengineering» is carried out in the form of the qualification work defence and ends with an issuance of the document (diploma) of the established sample on awarding his bachelor's degree with qualification: Bachelor in Electronics and Telecommunications for an educational and professional program «Information-computing means of radio electronic systems».

Final assessment is carried out openly and publicly. Qualification work is checked for plagiarism according to the «Regulations on the Prevention of Academic Plagiarism» of Igor Sikorsky Kyiv Polytechnic Institute.

**5. CORRESPONDENCE MATRIX OF PROGRAM COMPETENCES TO COMPONENTS OF THE EDUCATIONAL PROGRAM**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | GT1 | GT 2 | GT 3 | GT 4 | GT 5 | GT 6 | GT 7 | GT 8 | GT 9 | GT 10 | GT 11 | GT 12 | GT 13 | GT 14 | GT 15 | GT 16 | GT 17 | VT1 | VT 2 | VT 3 | VT 4 | VT 5 | VT 6 | VT 7 | VT 8 | VT 9 | VT 10 | VT 11 | VT 12 | VT 13 | VT 14 | VT 15 | VT 16 | VT 17 |
| GC1 |  |  |  |  |  |  | **+** | **+** | **+** |  |  |  |  |  |  |  |  | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| GC2 | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** |  | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** |
| GC3 | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | **+** | **+** | **+** | **+** | **+** | **+** | **+** |
| GC4 |  |  |  |  | **+** |  | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | + |
| GC5 | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** |
| GC6 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | + | + | + | + | + | + | + | + | + | + | + | **+** | **+** | **+** | **+** | **+** | **+** |
| GC7 |  | **+** |  |  | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | + |
| GC8 |  |  |  |  |  |  |  |  |  |  |  |  | **+** | **+** | **+** | **+** | **+** |  |  |  | **+** |  |  |  | **+** |  | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** |
| GC9 |  |  |  |  |  | **+** |  |  |  |  | **+** |  |  |  |  |  |  | + | + | + | + | + | + | + | + | + | + | + | **+** | **+** | **+** | **+** | **+** | **+** |
| GC10 |  |  |  |  | **+** | **+** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** | **+** |
| GC11 |  |  |  |  | **+** | **+** |  |  |  |  |  |  |  |  |  |  |  | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | **+** | **+** |
| GC12 |  | **+** |  |  |  |  |  |  |  |  | **+** |  |  |  | **+** |  | **+** | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | **+** | **+** |
| PC 1 |  | **+** |  |  | + |  |  |  |  | **+** |  |  |  |  |  |  |  | **+** |  |  | + | + | + |  |  |  |  |  |  |  |  |  | **+** | **+** |
| PC 2 |  |  |  |  | + |  |  |  |  |  | **+** |  | **+** | **+** | **+** | **+** | **+** | **+** |  |  |  |  |  |  |  |  |  | **+** | **+** | **+** | **+** | **+** | **+** | **+** |
| PC 3 |  |  |  |  |  |  |  |  |  | **+** | **+** | **+** |  |  |  |  |  | **+** | **+** | **+** |  |  | **+** | **+** |  | **+** |  |  | **+** | **+** | **+** | **+** | **+** | **+** |
| PC 4 |  |  |  |  | + |  | + | + | + | + | + | + | + | + | + | + | + | **+** | + | + | + | + | + | + | + | + | **+** | **+** |  | **+** |  | **+** |  | **+** |
| PC 5 |  |  |  |  |  |  | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | **+** | **+** | **+** | **+** | **+** | **+** |
| PC 6 |  |  |  |  |  |  |  |  |  |  | **+** |  |  |  |  |  |  |  |  |  | + | + |  |  |  |  |  |  | **+** | **+** | **+** | **+** |  | **+** |
| PC 7 |  |  |  |  |  | **+** |  |  |  |  |  |  |  |  |  |  |  | + | + | + | + | + |  |  |  |  |  |  |  |  |  |  | **+** | **+** |
| PC 8 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | + | + | + | **+** | **+** | **+** | + | + | + | + | **+** | **+** | **+** | **+** | **+** | **+** |
