**MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE**

**NATIONAL TECHNICAL UNIVERSITY OF UKRAINE**

**“Igor Sikorsky Kyiv Polytechnic Institute”**

APPROVE

Academic Council of "Igor Sikorsky Kyiv Polytechnic Institute"

(Meeting protocol from «3» 15.03\_2021р.)

Head of Academic Council

\_\_\_\_\_\_\_\_\_\_\_\_\_ Mykhailo ILCHENKO

**Engineering of Іntelligent Electrotechnical and Mechatronic Complexes**

**EDUCATIONAL PROFESSIONAL PROGRAM**

**second (master's) level of higher education**

|  |  |
| --- | --- |
| **specialty** | **141 Electric Power Engineering, Electrotechnics and Electromechanics** |
| **field of knowledge** | **14 Electrical Engineering** |
| **qualification** | **Master of Electric Power Engineering, Electrotechnics and Electromechanics** |

Put into effect by the Rector's Order Igor Sikorsky Kyiv Polytechnic Institute

From19.04.2021№ НОН/89/2021

Kiev – 2021

PREAMBLE

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| --- | --- |
| DEVELOPED by a working group: |  |
|  |  |
| **Chairman of the working group** |  |
| Shevchuk Stepan Prokopovich, Doctor of Technical Sciences, Professor of the Department  Automation of Electrical and Mechatronic Complexes |  |
|  |  |
|  |  |
| **Members of the working group:** |  |
|  |  |
| Mayta Oleksandr, Candidate of Engineering Sciences (Ph.D.),  Associate Professor at the Department of |  |
| Automation of Electrical and Mechatronic Complexes  Danilin Alexander, Candidate of Engineering Sciences (Ph.D.),  Associate Professor at the Department of  Automation of Electrical and Mechatronic Complexes  Bosak Alla, Candidate of Engineering Sciences (Ph.D.),  Associate Professor at the Department of  Automation of Electrical and Mechatronic Complexes |  |
| Polishchuk Valentina, Senior Lecturer at the Department of |  |
| Automation of Electrical and Mechatronic Complexes  Novikov Anton Alexandrovich, student at the Department of  Automation of Electrical and Mechatronic Complexes |  |
|  |  |
| **Head of the Department of**  **Automation of Electrical and Mechatronic Complexes** |  |
| **Rozen Viktor,** Doctor of Technical Sciences, Professor |  |
|  |  |

AGREED:

*Scientific and methodical commission of Igor Sikorsky Kyiv Polytechnic Institute 141 specialty " Electric Power Engineering, Electrotechnics and Electromechanics "*

*Head of Scientific and Methodological*

*Subcommittee on Specialty\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Oleksandr Yandulskyi*

*(Meeting protocol № 4\_ of "18" 02 2021)*

*Methodical council of Igor Sikorsky Kyiv Polytechnic Institute*

*Chairman of the Methodological Council\_\_\_\_\_\_\_\_\_\_\_\_\_ Yurii Yakymenko*

*(Meeting protocol № 6 from 25.02.2021*

Educational and professional program "Engineering of intelligent electrical and mechatronic complexes" of the second (master's) level of higher education has passed external testing and received feedback and reviews from stakeholders: LLC "Axion Energy Global Ukraine", LLC "NTK ENPASELECTRO", Enercis Ukraine LLC.

The Program takes into account the proposals of stakeholders and professional associations.

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# 1. DESCRIPTION OF THE EDUCATIONAL PROGRAM

