

**MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE  
NATIONAL TECHNICAL UNIVERSITY OF UKRAINE  
“Igor Sikorsky Kyiv Polytechnic Institute”**

Approve

Head of the science board of

Igor Sikorsky Kyiv Polytechnic Institute

\_\_\_\_\_ M.Z. Zgurovsky

«\_\_»\_\_\_\_\_20\_\_ p.

**EDUCATIONAL PROGRAMM**

**«Automated and robotic mechanical systems»**

**The 2<sup>nd</sup> (Master) educational degree**

|                            |                                    |
|----------------------------|------------------------------------|
| <b>Specialty</b>           | <b>131 Applied mechanics</b>       |
| <b>Branch of knowledge</b> | <b>13 Mechanical engineering</b>   |
| <b>Qualification</b>       | <b>Master of Applied mechanics</b> |

Approved by the Science Board of University  
on the «\_\_»\_\_\_\_\_20\_\_ p.  
protocol № \_\_\_\_

## INTRODUCTION

### Developed by the work group:

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Head of the project group (Guarantor of the educational program)

Uzunov Oleksandr Vasylyovych Doctor of tech. science, professor, professor of department of applied hydro-aeromechanics and mechatronics \_\_\_\_\_

Educational program reviewed and approved by the Methodical board of university (Protocol №   9   on the «   29   »    March    2018)

Head of the Methodical board

\_\_\_\_\_ Yu.I. Yakymenko

Science secretary of the Methodical board

\_\_\_\_\_ V.P. Golovenkin

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## 1. Educational program curriculum

### specialty 131 Applied mechanics

#### specializations:

*“Mechatronic and robotic systems in mechanical engineering”,  
“Hydro-pneumo automatics and hydraulic and pneumatic machines”,  
“Automated logistics systems”*

| <b>1 – General information</b>   |  |
|--|--|
| Full names of the high educational institution and faculty   | NATIONAL TECHNICAL UNIVERSITY OF UKRAINE<br>“Igor Sikorsky Kyiv Polytechnic Institute”, Mechanical Engineering Institute   |
| Educational degree and qualification   | Master degree<br>Qualification – Master of Applied mechanics   |
| QF for LLL   | QF for LLL of Ukraine – Level 8  |
| Official name of educational program   | Automated and robotic mechanical systems   |
| Type of diploma and educational program volume   | Master Diploma, single, 90 credits, terms – 1 year and 4 months.   |
| Existing accreditation   | Being accredited for the first time  |
| Precondition   | Bachelor degree  |
| Language   | Ukrainian/English  |
| Term of educational program  | Till next accreditation  |
| WEB-version of the educational program   | <a href="http://weld.kpi.ua/op">http://weld.kpi.ua/op</a>  |
| <b>2 – The aim of the educational program</b>  |  |
| Training of the specialist, who can solve complex tasks and problems of applied mechanics and is able to professional development. |  |
| <b>3 – Educational program characteristics</b>   |  |
| Subject area (branch of knowledge, specialty, specialization (-s), (if existing))  | specialty 131 –Applied mechanics<br>branch of knowledge 13 – Mechanical engineering,<br>specializations:<br>“Mechatronic and robotic systems in mechanical engineering”,<br>“Hydro-pneumo automatics and hydraulic and pneumatic machines”,<br>“Automated logistics systems” |
| Orientation of educational program   | Educational and professional   |
| Main focus of educational program and specialty  | Special education in applied mechanics area<br><br>Keywords: mechatronics, automation in mechanical engineering, hydro- and pneumo- automatic, logistics systems, robots and manipulators, hydraulic and pneumatic machines, Hoisting-and-transport machines                 |
| Features of program  | without features   |
| <b>4 – Suitability of graduates for employment and further training</b>  |  |
| Suitability for employment   | Specialist is able to do professional work according to the classificatory of <b>professions ДК 003:2010</b> in specialty  |
| Further training/education   | Graduates are able to continue education on the 3 <sup>rd</sup> educational degree   |

