**MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE**

**NATIONAL TECHNICAL UNIVERSITY OF UKRAINE**

**"IGOR SIKORSKY KYIV POLYTECHNICAL INSTITUTE**

APPROVED by

Academic council of

Igor Sikorsky Kyiv Polytechnic Institute

(protocol №3 from 15.03.2021 )

Head of academic council

\_\_\_\_\_\_\_\_\_\_Mykhailo ILCHENKO

**INFORMATION AND COMMUNICATION RADIOENGINEERING**

**EDUCATIONAL SCIENTIFIC PROGRAM**

**of the 2nd (Master) level of higher education**

|  |  |
| --- | --- |
| **speciality** | **172 Telecommunications and radio engineering** |
| **branch of knowledge** | **17 Electronics and telecommunications** |
| **qualification** | **Bachelor in telecommunication and radio engineering**  |

Implemented from 2021/2022 year

by the order of the rector of

Igor Sikorsky Kyiv Polytechnic Institute

from 19.04.2021 № MOM/89/2021

Kyiv – 2021

**PREAMBLE**

**DEVELOPED by the project team:**

Project team leader:

Guarantor of the educational program,

|  |  |
| --- | --- |
| Doctor of physical and mathematical Sciences, professor, Professor of the Department of Theoretical Foundations of Radio Engineering Victor NAYDENKO |  |

Project team members:

|  |  |
| --- | --- |
| Doctor of Technical Sciences, professor, Professor of the Department of Theoretical Foundations of Radio Engineering |  |
| Oleh SHARPAN  | \_\_\_\_\_\_\_\_\_\_ |
| PhD, Associate Professor of the Department of Theoretical Foundations of Radio EngineeringOleksandr SUSHKO | \_\_\_\_\_\_\_\_\_\_ |

The department of theoretical foundations of radio engineering is responsible for the preparation of students according to the educational program

|  |  |
| --- | --- |
| **Deputy head of**  the Department of Theoretical Foundations of Radio Engineering Doctor of Technical Sciences, professor,Fedir DUBROVKA |  |

**APPROVED BY**

Scientific and Methodological Commission of Igor Sikorsky KPI, speciality 172 Telecommunications and Radio Engineering

Head of SMC 172\_\_\_\_\_\_\_\_\_\_\_ Leonid URYVSKY

(№ 3, 09/Feb/2021 )

Methodological Commission of Igor Sikorsky KPI

Head of Methodological Commission

\_\_\_\_\_\_\_\_\_\_\_\_\_ Yurii YAKYMENKO

(protocol № 6, 25. 02. 2021)

**ACCOUNTED FOR:**

 Amendments to the Law of Ukraine "On Higher Education", Order №7 / 70 of 07.04.2020 Igor Sikorsky KPI "On approval of the Regulations on the development, approval, monitoring and review of educational programs in Igor Sikorsky KPI», recommendations and suggestions of specialists in the field of telecommunications and radio engineering from the enterprises of «VD MAIS», LLC «Aviaelektronika», results of discussion of the educational program at the meeting of the department of theoretical foundations of radio engineering (minutes № 12/2020 from 23.12.2020) .

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# 1. PROFILE OF THE EDUCATIONAL PROGRAM