|  |  |  |
| --- | --- | --- |
| **1 – General information** | | |
| Full name of the Higher Education Institution and Institute /Faculty | National Technical University of Ukraine "Kyiv Polytechnic Institute named after Igor Sikorsky", Institute of Energy Conservation and Energy Management | |
| Higher education degree and title of qualification in the original language | Degree – Master  Qualification - Master of Electric Power Engineering, Electrotechnics and Electromechanics | |
| The official name of the educational program | Engineering of intelligent electrical and mechatronic complexes | |
| Type of diploma and scope of educational program | Master's degree, single, 90 credits, term of study 1 year, 4 months | |
| Availability of accreditation | Accredited for the first time | |
| Level of National Qualifications Framework | NQF of Ukraine - level 7  QF-EHEA – the second cycle  ЕQF-LLL – Level 7 | |
| Prerequisites | Having a bachelor's degree | |
| Language (s) of teaching | Ukrainian | |
| The duration of the Educational Program | Accredited for the first time | |
| Internet address of the permanent placement of the educational program | <https://osvita.kpi.ua/> section "Educational programs"  <https://auek.kpi.ua/> section "Educational programs"  <http://emoev.kpi.ua/> section "Educational process / Training - Educational programs" | |
| **2 – The purpose of the educational program** | | |
| Training of specialists capable of solving specialized problems and practical problems in the field of power engineering, electrical engineering and electromechanics, which involve the development and improvement of intelligent control systems for electrical and mechatronic systems based on modern modeling technologies, control methods in complex systems using modern software. The purpose of the educational program corresponds to the development strategy of KPI. Igor Sikorsky for 2020-2025 on the formation of the society of the future on the basis of the concept of sustainable development, as well as in the transformation of the labor market through interaction with employers and other stakeholders. | | |
| **3 – Characteristics of the educational program** | | |
| Subject area | *Objects of study and activity:*   * electrical and electromechanical services of enterprises, scientific and design institutions;   - enterprises of the electric power industry, including the fuel and energy complex;  - production, transmission, distribution and conversion of electric energy at power plants, electric networks and systems and their engineering;  - electrotechnical equipment, electromechanical and switching equipment, electromechanical, electrotechnical complexes, and intelligent control systems.  *The purpose of training*: training of specialists capable of designing, designing, operating, providing a safety culture, performing installation, commissioning and repair, creating new equipment and implementing the latest technologies, conducting research and teaching.  *Theoretical content of the subject area*: basic concepts of the theory of electric, electromagnetic circuits and technical mechanics, modeling, optimization and analysis of modes of operation of power plants, networks and systems, electric machines, electric drives, electrotechnical and mechatronic systems and complexes.  *Methods, techniques and technologies:* analytical methods for calculating electrical circuits, power supply systems, electrical machines and devices, intelligent control systems for electrical, electromechanical and mechatronic systems, electrical loads using specialized laboratory equipment, personal computers, microprocessors and programmable logic systems.  *Tools and equipment*: control and measuring devices, electrical and electronic devices, microcontrollers, computers. | |
| Orientation of the educational program | Educational and professional | |
| The main focus of the educational program | The program is based on well-known scientific principles, taking into account the current state of development of energy, electrical engineering, electromechanics and mechatronics focuses on current specializations, within which further professional and scientific activities are possible. The program is aimed at the formation of such competencies of higher education students that make possible their comprehensive professional, scientific, intellectual and social development in the field of electrical engineering, engineering of intelligent electrical and mechatronic systems/  Key words: electrotechnical and electromechanical systems and complexes, devices and equipment, control systems, intelligent automation systems, engineering | |
| Peculiarities of the program | Involvement of scientists and practitioners in industry institutions and enterprises. | |
| **4 – Eligibility of graduates for employment and further education** | | |
| Eligibility for employment | According to the classifier of professions DK003: 2010 graduates can perform the following types of professional work:  2143.2 Relay protection and electrical automation engineer  2143.2 Power line service engineer  2143.2 Engineer of the conversion complex  2143.2 Electrical engineer in the energy sector  2143.2 Power Engineer  2143.2 Design engineer (electrical engineering)  Professional certification is possible | |
| Further training | Continuation of education at the third (educational and scientific) level of higher education and / or acquisition of additional qualifications in the system of adult education. | |
| **5 – Teaching and evaluation** | | |
| Teaching and studying | Involvement of specialists from other educational institutions in teaching academic disciplines; conducting internships for students in the industry; participation of VO applicants in student research circles. | |