| <b>5 – Teaching and evaluating</b>                 |  |
|--|--|
| Teaching and learning                              | Lectures, practices and seminars, computer practices and lab works, course projects and works, combined education technology, excursions, implementation of the master's thesis  |
| Evaluating   | Rating system, oral and written exams, tests etc.  |
| <b>6 – Competencies of the program</b>             |  |
| Integral competence                                | Ability to solve complex tasks and problems of automation for engineering and similar technical objects or in studying process, that needs researching and/or innovating and is characterized by undetermined conditions and requirements.   |
| <b>General competencies (GC)</b>                   |  |
| GC 1   | Ability to find, formulate and solve problems  |
| GC 2   | Ability to make informed decisions   |
| GC 3   | Skills of using information and communication technologies   |
| GC 4   | Ability to generate new ideas (creativity)   |
| GC 5   | Ability to develop and manage projects   |
| GC 6   | Ability to communicate with agents of other professional groups of different levels (with experts in other branches of knowledge/areas of business)  |
| GC 7   | Ability to speak foreign language  |
| GC 8   | Ability to learn and use modern knowledge  |
| GC 9   | Ability of abstract thinking, analyze and synthesis  |
| GC 10  | Ability to make researches at the required level   |
| GC 11  | Ability to search, process and analyze information from different sources  |
| <b>Professional competencies of specialty (PC)</b> |  |
| PC 1   | Special concept knowledge of the newest methods of develop and study design, machines and/or processes in mechanical engineering   |
| PC 2   | Ability of critical analyzing and predicting of operational parameters for new and existing mechanical designs, machines, materials and production processes in the engineering by using general knowledge and modern analytic and/or computing methods                              |
| PC 3   | Ability to solve different engineering tasks, with understanding of invariance solutions, via using required methods and resources of the modern enginery and information technology   |
| PC 4   | Ability of critical comprehension of problems in studying, at professional and researching areas on the level of new achievements in engineering and at the edge of other sciences   |
| PC 5   | Ability to formulate a task and detect ways to solve problems through applied mechanics and similar subject areas, to use knowledge about methods of searching the optimal solution, taking into account conditions of insufficient information and contradictory requirements       |
| PC 6   | Ability to use required mathematical, scientific and technical methods, information technology and applied computer software to solve engineering and scientific tasks of applied mechanics  |
| PC 7   | Ability to describe, determine and simulate technical objects and processes, that based on knowledge and comprehension of mechanical theories and practices, also as on basic knowledge of similar sciences  |
| PC 8   | Ability to generate new ideas and inform new innovation projects and promote them on market  |
| PC 9   | Ability of self-employment and effective managing the group or department in solving production tasks, developing complex project, doing scientific researches, as a head. Charge in to develop professional knowledge and skills, and evaluation of strategical evolution of a team |

|  |  |
|--|--|
| PC 10  | Ability to represent own conclusions, knowledge and explanations to specialists and non-specialists, in understandable form and without contradictions, also in educational process. Ability to understand other people's work, giving and receiving concrete instructions |
| PC 11  | Ability to plan and do experimental studies, processing results of an experiment via modern information technology and microprocessor techniques, to explain results of experiments and simulations  |
| Unit 1 (specialization "Mechatronic and robotic systems in mechanical engineering")    |  |
| PC 1.1   | Ability to use basic concepts about different of approaches and tools for creating intelligent mechatronic and robotic systems   |
| PC 1.2   | Ability to use modern methods for design pneumatic, hydraulic, electrical and mechanical devices with different physical sources of operational signals  |
| PC 1.3   | Ability to use modern methods of the mechatronic and robotic engineering systems design  |
| PC 1.4   | Ability to make the structural and logical synthesis and to develop algorithms and control systems for multifunctional versatile mechatronic systems   |
| PC 1.5   | Ability to simulate and study pneumatic, hydraulic, electrical and mechanical devices and systems, as a part of multi-partition automated technical objects  |
| PC 1.6   | Ability to develop and innovate technical objects and raise efficiency of the production taking into account ISO and modern management methods   |
| PC 1.7   | Ability to evaluate efficiency of mechatronic devices and multi-functional automated systems via complex criterions and modern methods   |
| PC 1.8   | Ability to innovate by creating new mechatronic and robotic systems and their parts  |
| Unit 2 (specialization "Hydro-pneumo automatics and hydraulic and pneumatic machines") |  |
| PC 2.1   | Ability to use basic concepts about different approaches and tools for creating hydraulic and pneumatic automated systems, machines and devices  |
| PC 2.2   | Ability to use modern methods of the hydraulic and pneumatic actuators design, also controlling and operational devices of hydraulic and pneumatic machines  |
| PC 2.3   | Ability to use modern methods of the hydraulic and pneumatic systems and aggregates design   |
| PC 2.4   | Ability to develop control systems for hydraulic and pneumatic actuators   |
| PC 2.5   | Ability to simulate and study hydraulic and pneumatic machines, devices and automated systems  |
| PC 2.6   | Ability to develop and innovate technical objects and raise efficiency of the production taking into account ISO and modern management methods   |
| PC 2.7   | Ability to evaluate efficiency of hydraulic and pneumatic machines and automated systems via complex criterions and modern methods   |
| PC 2.8   | Ability to innovate by creating new developments in hydro-pneumo automation area   |
| Unit 3 (specialization "Automated logistics systems")                                  |  |
| PC 3.1   | Ability to use basic concepts about different forms of the logistics systems functional structure and approaches and tools for the soft- and hardware of logistics processes creating  |
| PC 3.2   | Ability to use modern methods for the logistics systems automation of the motion of the materials flow, Hoisting-and-transport machines and mechanisms, also controlling and operational devices   |
| PC 3.3   | Ability to use modern methods of the systems "storage and transportation" , micro-systems design for engineering industries, municipal and domestic branches   |
| PC 3.4   | Ability to analyze outer and inner environments of logistics systems, to organize logistics processes, also to develop soft- and hardware for logistics processes  |
| PC 3.5   | Ability to simulate and study mechanical, electromechanical, hydraulic and mechatronic devices, as parts of automated logistics systems  |
| PC 3.6   | Ability to raise efficiency of the logistics systems functionality taking into account ISO and modern management methods   |
| PC 3.7   | Ability to evaluate efficiency of logistics processes, soft- and hardware of automated logistics systems via complex criterions and modern methods   |