**specialty 172 Telecommunications and radio engineering**

|  |
| --- |
| **1 – General information** **Загальна інформація/** |
| Full name of University and faculty/institute  | National technical university of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”, Radio engineering Faculty  |
| Higher education degree and title of qualification in the original language | Degree - Master Educational qualification - Master of Telecommunications and Radio Engineering  |
| Official name of educational program | Information and communication radio engineering  |
| Type of diploma and volume of educational program  | Master's degree, 120 credits, study period 1 year 9 months  |
| Accreditation  | Certificate of accreditation ND №1192634 from 25.09.17validity: until 01.07.2024  |
| Level from National frame of qualifications (NFQ) | NFQ of Ukraine - level 7(QF-EHEA - second cycle, EQF-LLL - level 7)  |
| Prerequisites  | Bachelor's degree  |
| Language  | Ukrainian |
| Validity of educational program | Until the next accreditation  |
| Link of permanent storage of educational program | <http://kpi.ua/master> <http://rtf.kpi.ua/admission-master/> |
| **2 – Goal of educational program** |
| Training of a specialist capable of solving complex problems and problems in the field of telecommunications and radio engineering and carrying out innovative professional activities and conduct their own research, the results of which have scientific novelty, theoretical and practical significance. The purpose of the educational program corresponds to the development strategy of Igor Sikorsky KPI for 2020-2025 on the formation of the society of the future on the basis of the concept of innovation and sustainable development.  |
| **3 – Characteristics of the educational program**  |
| Subject category | Objects of study: a set of technologies, means, methods and techniques of processing, storage and exchange of information at a distance and the use of electromagnetic oscillations and waves, in particular in telecommunications, television, communications, radar and radio navigation, for control and management of machines and mechanisms and technological processes in electronic, medical equipment, measuring devices and systems.The purpose of training: the formation and development of general and professional competencies for the implementation and application of telecommunications and radio engineering technologies that contribute to the social stability and mobility of the graduate in the labor market.Theoretical content includes: - theory, models and principles of functioning of telecommunication and radio systems, electronic devices;- principles, methods and means of ensuring the specified operational characteristics and properties of telecommunication and radio systems; - regulatory framework of Ukraine and the requirements of international standards in the field of telecommunications and radio engineering; - modern software and hardware of radio and telecommunication systems and networks.Methods, techniques, approaches and technologies: Methods, techniques, information and communication and other technologies of telecommunications and radio engineering.Tools and equipment: - systems of development, provision, monitoring and control of processes in telecommunication and radio engineering systems; - modern software and hardware of telecommunication technologies and radio engineering. |
| Type of the educational program  | Educational scientific  |
| The main focus of the educational program | Modern scientific and technical research and development in the field of ultra-high frequency radio information and communication systems.Emphasis on the development and implementation of innovative methods and technologies in the design, engineering implementation and application of radio information and communication high-frequency systems, including high-frequency antenna, mobile and satellite systems of the new generation, in various fields of economic activity.Keywords: radio engineering, telecommunications, radio electronics, radio engineering systems, radio communication, microwave technology, antennas, signal processing |
| Features of the program  | The educational program is focused on training specialists with a master's degree, who will be able to conduct research, offer innovative ideas, develop, test and operate radio frequency parts (in the frequency range from 10 MHz to 1 THz, or ultra-high frequency) information and communication systems, namely complex antenna systems and antenna arrays, low-noise microwave receivers, powerful microwave transmitters, microwave synthesizers, etc. The program is based on the implementation of the requirements of the *(European Qualifications Framework for Lifelong Learning EQF-LLL)*. The educational program "Information and Communication Radio Engineering" corresponds to the "Radio Frequency Electronics Engineering" programs of universities in Europe and the United States, which provide training for high-class specialists in the field of high-frequency radio electronics and antennas.Practice at the enterprise is provided in order to provide conditions for training a specialist in a real environment of future professional activity.Semester (and/or project implementation) of international mobility is possible |