| PC 9 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| PC 10 |  |  |  |  |  |  |  |  |  |  | **+** |  |  |  |  |  |  | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| PC 11 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | + | + | + | + | + | + | + | + | + | + | + | **+** | **+** | **+** | **+** | **+** | **+** |
| PC 12 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | + | + | + | + | + | + | + | + | + | + | + | **+** | **+** | **+** | **+** | **+** | **+** |
| PC 13 |  |  |  |  |  | **+** |  |  |  |  |  |  |  |  |  |  |  | + | + | + | + | + | + | + | + | + | + | + | **+** | **+** | **+** | **+** | **+** | **+** |
| PC 14 |  |  |  |  |  | **+** |  |  |  |  |  |  |  |  |  |  |  | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| PC 15 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** |

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

|  | GT 1 | GT 2 | GT 3 | GT 4 | GT 5 | GT 6 | GT 7 | GT8 | GT9 | GT 10 |  GT 11 | GT 12 | GT 13 | GT 14 | GT 15 | GT 16 | GT 17 | VT 1 | VT 2 | VT 3 | VT 4 | VT 5 | VT 6 | VT 7 | VT 8 | VT 9 | VT 10 | VT 11 | VT 12 | VT 13 | VT 14 | VT 15 | VT 16 | VT 17 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| KW 1 |  | **+** |  | **+** |  |  | **+** | **+** | **+** | **+** | **+** | **+** |  | **+** |  | **+** | **+** |  | **+** | **+** |  |  | **+** | **+** |  |  | **+** |  |  |  |  |  | **+** | **+** |
| KW 2 |  | **+** |  |  | **+** | **+** | **+** | **+** | **+** | **+** |  | **+** | **+** |  |  |  | **+** | **+** | **+** |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** | **+** |
| KW 3 |  | **+** |  |  | **+** | **+** |  |  |  | **+** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** | **+** |
| KW 4 |  |  |  |  |  |  |  |  |  | **+** |  |  |  |  |  |  |  |  |  |  | **+** | **+** |  |  | **+** |  |  | **+** | **+** | **+** | **+** |  | **+** | **+** |
| KW 5 |  |  |  | **+** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** | **+** |
| KW 6 |  |  |  |  | **+** |  | **+** | **+** |  |  |  |  |  | **+** | **+** | **+** | **+** | **+** |  | **+** | **+** |  |  |  |  | **+** | **+** |  |  |  |  |  | **+** | **+** |
| KW 7 |  |  |  |  |  |  |  |  |  |  |  |  | **+** |  |  | **+** |  |  | **+** | **+** |  |  |  |  |  |  |  |  | **+** | **+** | **+** |  | **+** | **+** |
| KW 8 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** |  |  |  |  |  |  |  |  | **+** |  |  |  | **+** | **+** |
| KW 9 |  |  |  |  |  |  |  |  |  |  | **+** |  | **+** |  |  |  |  |  |  | **+** | **+** | **+** |  |  |  |  |  |  | **+** |  |  |  | **+** | **+** |
| KW10 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** | **+** | **+** | **+** |  | **+** |  |  | **+** | **+** | **+** | **+** | **+** | **+** | **+** |
| KW11 |  |  |  |  | **+** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** |  |  |  |  |  |  |  |  |  |  |  | **+** | **+** |
| KW12 |  |  |  |  |  | **+** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** | **+** |
| KW13 |  |  |  |  |  | **+** |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** |  |  |  |  |  |  |  |  |  |  |  | **+** | **+** |
| KW14 |  |  |  |  |  |  |  |  |  |  | **+** |  |  |  |  |  |  |  | **+** | **+** | **+** |  |  |  |  |  |  |  |  |  |  |  | **+** | **+** |
| KW15 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** |  |  |  |  | **+** | **+** |
| KW16 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** |  |  |  |  | **+** |  | **+** |  | **+** | **+** | **+** |  |  |  | **+** |  |  |
| KW17 |  |  |  |  |  |  |  |  |  |  |  |  | **+** |  | **+** | **+** | **+** | **+** |  |  |  | **+** | **+** |  |  | **+** | **+** | **+** |  |  | **+** | **+** |  |  |