|  |   |
|--|---|
| PC 3.8                                 | Ability to innovate by creating new developments in the area of logistic implementation for technological processes   |
| <b>7 – Program results of studying</b> |   |
| <b>KNOWLEDGE</b>                       |   |
| KN 1                                   | knowledge about modern tendencies, approaches and methods of the typical and conceptual solves using and creating new engineering implementations for automated devices and systems, including new types of product, automated manufacturing, doing engineering researches and/or development and automation for operational, technological and logistical processes in engineering and for different technological objects |
| KN 2                                   | knowledge of principle structure and functionality of CAD/CAE/CAM-systems, software for studying, simulation and analyzes of automation devices and systems in engineering  |
| KN 3                                   | knowledge and skills of using modern methods to find out optimal solutions and rational parameters for technical devices and automated systems via simulations, system analyzes, also in cases of insufficient information and contradictory requirements   |
| KN 4                                   | knowledge about methods to perform innovating tasks (qualification work, course project), ability to argue and assert results and implementations, also in public speaking  |
| KN 5                                   | knowledge about basics of organization and management of staff  |
| KN 6                                   | knowledge about architecture, function, soft- and hardware of computer aided control-measurement systems in engineering   |
| KN 7                                   | knowledge and comprehension of the basic structure of the manufacturing process   |
| KN 8                                   | knowledge about architecture, function, soft- and hardware of computer aided information and measurement systems for the mechanic systems and processes studying  |
| KN 9                                   | knowledge and comprehension of basic organization of the studying process   |
| KN 10                                  | knowledge, comprehension and practical using of the theory of the experiment, the planning methods of experimental studying and results verification, methods of analyzes of experimental data and creating simulations, based on it, also using new methods via modern information technologies  |
| KN 11                                  | knowledge about principles and methods for the modern automated intelligent systems, mechatronic and robotic devices design, practice experience in performing project documentation according to world standards   |
| KN 12                                  | knowledge about modern methods, approaches and algorithms of the automated control for operational, technological and logistical processes and acts in engineering complex and specialized technical objects  |
| KN 13                                  | knowledge about the automated mechanical systems and objects modernization, design, simulation and development of unusual and innovating mechanical, pneumatic, electrical automation devices   |
| KN 14                                  | knowledge about synthesis methods for the optimal structural solutions and determination of mechatronic and robotic system rational parameters via simulation, system analyzes, also in case of conditions of insufficient and contradictory information  |
| KN 15                                  | knowledge about approaches, methods and criteria to evaluate the multi-partition automated systems and devices efficiency and quality in variable and complicated operation modes   |
| KN 16                                  | knowledge about principles and methods of the hydraulic, pneumatic automated systems and devices design, the hydraulic and pneumatic machines (volumetric and dynamic types) design, practice experience in performing project documentation according to world standards   |
| KN 17                                  | knowledge about modern methods, approaches and technical solutions of the automated control systems design for the pneumatic, hydraulic systems and aggregates  |

|               |   |
|---------------|---|
| KN 18         | knowledge about modernization ways for hydraulic, pneumatic automated systems and devices, design and simulation of unusual and innovating hydraulic and pneumatic devices, machines and systems  |
| KN 19         | knowledge about physical processes in hydraulic and pneumatic devices, on which their working based, and modern methods of analyzes, simulation and design of optimal and rational hydraulic and pneumatic automated systems, taking into account operation modes and circumstances, in case of conditions of insufficient and contradictory information  |
| KN 20         | knowledge about approaches, methods and criterions to evaluate the efficiency and quality of hydraulic and pneumatic drive systems and machines   |
| KN 21         | knowledge about principles and methods of the logistics systems, devices for automated systems of the motion of the materials flow, Hoisting-and-transport machines and mechanisms design, controlling and operational devices, practice experience in performing project documentation according to world standards  |
| KN 22         | knowledge about modern methods, approaches and algorithms of the automated control for the logistics systems equipment in engineering industries, municipal and domestic branches   |
| KN 23         | knowledge about modernization ways for equipment of logistics systems, design and simulation of unusual and innovating mechanisms and devices for providing motion of the materials flow  |
| KN 24         | knowledge about physical processes in equipment of logistics systems, on which their working based, especially of Hoisting-and-transport machines and mechanisms, mechanical, electromechanical, hydraulic and mechatronic devices, economic methods of analyzes, simulation and optimization of logistics processes, taking into account operation modes and circumstances, different outer influences, also in case of conditions of insufficient and contradictory information |
| KN 25         | knowledge about approaches, methods and criterions to evaluate the efficiency and quality of functionality of logistics systems and their soft- and hardware  |
| <b>SKILLS</b> |   |
| SK 1          | skills in development, design, simulation and studying devices, mechanisms, automated mechanical systems on the design stage via modern computer systems  |
| SK 2          | skills in argumentation and evaluation of innovational projects, knowing of promotion methods on the market, capability to make econometric and scientifically evaluation and to evaluate efficiency of the practice tasks solution   |
| SK 3          | skills in checking non-contradictory of control systems of the quality to world standards   |
| SK 4          | skills in development and performing project documentation, control systems and algorithms of modern mechatronic systems according to standard obligators, including, innovational technical solutions  |
| SK 5          | skills in complectation, assembling, adjustment and commissioning mechatronic and robotic systems, that consist of mechanical, hydraulic, pneumatic electrical parts with complex control and functional algorithms   |
| SK 6          | skills in upgrading automation level in existing objects by modernizing and re-engineering mechanical systems within methods of mechatronic, robotic and artificial intellect   |
| SK 7          | skills in performing design and project documentation of operational, control, measuring and supporting devices and energetic aggregates of hydro-pneumo automatics according to requirement, including optimized and innovational technical solutions  |
| SK 8          | skills in complectation, assembling, adjustment and commissioning pneumatic and hydraulic machines and hydro-pneumo automatics systems of technical objects, taking into account operational modes and circumstances  |
| SK 9          | skills in upgrading automation level in existing objects by modernizing and re-engineering hydro-pneumo automatic systems, optimizing operational modes and complement, using innovational technical solutions and methods  |