| **4 – Suitability of graduates for employment and further study**  |
| Suitability for employment  | According to the Classifier of professions DK 003: 2010 according to the received qualification:2144 Professionals in electronics and telecommunications 2144.1 Researchers (electronics, telecommunications)2144.2 Engineers in the field of electronics and telecommunications 2132.2 Computer program developers (application programmer) 2310 Teachers of universities and higher educational institutions (assistant, teacher of a professional educational institution, etc.).  |
| Further training  | To continue education at the third (educational-scientific) level of higher education. |
| **5 – Teaching and assessment**  |
| Teaching | Lectures, practice and seminar classes, computer workshops and laboratory works; course projects and works; technology of blended learning, practice and excursions; master's dissertation |
| Evaluation/assessment | Assessment of students' knowledge is carried out in accordance with the Regulations on the system of assessment of learning outcomes in Igor Sikorsky KPI for all types of classroom and extracurricular work (current, calendar, semester control), oral and written exams, knowledge testing, current control, master's thesis viva |
| **6 – Program competencies**  |
| Integral competenceІнтегральна компетентність | Ability to solve complex problems and problems in the field of radio engineering and telecommunications, which involves research and / or innovation and is characterized by uncertainty of conditions and requirements |
| **General Competences (GC)** |
| GC 1 | Ability to improve and develop one's intellectual and cultural level, to build one's own trajectory of professional development and career. |
| GC 2 | Ability to generate new ideas and non-standard approaches to their implementation (creativity). |
| GC 3 | Ability to make management decisions, assess their possible consequences and be responsible for the quality of the end result. |
| GC 4 | Ability to manage projects, organize teamwork, take the initiative to improve activities. |
| GC 5 | Ability to analyze, verify, assess the completeness of information in the course of professional activities, if necessary, to supplement and synthesize missing information and work in conditions of uncertainty. |
| GC 6 | Ability to propose concepts, models, invent and test methods and tools of professional activity using the natural, social sciences, humanities and economics. |
| GC 7 | Ability to build professional activities, business and make decisions based on the principles of social responsibility, legal and ethical norms. |
| GC 8 | Ability to effective communication interactions, in particular by means of information technology. |
| GC 9 | Ability to define, broadcast common goals in professional and social activities |
| GC 10 | Ability to solve significant ideological, social and personal problems. |
| GC 11 | The ability to identify the scientific nature of problems in the professional sphere, to find adequate ways to solve them.  |
| GC 12 | Ability to independently master new research methods, change the scientific and research and production profile of their activities.  |
| GC 13 | Ability to investigate problems using systems analysis, synthesis and other general scientific methods of cognition.  |
| GC 14 | Ability to conduct professional, including research activities in an international environment.  |
| **Special competencies (SC)** |
| SC 1 | Ability to ensure compliance with the legislation of Ukraine, to organize the protection of the rights and economic interests of the team (enterprise) in the field of intellectual property of engineering developments in market conditions. |
| SC 2 | Ability to assess the level of existing technologies in the field of professional activity, the effectiveness of technical solutions and the possibility of the emergence of intellectual property rights, to find ways and opportunities to implement scientific ideas in profitable business projects and startups. |
| SC 3 | Ability to system thinking, solving problems of development, optimization and updating of structural units of telecommunication, radio engineering and information systems. |
| SC 4  | Ability to use a foreign language for translation, generalization and use of foreign specialized scientific, technical and reference literature. |
| SC 5  | Ability to provide a comfortable psychological environment in the team for fruitful innovative scientific and technical activities. |
| SC 6  | Ability to demonstrate and apply in practice knowledge of methods of mathematical modeling of dynamic systems, evaluation of system efficiency and methods of evaluation of measurement quality in telecommunication and radio systems. |
| SC 7 | Ability to apply basic ideas about innovation and features of acquisition and use of intellectual property rights. |