| Assessment | Current and semester control in the form of laboratory reports, presentations, essays, written and oral examinations and defense of qualification work are evaluated in accordance with the defined criteria of the Rating system | |
| **6 – Program competencies** | | |
| Integral competence | Ability to solve complex problems and problems during professional activities in the field of power engineering, electrical engineering, electromechanics and mechatronics or in the learning process involving research and / or innovation. | |
| General competencies (GC) | GC1 | Ability to abstract thinking, analysis and synthesis. |
| GC2 | Ability to search, process and analyze information from various sources. |
| GC3 | Ability to use information and communication technologies. |
| GC4 | Ability to apply knowledge in practical situations. |
| GC5 | Ability to use a foreign language to carry out scientific and technical activities. |
| GC6 | Ability to make informed decisions. |
| GC7 | Ability to learn and master modern knowledge. |
| GC8 | Ability to identify and assess risks. |
| GC9 | Ability to work independently and in a team. |
| GC10 | Ability to identify feedback and adjust your actions based on them. |
| Professional competencies (PC) | PC1 | Ability to apply the acquired theoretical knowledge, scientific and technical methods to solve scientific and technical problems and problems of power engineering, electrical engineering and electromechanics. |
| PC2 | Ability to apply existing and develop new methods, techniques, technologies and procedures to solve engineering problems of power engineering, electrical engineering and electromechanics. |
| PC3 | Ability to plan, organize and conduct research in the field of power engineering, electrical engineering and electromechanics. |
| PC4 | Ability to develop and implement measures to improve the reliability, efficiency and safety in the design and operation of equipment and facilities of electricity, electrical engineering and electromechanics. |
| PC5 | Ability to analyze technical and economic indicators and examination of design decisions in the field of power engineering, electrical engineering and electromechanics. |
| PC6 | Ability to demonstrate knowledge and understanding of mathematical principles and methods required for use in power engineering, electrical engineering and electromechanics. |
| PC7 | Ability to demonstrate awareness of intellectual property and contracts in power engineering, electrical engineering and electromechanics. |
| PC8 | Ability to research and identify problems and identify constraints, including those related to nature protection, sustainable development, health and safety and risk assessments in electricity, electrical engineering and electromechanics. |
| PC9 | Ability to understand and take into account social, environmental, ethical, economic and commercial considerations that affect the implementation of technical solutions in power engineering, electrical engineering and electromechanics. |
| PC10 | Ability to manage projects and evaluate their results. |
| PC11 | Ability to evaluate indicators of reliability and efficiency of operation of electric power, electrotechnical and electromechanical objects and systems. |
| PC12 | Ability to develop plans and projects to ensure the achievement of a specific goal, taking into account all aspects of the problem, including the production, operation, maintenance and disposal of equipment for power, electrical and electromechanical systems. |
| PC13 | Ability to demonstrate awareness and ability to use regulations, norms, rules and standards in power engineering, еlectrical engineering and electromechanics. |
| PC14 | Ability to use methods of valuation of intellectual property rights for their further commercialization, including for the sale of licenses and technology transfer. |
| PC15 | Ability to publish the results of their research in scientific journals. |
| PC16 | Ability to formulate technical requirements for developed products and technologies, to determine technical conditions of operation and maintenance of new equipment, to make technical tasks for research and development, to allocate key technological parameters of developments and to define their target or normative values in the field of engineering. |
| PC17 | Ability to develop tools, methods and techniques of science and technology aimed at automating existing and creating new automated and automated technologies and industries. |
| PC18 | Ability to create universal most effective algorithms for modeling processes in electrical systems and conduct their research. |
| PC19 | Ability to optimize technological processes and build block diagrams of automated control systems. |
| PC20 | Ability on the basis of the analysis of static and dynamic loadings, mode characteristics to calculate and develop optimum designs of the equipment and operational modes of simple and difficult electromechanical complexes with use of modern computer methods of mathematical modeling. |
| PC21 | Ability to create new effective methods and techniques for designing, manufacturing, diagnosing and repairing energy-intensive electrical equipment. |
| **7 – Program outcomes of studying** | | |