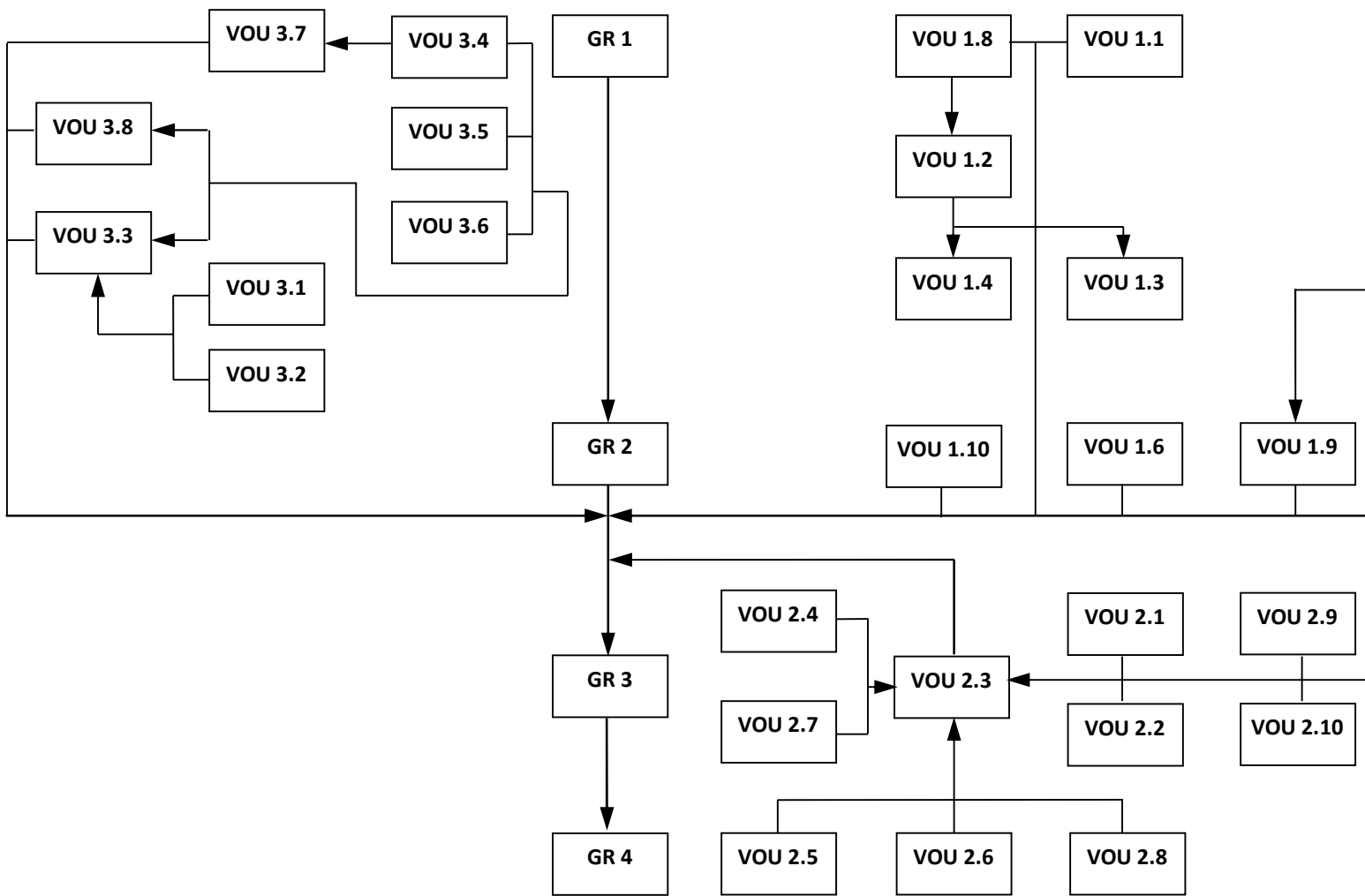
|  |  |
|--|--|
| SK 10  | skills in performing design and project documentation of operational, control, measuring and supporting equipment of logistics systems according to requirement, including optimized and innovational technical solutions  |
| SK 11  | skills in complectation, assembling, adjustment and commissioning pneumatic and hydraulic machines and hydro-pneumo automatic systems of technical objects, especially Hoisting-and-transport machines and mechanisms and mechanical, electromechanical, hydraulic, mechatronic devices and other technical objects, taking into account operational modes and circumstances |
| SK 12  | skills in upgrading automation level in existing objects by modernizing and re-engineering logistics systems, optimizing operational modes and complement, using innovational technical solutions and methods  |
| <b>8 – Resource providing of the program realization</b> |  |
| Staff  | According to requirements to the staff of providing education in high education institution on required level (appendix 12 of License circumstances), approved by Resolution of Cabinet of Ministers of Ukraine, 30.12.2015 №1187  |
| Equipment  | According to technical requirements to the equipment of providing education in high education institution on required level (appendix 13 of License circumstances), approved by Resolution of Cabinet of Ministers of Ukraine, 30.12.2015 №1187  |
| Information and teaching materials                       | According to technical requirements to information and teaching materials of providing education in high education institution on required level (appendices 14 and 15 of License circumstances), approved by Resolution of Cabinet of Ministers of Ukraine, 30.12.2015 №1187  |
| <b>9 – Academic mobility</b>                             |  |
| National credit mobility                                 | Possibility to make agreements of academic mobility and programs of the double-diplomas  |
| International credit mobility                            | Agreements of double-diplomas with:<br>Otto von Guericke University, Magdeburg, Germany  |
| High education for foreign students                      | Teaching in foreign language: English  |