| SC 8  |  Ability to evaluate and maximize efficiency, propose and design complex radio high-frequency telecommunication systems, taking into account the characteristics of individual microwave components and the relationship between them |
| SC 9 | Ability to design, configure, commission and maintain technical electronic medical systems and complexes of the new generation |
| SC 10 | Ability to conduct research, design and operate electronic microwave subsystems of terrestrial and onboard segments of satellite systems. |
| SC 11 | Ability to conduct research to design and optimize the characteristics of modern and advanced antenna systems |
| SC 12 | Ability to model, design and put into practice the benefits of adaptive digital radio signal processing systems |
| SC 13 | Ability to perform calculations of system characteristics of transceiver devices of digital antenna arrays; modeling of methods of determining the direction of signal arrival and formation of zeros of the radiation pattern in the MATLAB program. |
| **7 – Program results of teaching (PRT)** |
| PRT 1 | Basic principles, methods and forms of scientific activity |
| PRT 2 | System connections of disciplines of professional training and their complex use for the decision of problems of subject area. |
| PRT 3 | The main provisions of the concept of sustainable development of society. |
| PRT 4 | Legal content of intellectual property and the main forms and methods of protection of intellectual property. |
| PRT 5 | Foreign language at a level sufficient for professional and everyday communication. |
| PRT 6 | Fundamentals of patent science and copyright. |
| PRT 7 | Fundamentals of pedagogy and human psychology |
| PRT 8 | Contents of the business plan of the project in the subject area. |
| PRT 9 | The main provisions of the technical and economic analysis of design and production activities. |
| PRT 10 | Legal and economic aspects of business and production activities, as well as the structure and forms of documentation that provides it. |
| PRT 11 | Protection of the rights and economic interests of the team on intellectual property. |
| PRT 12 | Areas of innovation in the subject area. |
| PRT 13 | System statement and solution of theoretical and applied problems. |
| PRT 14 | A meaningful choice of the necessary approach for a formalized description of the system, process, object. |
| PRT 15 | The main provisions of the theory and practice of scientific knowledge. |
| PRT 16 | Principles of construction and methods of engineering implementation of telecommunication radio systems. |
| PRT 17 | Physical bases, structure, parameters and capabilities of modern electronic medical systems and complexes. |
| PRT 18 | Principles of construction, frequency ranges of physical processes and operational characteristics of satellite information systems based on geostationary, medium-orbit and low-orbit satellites, features of their energy (energy equations, block diagrams and diagrams of SIS energy levels), multi-station access methods, antenna modulation methods.  |
| PRT 19  | Designs, principles of construction, advantages and disadvantages of the main types of modern antenna systems, namely multi-reflector antennas, scanning digital antenna arrays, ultra-wideband antennas, antennas of mobile terminals. |
| PRT 20 | Fundamentals of adaptive control theory; basics of the theory of adaptive suppression of various obstacles; general provisions of the theory of adaptive antenna structures and adaptive radiation generation; features of application of signals with pseudo-random change of operating frequency;  |
| PRT 21 | Digital antenna array architectures; system characteristics of the components of digital antenna arrays: DAC, ADC, power amplifiers, switching devices, low-noise amplifiers, antenna arrays; principles of construction of antenna arrays of MIMO-systems; methods for determining the direction of signal arrival; methods of digital formation of the radiation pattern |
| UM 1 | Organize the acquired knowledge for setting and solving engineering and scientific problems, selection and use of appropriate analytical methods of calculation. |
| UM 2 | To determine the directions of modernization of technological aspects of production, introduction of the newest information and communication technologies. |
| UM 3 | Build a system of document management, preparation of technical, design, technological, metrological and organizational and management documentation, reporting, verification of compliance with current norms and standards of office work, implementation of quality management system at the enterprise. |
| UM 4 | Manage projects of international scientific cooperation and academic mobility with the writing of scientific papers, preparation of scientific reports, testing and implementation of research and development results, dissemination of information on research results at international conferences, seminars, etc. |
| UM 5 | Analyze technical and economic indicators, reliability, ergonomics, patent purity, market needs, investment climate and compliance of design solutions, research and development with the norms of Ukrainian legislation on intellectual property. |