| POS1 Know and understand the main types of intellectual property law and methods of its protection, methodological and legislative bases of creation of intellectual property objects.  POS2. Know and understand the main provisions of regulatory documents governing innovation in Ukraine.  POS3. Know the list of major open international banks of electronic resources to support educational, research and innovation activities.  POS4. Know the basic principles of sustainable development of society, taking into account the social, technological, economic and environmental aspects of human activity.  POS5. Know a foreign language at a level that provides free discussion with foreign scientists on current scientific and technical problems of power engineering, electrical engineering and electromechanics and the opportunity to speak at foreign conferences and symposia.  POS6. Know and understand current standards, regulations and rules according to which Ukraine operates in the field of electricity, electrical engineering and electromechanics.  POS7. Know and understand the rules of safe operation of electrical, electrical and electromechanical equipment.  POS8. Know the main provisions of the Energy Strategy of Ukraine and the principles of energy security.  POS9. Know the main effective methods and approaches aimed at improving energy efficiency and reliability of electrical, electrical and electromechanical equipment and related complexes and systems.  POS10. Know the basic principles of the latest approaches and modern methods of research in the field of power engineering, electrical engineering and electromechanics.  POS11. To reproduce processes in electric power, electrotechnical and electromechanical systems at their computer modeling.  POS12. Master new versions or new software designed for computer modeling of objects and processes in electrical, electrical and electromechanical systems.  POS13. Reconstruct existing electrical networks, stations and substations, electrical and electromechanical complexes and systems in order to increase their reliability, operational efficiency and resource life.  POS14. Apply the technique of intelligent control in the study and design of relevant complexes and systems.  POS15. Apply methods of engineering activities in the field of modern electrical systems.  POS16. Synthesize systems for automatic control of various objects based on the theory of fuzzy logic and using the theory of artificial neural networks.  POS17. Create universal most effective algorithms for modeling the processes of electrical complexes and conduct their research on modern equipment with modern software.  POS18. Create intelligent-adaptive systems of automated control and monitoring of technical condition by electromechanical equipment based on the use of programmable logic controllers.  POS19. Knowledge of the composition and sequence of development of innovative projects.  POS20. Knowledge, understanding and practical application of experimental theory, methods of experiment planning, evaluation of experimental results, methods of analysis of experimental data and construction of mathematical models based on them, including the use of new methods based on the use of modern information technologies.  POS21. Perform physical and mathematical modeling, static and dynamic analysis of structures, mechanisms, materials and processes at the design stage using modern computer systems.  POS22. Choose the element base of electromechanical and mechatronic systems, complete electric and hydraulic drives, control, protection, automation of power supply systems of machines and installations, production sites and enterprises.  POS23. Create intelligent-adaptive systems of automated control and monitoring of technical condition by electromechanical equipment based on the use of programmable logic controllers and on-board computers.  POS24. Calculate forces, stress-strain state, velocities, moments, power, static and dynamic properties, electromechanical equipment, perform power and hydraulic calculations of hydraulic drive elements, electric drives, linear and nonlinear elements, electric and magnetic circuits.  POS25. Fluently communicate orally and in writing in state and foreign languages on modern scientific and technical problems of electric power, electrical engineering and electromechanics.  POS26. Identify problems and identify constraints related to environmental, sustainable development, health and safety and risk assessments in the fields of electricity, electrical engineering and electromechanics. | | |
| **8 – Resource provision of the program’s implementation** | | |
| Staffing | In accordance with the personnel requirements for ensuring the implementation of educational activities for the appropriate level, approved by the resolution of the Cabinet of Ministers of Ukraine dated December 30, 2015 № 1187 (as amended by the resolution of the Cabinet of Ministers of Ukraine dated May 10, 2018 № 347) | |
| Information and methodological supplying | In accordance with the technological requirements for material and technical support of educational activities of the appropriate level of HE, approved by the resolution of the Cabinet of Ministers of Ukraine dated December 30, 2015 № 1187 (as amended by the resolution of the Cabinet of Ministers of Ukraine dated May 10, 2018 № 347) | |
| Information and methodological supplying | In accordance with the technological requirements for educational and methodological and informational support of educational activities of the relevant level of HE, approved by the Cabinet of Ministers of Ukraine dated December 30, 2015 № 1187 (as amended by the Cabinet of Ministers of Ukraine dated May 10, 2018 № 347) | |
| **9 – Academic mobility** | | |
| National Credit Mobility | Possibility to conclude agreements on academic mobility, double graduation, etc. | |
| International Credit Mobility | Possibility of concluding agreements on international academic mobility (Erasmus + K1), on double graduation, on long-term international projects that involve the inclusion of students, etc. | |
| Teaching of foreign applicants acquiring higher education | For foreign citizens, education is provided in Ukrainian. | |