## 2. Educational program components

| Code e/s   | Educational program components (subjects, practice, qualification works) | Credits | Examination |
|--|--|---------|-------------|
| 1  | 2  | 3       | 4           |
| <b>1. General training</b>   |  |         |             |
| <b>Required components (GR)</b>  |  |         |             |
| GR 1   | Patenting and Intellectual Property                                      | 3       | final test  |
| GR 2   | Scientific Work on the Topic of Master's Thesis                          | 4       | final test  |
| GR 3   | Pre-diploma Practice   | 14      | final test  |
| GR 4   | Master's Thesis Implementation   | 16      | graduation  |
| <b>Optional components (GO)</b>  |  |         |             |
| GO 1   | Subject on Sustainable Development Problems                              | 2       | final test  |
| GO 2   | Management Subject   | 3       | final test  |
| GO 3   | Workshop on Scientific Communication in Foreign Language                 | 3       | final test  |
| <b>Optional components</b>   |  |         |             |
| <i>Optional unit 1 (specialization “Mechatronic and robotic systems in mechanical engineering”)</i>      |  |         |             |
| VOU 1.1  | Multifunctional Mechatronic Systems in Energy Intensive Processes        | 4       | exam        |
| VOU 1.2  | Electro-Hydraulic Control Systems in Mechatronics                        | 7,5     | exam        |
| VOU 1.3  | Design of Intelligent Mechatronic Systems                                | 7       | final test  |
| VOU 1.4  | Electro-Pneumatic Control Systems  | 4       | exam        |
| VOU 1.5  | Electro-Pneumatic Automation   | 2,5     | final test  |
| VOU 1.6  | Modeling and Research of Mechatronic Objects                             | 2,5     | final test  |
| VOU 1.7  | Logic Control for Mechatronic Systems                                    | 5       | exam        |
| VOU 1.8  | Modular Production Systems   | 5       | exam        |
| VOU 1.9  | Multifunctional Actuators Subject  | 4       | exam        |
| VOU 1.10   | Re-Engineering Subject   | 3,5     | final test  |
| <i>Вибірковий блок 2 (за спеціалізацією «Гідропневмоавтоматика та гідравлічні і пневматичні машини»)</i> |  |         |             |
| VOU 2.1  | Pneumo automatics  | 4       | exam        |
| VOU 2.2  | Features of Hydraulic Control Systems Design                             | 3,5     | final test  |
| VOU 2.3  | Hydraulic Control Systems  | 7,5     | exam        |
| VOU 2.4  | Design of Hydraulic and Pneumatic Machines                               | 5       | final test  |
| VOU 2.5  | Impeller Hydro-Dynamic Transmissions                                     | 4,5     | exam        |
| VOU 2.6  | Production Technology of Hydro-Pneumo-Machines                           | 2,5     | final test  |
| VOU 2.7  | Compressors  | 3       | exam        |
| VOU 2.8  | PLC Programming for Hydraulic and Pneumatic Drive Systems                | 4       | exam        |
| VOU 2.9  | Fundamentals of Lubrication Theory                                       | 3,5     | final test  |
| VOU 2.10   | Computer Aided Design Subject  | 4,5     | exam        |
| VOU 2.11   | Operation of Drive Systems Subject                                       | 3       | final test  |
| <i>Optional unit 3 (specialization “Automated logistics systems”)</i>                                    |  |         |             |
| VOU 3.1  | Mathematical methods and modelling in Logistics                          | 3       | final test  |
| VOU 3.2  | Information Systems and Technologies in Logistics                        | 4       | final test  |
| VOU 3.3  | Logistics Systems Design   | 11,5    | exam        |
| VOU 3.4  | Micro-processing Control of Mechatronic Modules and Systems              | 7,5     | exam        |