| UM 6 | Investigate processes in telecommunications and radio systems using automation of engineering calculations, planning and conducting scientific experiments with processing and analysis of results. |
| UM 7 | Argue and defend the developed design and scientific and technical solutions to the customer, lead a reasoned professional and scientific discussion. |
| UM 8 | Combine the application of modern methods for the development of low-waste, energy-saving and environmentally friendly technologies that ensure the safety of human life and their protection from possible consequences of accidents, catastrophes and natural disasters, apply methods of rational use of raw materials, energy and other resources. |
| UM 9 | Assess the quality of production using modern control methods, conduct testing, certification and examination of production equipment, parts, assemblies and finished electronic products and devices. |
| UM 10 | Follow the principles of large-scale implementation of modern information technologies, means of communication, methods of improving energy and economic efficiency of development, production and operation of telecommunications and radio devices. |
| UM 11 | To generalize modern scientific knowledge and apply it to solve scientific and technical problems, assess the possibility of bringing the obtained solutions to the level of competitive developments, implementation of results in business projects. |
| UM 12 | Organize and manage research, innovation and investment activities, business projects and production processes, taking into account technical, technological and economic factors. |
| UM 13 | Evaluate, analyze, optimize and measure the main characteristics of ultra-high frequency telecommunication radio systems. |
| UM 14 | Conduct research, design, evaluate characteristics, ensure the correct operation of modern electronic medical systems and complexes. |
| UM 15 | Evaluate and measure the characteristics, design ultrahigh-frequency components of terrestrial and onboard segments of modern satellite systems |
| UM 16 | Competently choose the type, perform engineering calculations and measure the characteristics of modern antenna systems for various purposes |
| UM 17 | Analyze, optimize block diagrams and implement in practice adaptive digital schemes of spatial filtering of radio signals in order to increase the signal-to-noise ratio of telecommunication radio systems. |
| UM 18 | Calculate the parameters of the elements of the receiving and transmitting devices of digital antenna arrays; select the most efficient elements for digital antenna array transceivers operating in different frequency bands; to carry out engineering calculations of the main characteristics of the elements of the receiving and transmitting devices of digital antenna arrays.  |
| **8 – Resource support for program implementation** **Ресурсне забезпечення реалізації програми** |
| Staff | In accordance with the personnel requirements to ensure the implementation of educational activities for the relevant level of HE (Annex 2 to the License Conditions), approved by the Resolution of the Cabinet of Ministers of Ukraine dated 30.12.2015 № 1187 1187 as amended in accordance with the Resolution of the Cabinet of Ministers of Ukraine №347 dated 10.05. 2018 |
| Equipment | In accordance with the technological requirements for logistics of educational activities of the appropriate level of HE (Annex 4 to the License Terms), approved by the Resolution of the Cabinet of Ministers of Ukraine dated 30.12.2015 № 1187 1187 as amended in accordance with the Resolution of the Cabinet of Ministers of Ukraine №347 dated 10.05 .2018 р. |
| Information and educational and methodical support | In accordance with the technological requirements for educational and methodological and informational support of educational activities of the relevant level of HE (Annex 5 to the License Conditions), approved by the Resolution of the Cabinet of Ministers of Ukraine dated 30.12.2015 № 1187 1187 as amended in accordance with the Resolution of the Cabinet of Ministers of Ukraine №347 from 10.05.2018. |
| **9 – Academic mobility**  |
| National credit mobility | Possibility to conclude agreements on academic mobility and a double diploma |
| International credit mobility  | Memorandum of Understanding with Prague Technical University, Prague Czech Republic - cooperation provides for academic mobility of masters under the program of Nikola ShugaiMemorandum of Understanding with the Technical University of Brno, Brno, Czech RepublicMemorandum of Understanding with Ventspils High SchoolErasmus + K1 Credit Mobility Program with the University of Luxembourg, Luxembourg; Istanbul City University, Turkey, Valencia Polytechnic University, Spain; University of Salerno, Italy |
| Training of foreign applicants for higher education | In separate academic groups, the Ukrainian language is studied as a foreign language or in Ukrainian when studying in joint academic groups with Ukrainian-speaking applicants. |