# 2. LIST OF COMPONENTS OF THE EDUCATIONAL PROGRAM

|  |  |  |  |
| --- | --- | --- | --- |
| E/D  code | Components of the educational program (disciplines, course projects (works), practices, qualification work) | Number of credits | Final assessment form |

| 1 | 2 | 3 | 4 |
| --- | --- | --- | --- |
| **NORMATIVE educational components** | | | |
| **General training cycle** | | | |
| GT1 | Intellectual property and patent science | 3 | credit |
| GT2 | Fundamentals of engineering and technology of sustainable development | 2 | credit |
| GT3 | Workshop of foreign language professional communication | 3 | credit |
| GT4 | Management of startup projects | 3 | credit |
| **Vocational training cycle** | | | |
| VT1 | Engineering of electrical and mechatronic systems | 5 | exam |
| VT2 | Intelligent decision making systems | 4,5 | credit |
| VT3 | Automated design systems for electromechanical systems and complexes | 4 | exam |
| VT4 | Reliability of electrical and mechatronic systems | 4 | exam |
| VT5 | Computer control of technological processes, experiment, equipment | 4,5 | credit |
| VT6 | Virtual devices of engineering researches | 4 | credit |
| **Research (scientific) component** | | | |
| VT7 | Scientific work on the topic of master's dissertation | 4 | credit |
| VT8 | Practice | 14 | credit |
| VT9 | Execution of a master's dissertation | 12 | defense |
| **SELECTIVE educational components** | | | |
| **Vocational training cycle (Оptional subjetcs from Faculty catalogue)** | | | |
| VO 1 | Educational component 1 from F-Catalog | 5 | exam |
| VO 2 | Educational component 2 from F-Catalog | 4 | credit |
| VO 3 | Educational component 3 from F-Catalog | 5 | exam |
| VO 4 | Educational component 4 from F-Catalog | 4 | credit |
| VO 5 | Educational component 5 from F-Catalog | 5 | exam |
| Total scope of normative educational components:: | | 67 | |
| Total scope of selective educational components: | | 23 | |
| **TOTAL SCOPE OF THE EDUCATIONAL PROGRAM** | | **90** | |

# 3. STRUCTURAL-AND-LOGICAL SCHEME OF THE EDUCATIONAL PROGRAM



Execution of a master's dissertation

Practice

# 4. THE FORM OF GRADUATION CERTIFICATION FOR THE RECIPIENTS OF HIGHER EDUCATION

Certification of applicants for higher education under the educational-professional program "Engineering of intelligent electrical and mechatronic complexes" specialty 141 "Electricity, electrical engineering and electromechanics" is carried out in the form of public defense of the qualifying work and ends with the issuance of a standard document. , electrical engineering and electromechanics for OPP "Engineering of intelligent electrical and mechatronic complexes".

Qualification work is checked for plagiarism and after the defense is placed in the repository of NTB University for free access.

Protection is open and public.