| KW18 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** | **+** | **+** |  |  |  | **+** | **+** |  |  | **+** | **+** | **+** |  | **+** |  |
| KW19 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** | **+** | **+** |  |  |  | **+** | **+** |  |  | **+** | **+** | **+** |  | **+** |  |
| KW20 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** |  |  |  |  |  |  |  |  | **+** |  |  | **+** |  |  |  |  |  |  |  |
| KW21 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** | **+** |  | **+** |  |  |  | **+** | **+** | **+** |  | **+** | **+** | **+** |  |  |  | **+** |  |  |
| SK 1 |  |  |  |  |  |  |  |  |  |  | **+** |  |  |  | **+** |  |  |  | **+** | **+** | **+** |  |  | **+** | **+** |  |  | **+** | **+** | **+** |  | **+** | **+** | **+** |
| SK 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** | **+** | **+** | **+** | **+** | **+** |
| SK 3 |  |  |  |  |  |  |  |  |  |  | **+** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** | **+** | **+** | **+** | **+** | **+** |
| SK 4 |  |  |  |  |  |  |  |  |  |  | **+** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** | **+** | **+** | **+** | **+** | **+** |
| SK 5 |  |  |  |  |  |  |  |  |  |  | **+** |  |  |  |  |  |  |  | **+** |  | **+** | **+** | **+** | **+** |  |  |  |  | **+** | **+** | **+** | **+** | **+** | **+** |
| SK 6 |  |  |  |  |  |  |  |  |  |  | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** |
| SK 7 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** |
| SK 8 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** |  | **+** |  |  |  | **+** | **+** |  |  | **+** |  |  |  |  | **+** |  |  | **+** | **+** |
| SK 9 | **+** |  |  | **+** | **+** | **+** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** | **+** |
| SK 10 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** |  | **+** | **+** | **+** |  | **+** | **+** |
| SK 11 | **+** |  |  | **+** | **+** | **+** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** |  | **+** | **+** | **+** |  | **+** | **+** |
| SK 12 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** |  | **+** | **+** | **+** |  | **+** | **+** |
| SK 13 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **+** |  | **+** | **+** | **+** |  |  |  |  |  | + |  |  |  | **+** | **+** |
| SK 14 |  |  |  |  |  |  |  |  | **+** |  |  |  |  |  |  |  | + | + |  | + | + | + | + | + | + | + | + | + | + | + |  |  | **+** | **+** |
| SK 15 |  |  |  |  |  |  |  |  |  |  | + |  |  |  |  |  |  |  |  |  | + |  |  |  |  |  |  |  |  |  |  |  | **+** | **+** |
| SK 16 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | + |  |  |  | + |  |  |  |  |  |  |  | **+** | **+** |
| SK 17 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | **+** | **+** |
| SK 18 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | + | + | + | + | + | + | **+** | **+** |
| SK 19 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | + | + | + | + | + | + | + | + | + | + | + | + | **+** | **+** |
| SK 20 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | + |  |  |  |  |  |  |  |  | + |  |  |  |  |  |  |  | **+** | **+** |
| SK 21 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | + |  |  |  |  |  |  |  |  | + |  |  |  |  |  |  |  | **+** | **+** |
| SK 22 | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | **+** | **+** |
| SK 23 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | + | + | + | + | + | + | + | + | + | + | + | + | + |
| SK 24 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| SK 25 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| SK 26 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| SK 27 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | + | + | + | + | + | + | + | + | + | + | + | + | + | + |