# 2. LIST OF EDUCATIONAL PROGRAM COMPONENTS

|  |  |  |  |
| --- | --- | --- | --- |
| Code of subject | Components of the educational program | Number of credits | Form of final control/exam |

|  |
| --- |
| 1. **Compulsory educational components**

 |
| * 1. **General training cycle**
 |
| CC 1 | Intellectual property and patents | 3 | Pass/not pass |
| CC 2 | Sustainable innovative development | 2 | Pass/not pass |
| CC 3 | Practical course of foreign language scientific communication | 4,5 | Pass/not pass |
| CC4 | Management of startup projects | 3 | Pass/not pass |
| CC5 | Pedagogy of high school | 2 | Pass/not pass |
| CC 6  | Mathematical modeling of processes and systems | 4 | Exam |
| CC 7 | Mathematical methods of optimization | 4 | Exam |
| * 1. **Cycle of professional training**

 |
| PT 1 | Microwave radio engineering | 5 | Exam |
| PT 2 | Radio-electronic medical systems and complexes | 5 | Pass/not pass |
| PT 3 | Satellite information systems | 4 | Exam |
| PT 4 | Course work on the subject of Satellite Information Systems | 1 | Pass/not pass |
| PT 5 | Antenna systems | 5 | Pass/not pass |
| PT 6 | Adaptive signal processing systems | 5 | Pass/not pass |
| PT 7 | Smart systems | 5,5 | Exam |
| **Research (scientific) component** |
| PT 8 | Scientific work on the topic of master's dissertation | 10 | Pass/not pass |
| PT 9 | Research practice | 9 | Pass/not pass |
| PT 10 | Master's thesis | 17 | viva |
| 1. **Optional educational components**
 |
| **2.1. Cycle of professional training****(optional educational components from faculty / department catalogs)** |
| OC1 | Educational component 1 of the F-Catalog | 5 | Exam |
| OC 2 | Educational component 2 of the F-Catalog | 5 | Exam |
| OC 3 | Educational component 3 of the F-Catalog | 5 | Exam |
| OC 4 | Educational component 4 of the F-Catalog | 4 | Pass/not pass |
| OC 5 | Educational component 5 of the F-Catalog | 4 | Pass/not pass |
| OC 6 | Educational component 6 of the F-Catalog | 4 | Pass/not pass |
| OC 7 | Educational component 7 of the F-Catalog | 4 | Pass/not pass |
| **The total amount of components of general training:** | **22,5** |
| **The total volume of special components:** | **32** |
| **The total amount of research components:** | **36** |
| **The total amount of compulsory components:** | **89** |
| **The total amount of optional components:** | **31** |
| **TOTAL VOLUME OF THE EDUCATIONAL PROGRAM** | **120** |

1. **Structural diagramd logical scheme of the educational program**

# FORM OF EVALUATION OF STUDENTS

Certification of higher education students in the educational program "Information and Communication Radio Engineering" is carried out in the form of master's thesis defense and ends with the issuance of a standard document on awarding a master's degree with a master's degree in telecommunications and radio engineering in 172 Telecommunications.

Qualification work is checked for plagiarism and after the defense is placed in the electronic archive of scientific and educational materials of the University for free access.

Certification is carried out openly and publicly.

# Matrix of correspondence between program competences and components of educational program

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | CC1 | CC 2 | CC3 | CC4 | CC5 | CC6 | CC7 | PT1 | PT2  | PT3 | PT4 | PT5 | PT 6 | PT7 | PT8 | PT9 | PT10 |
| GC1 | + | + |  | + | + |  |  |  |  |  |  |  |  |  |  |  |  |
| GC2 | + | + | + |  |  |  |  | + |  |  |  |  | + | + |  |  |  |
| GC3 |  |  |  | + | + |  |  |  |  |  |  |  |  |  |  |  |  |
| GC4 |  |  |  | + | + |  |  |  |  |  |  |  |  |  |  |  |  |
| GC5 |  |  |  |  |  |  |  |  |  |  |  |  |  | + | + |  | + |
| GC6 | + | + | + | + |  |  |  |  |  |  |  |  |  |  | + | + |  |
| GC7 | + | + |  | + | + |  |  |  |  |  |  |  |  | + |  |  |  |
| GC8 |  |  | + | + | + |  |  |  |  |  |  |  |  |  |  | + |  |
| GC9 |  | + | + |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| GC10 | + | + |  | + |  |  |  |  |  |  |  |  |  |  | + | + | + |
| GC11 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | + |  |  |
| GC12 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | + |  |  |
| GC13 |  |  |  |  |  | + | + |  |  |  |  |  |  |  |  |  |  |
| GC14 |  |  | + | + |  |  |  |  |  |  |  |  |  |  | + |  |  |
| SC1 | + | + |  | + |  |  |  |  |  |  |  |  |  |  |  |  |  |
| SC2 | + |  |  | + |  |  |  |  |  |  |  |  |  |  |  |  |  |
| SC3 |  | + |  | + |  | + |  |  |  |  |  |  |  |  | + | + |  |
| SC4 |  |  | + |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| SC5 |  |  |  |  | + |  |  |  |  |  |  |  |  |  |  |  |  |
| SC6 |  |  |  |  |  | + |  |  | + | + | + | + | + | + | + | + |  |
| SC7 | + |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| SC8 |  |  |  |  |  |  |  | + | + | + | + | + | + | + |  | + | + |
| SC9 |  |  |  |  |  |  |  |  | + |  |  |  |  |  |  | + | + |
| SC10 |  |  |  |  |  |  |  | + |  | + | + | + |  | + | + | + |  |
| SC11 |  |  |  |  |  |  |  | + |  |  |  | + |  |  |  |  |  |
| SC12 |  |  |  |  |  |  |  |  |  |  |  |  | + | + |  |  |  |
| SC13 |  |  |  |  |  |  |  |  |  |  |  |  | + | + |  |  |  |