| 1                                    | 2  | 3         | 4          |
|--------------------------------------|--|-----------|------------|
| VOU 3.5                              | Diagnostics and Industrial Safety of Hoisting-and-Transport Machines | 7         | exam       |
| VOU 3.6                              | Hoisting-and-Transport Machines Dynamics                             | 5         | exam       |
| VOU 3.7                              | Automation of Storage-and-Transport Systems Subject                  | 4         | exam       |
| VOU 3.8                              | Resource-Saving Technologies in logistics Systems Subjects           | 3         | final test |
| ...                                  |  |           |            |
| <b>Total in General Training:</b>    |  | <b>45</b> |            |
| <b>Total in Vocational Training:</b> |  | <b>45</b> |            |
| <b>Total of Required Components:</b> |  | <b>37</b> |            |
| <b>Total of Optional Components:</b> |  | <b>53</b> |            |
| <b>Including Students Choice:</b>    |  | <b>23</b> |            |
| <b>TOTAL IN EDUCATIONAL PROGRAM</b>  |  | <b>90</b> |            |

### 3. Educational program structural-and-logic diagram



#### **4. . Form of Students Graduation**

Students Graduation Examination, according to Educational Program of Specialty 131 Applied Mechanics, is a public speaking and presentation of the qualification work and finishes with receiving standard form document Diploma of Master Degree in Applied Mechanics and one of specializations: “Mechatronic and robotic systems in mechanical engineering”, “Hydro-pneumo automatics and hydraulic and pneumatic machines”, “Automated logistics systems”.

Graduation Examination is public and visitable.

**5. The Matching Matrix of program competences to educational program components**  
*(specialization “Mechatronic and robotic systems in mechanical engineering”)*

|        | GR 1 | GR 2 | GR 3 | GR 4 | GO 1 | GO 2 | GO 3 | VOU 1.1 | VOU 1.2 | VOU 1.3 | VOU 1.4 | VOU 1.5 | VOU 1.6 | VOU 1.7 | VOU 1.8 | VOU 1.9 | VOU 1.10 |
|--------|------|------|------|------|------|------|------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|
| GC 1   |      | +    | +    |      |      |      |      |         |         | +       |         |         | +       | +       |         |         | +        |
| GC 2   |      | +    |      | +    |      |      |      | +       |         | +       |         |         |         |         | +       |         | +        |
| GC 3   |      |      |      | +    |      |      |      |         |         | +       |         |         | +       |         |         |         |          |
| GC 4   | +    | +    |      | +    | +    |      |      | +       | +       |         | +       | +       |         |         |         | +       |          |
| GC 5   |      |      |      |      | +    | +    |      | +       |         | +       |         |         |         |         |         |         | +        |
| GC 6   |      |      | +    |      |      |      | +    |         |         |         |         |         |         |         |         |         |          |
| GC 7   |      |      |      |      |      |      | +    |         |         |         |         |         |         |         |         |         |          |
| GC 8   | +    |      |      |      |      |      |      | +       |         |         |         |         |         |         |         |         |          |
| GC 9   |      | +    | +    | +    |      |      |      | +       |         |         |         |         |         | +       |         |         |          |
| GC 10  |      | +    | +    | +    |      |      |      |         |         |         |         |         | +       |         |         |         |          |
| GC 11  | +    |      |      |      |      |      | +    | +       |         |         | +       |         | +       |         |         |         |          |
| PC 1   | +    |      |      |      |      |      |      | +       |         | +       |         |         | +       |         |         | +       | +        |
| PC 2   |      |      |      |      |      |      |      |         | +       |         | +       | +       | +       | +       |         |         |          |
| PC 3   |      |      |      |      |      |      |      | +       |         | +       |         |         | +       |         |         |         | +        |
| PC 4   |      | +    | +    | +    |      |      |      |         |         |         |         |         |         |         |         |         |          |
| PC 5   |      | +    |      | +    | +    |      |      | +       |         | +       |         |         |         | +       |         |         | +        |
| PC 6   |      | +    |      |      |      |      |      | +       |         | +       |         |         | +       |         |         |         |          |
| PC 7   |      |      |      |      |      |      |      | +       |         |         |         | +       |         |         | +       |         |          |
| PC 8   | +    |      |      |      |      | +    | +    |         |         |         |         |         |         |         |         |         |          |
| PC 9   |      | +    | +    |      |      | +    |      |         |         |         |         |         |         |         |         |         |          |
| PC 10  |      |      |      | +    |      | +    | +    |         |         |         |         |         |         |         |         |         |          |
| PC 11  |      |      |      | +    |      |      |      | +       |         |         |         |         | +       |         |         |         |          |
| PC 1.1 |      |      |      |      |      |      |      | +       |         | +       |         |         |         |         |         |         |          |
| PC 1.2 |      |      |      |      |      |      |      | +       | +       | +       | +       | +       |         | +       |         |         |          |
| PC 1.3 |      |      |      |      |      |      |      | +       | +       | +       | +       | +       |         | +       |         |         |          |
| PC 1.4 |      |      |      |      |      |      |      |         |         |         |         |         |         | +       | +       |         |          |
| PC 1.5 |      |      |      |      |      |      |      |         |         |         | +       |         | +       | +       |         |         |          |
| PC 1.6 |      |      |      |      |      |      |      | +       | +       | +       |         | +       | +       | +       | +       |         | +        |
| PC 1.7 |      |      |      |      |      |      |      | +       |         |         |         |         | +       |         |         | +       |          |
| PC 1.8 |      |      |      |      |      |      |      |         | +       | +       | +       | +       |         |         | +       | +       | +        |