# 5. MATRIX OF CORRESPONDENCE OF PROGRAM COMPETENCES TO EDUCATIONAL PROGRAM COMPONENTS

|  | GT 1 | GT 2 | GT 3 | GT 4 | VT 1 | VT 2 | VT 3 | VT 4 | VT 5 | VT 6 | VT 7 | VT 8 | VT 9 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| GC1 |  |  |  |  |  |  | + | + |  | + |  |  |  |
| GC2 |  |  |  |  |  |  |  |  |  | + |  |  | + |
| GC3 |  |  |  |  |  |  | + |  |  | + |  | + | + |
| GC4 |  | + |  |  | + | + | + |  | + |  |  |  |  |
| GC5 |  |  | + |  |  |  | + | + |  | + |  |  |  |
| GC6 |  |  |  |  |  |  |  |  |  |  |  |  | + |
| GC7 |  |  |  | + |  |  |  |  |  | + | + |  |  |
| GC8 |  |  |  |  |  |  |  |  |  |  |  | + | + |
| GC9 |  |  |  |  |  |  |  |  |  |  |  | + |  |
| GC10 | + |  |  |  |  |  |  |  |  |  |  |  |  |
| PC1 |  |  |  |  |  |  |  | + |  |  |  |  | + |
| PC2 |  |  |  |  |  |  | + |  |  | + |  | + | + |
| PC3 |  |  |  |  |  |  |  |  |  |  |  | + | + |
| PC4 |  | + |  |  |  |  |  | + |  |  |  |  |  |
| PC5 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| PC6 |  |  |  |  |  |  | + | + |  |  |  |  | + |
| PC7 | + |  |  |  |  |  |  |  |  |  |  |  |  |
| PC8 |  | + |  |  |  |  |  |  |  |  |  |  |  |
| PC9 |  |  |  |  | + |  |  |  |  |  |  |  |  |
| PC10 |  |  |  |  | + |  |  |  |  |  |  |  | + |
| PC11 |  |  |  |  | + | + |  | + |  |  |  |  |  |
| PC12 |  |  |  |  |  |  |  |  |  |  |  |  | + |
| PC13 |  |  |  |  |  |  | + | + |  |  |  |  | + |
| PC14 | + |  |  |  |  |  |  |  |  |  |  |  |  |
| PC15 |  |  |  |  |  |  | + | + |  | + |  |  | + |
| PC16 |  |  |  |  | + |  |  |  |  | + |  |  |  |
| PC17 |  |  |  |  | + | + | + |  | + |  |  |  |  |
| PC18 |  |  |  |  | + |  | + | + | + |  |  |  |  |
| PC19 |  |  |  |  |  | + |  |  | + |  |  |  |  |
| PC20 |  |  |  |  |  |  | + |  |  |  |  |  |  |
| PC21 |  |  |  |  |  |  | + |  |  |  |  |  |  |

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

|  | GT 1 | GT 2 | GT 3 | GT 4 | VT 1 | VT 2 | VT 3 | VT 4 | VT 5 | VT 6 | VT 7 | VT 8 | VT 9 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| POS1 | + |  |  |  |  |  |  |  |  | + |  |  |  |
| POS2 |  | + |  |  |  |  |  |  |  |  |  |  | + |
| POS3 |  |  |  |  |  |  | + |  |  | + |  |  | + |
| POS4 |  | + |  |  |  |  |  |  |  |  |  |  |  |
| POS5 |  |  | + |  |  |  | + | + |  |  |  |  |  |
| POS6 |  |  |  |  |  |  | + |  |  | + |  |  | + |
| POS7 |  |  |  |  |  |  |  |  |  |  |  |  | + |
| POS8 |  |  |  |  |  |  | + | + |  | + | + |  | + |
| POS9 |  | + |  | + |  |  |  | + |  |  |  |  |  |
| POS10 |  |  |  |  |  |  | + |  |  | + | + |  | + |
| POS11 |  |  |  |  |  |  | + |  | + |  |  |  |  |
| POS12 |  |  |  |  |  |  | + |  | + | + |  |  |  |
| POS13 |  |  |  |  |  |  |  | + |  |  |  |  |  |
| POS14 |  |  |  |  |  | + |  |  |  |  |  |  |  |
| POS15 |  |  |  |  | + |  |  |  |  |  |  |  |  |
| POS16 |  |  |  |  | + |  |  |  |  |  |  |  |  |
| POS17 |  |  |  |  |  | + | + |  | + | + |  |  |  |
| POS18 |  |  |  |  | + |  | + |  |  | + |  |  |  |
| POS19 |  |  |  |  | + | + |  |  |  | + |  |  |  |
| POS20 |  |  |  |  | + |  |  |  |  | + |  |  |  |
| POS21 |  |  |  |  |  |  |  | + |  |  |  |  |  |
| POS22 |  |  |  |  | + |  |  |  |  |  |  |  |  |
| POS23 |  |  |  |  |  | + |  |  |  |  |  |  |  |
| POS24 |  |  |  |  |  |  | + |  |  |  |  |  |  |
| POS25 |  |  |  |  |  |  | + | + |  | + |  |  |  |
| POS26 |  |  |  |  |  |  |  |  |  | + |  |  |  |