# Matrix of correspondence between program educational results and respective components of educational program

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|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | CC1 | CC2  | CC3 | CC4 | CC5 | CC6 | CC7 | PT1 | PT2  | PT3 | PT4 | PT5 | PT6 | PT7 | PT8 | PT9 | PT10 |
| PRT1 | + | + |  |  |  |  |  |  |  |  |  |  |  |  | + |  |  |
| PRT2  |  | + |  |  |  |  |  |  |  |  |  |  |  |  | + | + | + |
| PRT3 |  | + |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| PRT 4  | + |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| PRT 5  |  |  | + |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| PRT 6  | + |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| PRT 7  |  |  |  |  | + |  |  |  |  |  |  |  |  |  |  |  |  |
| PRT 8  |  |  |  | + |  |  |  |  |  |  |  |  |  |  |  |  |  |
| PRT 9  |   |  |  | + |  |  |  |  |  |  |  |  |  |  |  | + | + |
| PRT 10  | + |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| PRT 11  | + | + |  | + |  |  |  |  |  |  |  |  |  |  |  |  |  |
| PRT 12  |  | + |  |  |  |  |  |  |  |  |  |  |  |  | + |  |  |
| PRT 13  |  |  |  |  |  |  |  |  |  |  |  |  |  | + | + | + |  |
| PRT 14  |  |  |  |  |  | + |  |  |  |  |  |  |  |  | + |  |  |
| PRT 15  |  | + |  |  |  |  |  |  |  |  |  |  |  |  | + |  |  |
| PRT 16  |  | + |  |  |  |  |  | + | + | + | + | + |  | + | + | + | + |
| PRT 17  |  |  |  |  |  |  |  |  | + |  |  |  |  |  |  |  |  |
| PRT 18  |  |  |  |  |  |  |  |  |  | + | + |  |  |  |  |  |  |
| PRT 19  |  |  |  |  |  |  |  |  |  |  |  | + |  |  |  |  |  |
| PRT 20  |  |  |  |  |  |  |  |  |  |  |  |  | + |  |  |  |  |
| PRT 21  |  |  |  |  |  |  |  |  |  |  |  | + | + | + |  |  |  |
| UM1  |  |  |  | + |  |  |  |  |  |  |  |  |  |  | + | + |  |
| UM2  |  | + |  |  |  |  |  |  |  |  |  |  |  |  | + |  |  |
| UM3  |  |  | + | + |  |  |  |  |  |  |  |  |  |  |  |  |  |
| UM4  |  |  | + | + |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | CC1 | CC2 | CC3 | CC4 | CC5 | CC6 | CC7 | PT1  | PT2  | PT3 | PT4  | PT5 | PT6  | PT7  | PT8  | PT9  | PT10 |
| UM5  | + |  |  | + |  |  |  |  |  |  |  |  |  |  |  |  | + |
| UM6  |  |  |  | + |  |  |  | + | + | + |  | + | + | + |  | + | + |
| UM7  |  |  |  |  |  |  |  |  |  |  | + |  |  |  |  | + | + |
| UM8  |  | + |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| UM9  |  | + |  |  |  |  |  | + |  |  |  |  |  |  |  | + | + |
| UM10  | + | + |  | + |  |  |  |  |  |  |  |  |  | + | + | + |  |
| UM11  |  |  |  | + |  |  | + |  |  |  |  |  |  | + | + | + |  |
| UM12  |  |  |  | + |  |  |  |  |  |  |  |  |  |  | + | + |  |
| UM13  |  |  |  |  |  |  |  | + |  |  |  |  |  |  |  |  |  |
| UM14 |  |  |  |  |  |  |  |  | + |  |  |  |  | + | + | + |  |
| UM15 |  |  |  |  |  |  |  |  |  | + | + |  |  | + | + | + |  |
| UM16 |  |  |  |  |  |  |  |  |  | + |  | + |  | + | + | + |  |
| UM17 |  |  |  |  |  |  |  |  |  |  |  |  | + | + | + | + |  |
| UM18 |  |  |  |  |  |  | + |  |  |  |  | + |  | + |  |  |  |