**5.2 The Matching Matrix of program competences to educational program components**  
*(specialization “Hydro-pneumo automatics and hydraulic and pneumatic machines”)*

|        | GR1 | GR2 | GR3 | GR4 | GO1 | GO2 | GO3 | VOU 2.1 | VOU 2.2 | VOU 2.3 | VOU 2.4 | VOU 2.5 | VOU 2.6 | VOU 2.7 | VOU 2.8 | VOU 2.9 | VOU 2.10 | VOU 2.11 |
|--------|-----|-----|-----|-----|-----|-----|-----|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|
| GC 1   |     | +   | +   |     |     |     |     | +       | +       |         | +       |         | +       |         |         |         |          | +        |
| GC 2   |     | +   |     | +   |     |     |     |         | +       |         | +       |         |         |         |         |         |          |          |
| GC 3   |     |     |     | +   |     |     |     |         |         |         |         |         |         |         | +       |         |          |          |
| GC 4   | +   | +   |     | +   | +   |     |     | +       |         | +       | +       |         |         |         |         |         | +        |          |
| GC 5   |     |     |     |     | +   | +   |     |         | +       |         | +       |         |         |         |         |         |          | +        |
| GC 6   |     |     | +   |     |     |     | +   |         |         |         |         |         |         |         |         |         |          |          |
| GC 7   |     |     |     |     |     |     | +   |         |         |         |         |         |         |         |         |         |          |          |
| GC 8   | +   |     |     |     |     |     |     |         | +       |         |         |         |         | +       |         |         |          |          |
| GC 9   |     | +   | +   | +   |     |     |     |         |         |         |         | +       |         |         |         | +       |          |          |
| GC 10  |     | +   | +   | +   |     |     |     |         |         |         |         |         |         | +       |         |         |          |          |
| GC 11  | +   |     |     |     |     |     | +   | +       |         |         |         |         |         |         |         |         |          | +        |
| PC 1   | +   |     |     |     |     |     |     |         | +       |         | +       |         | +       |         |         | +       |          |          |
| PC 2   |     |     |     |     |     |     |     | +       |         | +       |         | +       |         | +       |         |         |          |          |
| PC 3   |     |     |     |     |     |     |     |         | +       |         |         |         |         |         |         |         |          |          |
| PC 4   |     | +   | +   | +   |     |     |     |         |         |         |         |         |         |         |         |         |          |          |
| PC 5   |     | +   |     | +   | +   |     |     |         | +       |         | +       |         |         | +       |         |         |          |          |
| PC 6   |     | +   |     |     |     |     |     |         |         |         | +       |         |         |         |         |         |          |          |
| PC 7   |     |     |     |     |     |     |     |         | +       |         |         |         |         |         | +       |         | +        |          |
| PC 8   | +   |     |     |     |     | +   | +   |         |         |         |         |         |         |         |         |         |          |          |
| PC 9   |     | +   | +   |     |     | +   |     |         |         |         |         |         |         |         |         |         |          |          |
| PC 10  |     |     |     | +   |     | +   | +   |         |         |         |         |         |         |         |         |         |          |          |
| PC 11  |     |     |     | +   |     |     |     |         |         |         |         | +       |         | +       |         | +       |          | +        |
| PC 2.1 |     |     |     |     |     |     |     | +       | +       | +       |         | +       |         |         | +       | +       |          |          |
| PC 2.2 |     |     |     |     |     |     |     | +       | +       | +       | +       | +       |         | +       |         |         |          | +        |
| PC 2.3 |     |     |     |     |     |     |     | +       | +       | +       | +       | +       |         | +       |         |         |          | +        |
| PC 2.4 |     |     |     |     |     |     |     |         |         |         |         |         |         | +       | +       | +       |          |          |
| PC 2.5 |     |     |     |     |     |     |     |         |         |         | +       |         | +       | +       |         |         |          |          |
| PC 2.6 |     |     |     |     |     |     |     | +       | +       | +       |         | +       | +       | +       | +       | +       | +        |          |
| PC 2.7 |     |     |     |     |     |     |     | +       |         |         |         |         | +       |         |         |         |          |          |
| PC 2.8 |     |     |     |     |     |     |     |         | +       | +       | +       | +       |         |         | +       | +       | +        | +        |

**5.3 The Matching Matrix of program competences to educational program components**  
*(specialization “Automated logistics systems”)*

|        | GR1 | GR2 | GR3 | GR4 | GO1 | GO2 | GO3 | VOU 3.1 | VOU 3.2 | VOU 3.3 | VOU 3.4 | VOU 3.5 | VOU 3.6 | VOU 3.7 | VOU 3.8 |
|--------|-----|-----|-----|-----|-----|-----|-----|---------|---------|---------|---------|---------|---------|---------|---------|
| GC 1   |     | +   |     |     |     |     |     |         |         | +       | +       | +       | +       | +       | +       |
| GC 2   |     | +   |     | +   |     |     |     |         |         | +       |         |         |         |         | +       |
| GC 3   |     |     |     | +   |     |     |     |         | +       | +       | +       |         | +       |         |         |
| GC 4   |     | +   |     | +   | +   |     |     |         |         | +       |         |         |         | +       | +       |
| GC 5   |     |     |     |     |     | +   |     |         |         | +       |         |         |         | +       |         |
| GC 6   |     |     | +   |     |     |     | +   | +       | +       | +       | +       |         |         |         |         |
| GC 7   |     |     |     |     |     |     | +   |         |         |         |         |         |         |         |         |
| GC 8   |     |     |     |     |     |     |     | +       | +       | +       | +       | +       | +       | +       | +       |
| GC 9   |     | +   | +   | +   |     |     |     | +       |         | +       | +       |         |         |         |         |
| GC 10  |     | +   | +   | +   |     |     |     |         |         |         |         |         | +       |         |         |
| GC 11  | +   |     |     |     |     |     | +   | +       | +       | +       | +       | +       | +       | +       | +       |
| PC 1   | +   |     |     |     |     |     |     |         |         | +       |         | +       | +       | +       |         |
| PC 2   |     |     |     |     |     |     |     |         |         | +       |         | +       | +       |         | +       |
| PC 3   |     |     |     |     |     |     |     |         | +       |         |         |         |         |         |         |
| PC 4   |     | +   | +   | +   |     |     |     |         |         |         |         | +       |         |         |         |
| PC 5   |     | +   |     | +   |     |     |     |         |         |         |         |         | +       |         |         |
| PC 6   |     | +   |     |     |     |     |     |         | +       |         |         |         | +       |         |         |
| PC 7   |     |     |     |     |     |     |     |         |         | +       | +       |         | +       |         | +       |
| PC 8   |     |     |     |     |     | +   | +   | +       |         | +       |         |         |         | +       | +       |
| PC 9   |     | +   |     |     |     |     |     |         |         | +       |         |         |         |         |         |
| PC 10  |     |     |     | +   |     |     | +   |         |         | +       |         |         |         | +       |         |
| PC 11  |     |     |     |     |     |     |     |         |         |         | +       |         | +       |         |         |
| PC 3.1 |     |     |     |     |     |     |     |         | +       | +       | +       |         |         | +       | +       |
| PC 3.2 |     |     |     |     |     |     |     |         | +       | +       | +       |         |         | +       | +       |
| PC 3.3 |     |     |     |     |     |     |     |         |         | +       |         |         |         | +       | +       |
| PC 3.4 |     |     |     |     |     |     |     | +       | +       | +       | +       |         |         | +       |         |
| PC 3.5 |     |     |     |     |     |     |     |         |         |         | +       | +       | +       | +       | +       |
| PC 3.6 |     |     |     |     |     |     |     |         |         | +       |         |         |         |         |         |
| PC 3.7 |     |     |     |     |     |     |     |         |         | +       | +       |         | +       |         | +       |
| PC 3.8 |     |     |     |     |     |     |     |         |         | +       |         |         |         | +       | +       |



**6.1 The Matrix of providing program educational results via educational program components**  
*(specialization “Mechatronic and robotic systems in mechanical engineering”)*

|       | GR 1 | GR 2 | GR 3 | GR 4 | GO 1 | GO 2 | GO 3 | VOU 1.1 | VOU 1.2 | VOU 1.3 | VOU 1.4 | VOU 1.5 | VOU 1.6 | VOU 1.7 | VOU 1.8 | VOU 1.9 | VOU 1.10 |
|-------|------|------|------|------|------|------|------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|
| KN 1  | +    | +    |      | +    |      | +    | +    | +       |         | +       |         |         |         |         | +       | +       |          |
| KN 2  |      | +    |      | +    |      |      |      | +       |         | +       |         |         | +       |         |         | +       |          |
| KN 3  |      | +    | +    | +    |      |      | +    | +       |         |         |         |         | +       |         | +       |         |          |
| KN 4  |      | +    | +    | +    |      |      |      |         | +       | +       |         |         |         |         |         |         |          |
| KN 5  |      |      |      |      | +    | +    |      |         |         |         |         |         |         |         |         |         |          |
| KN 6  |      |      |      |      |      |      |      | +       |         |         |         |         |         |         | +       |         |          |
| KN 7  |      |      |      |      |      | +    |      |         |         |         |         |         |         |         |         |         | +        |
| KN 8  |      | +    | +    | +    |      |      |      | +       |         |         |         |         |         |         |         |         |          |
| KN 9  |      | +    | +    | +    |      |      |      |         |         |         |         |         |         |         |         |         |          |
| KN 10 |      | +    | +    | +    |      |      | +    |         |         |         |         |         | +       |         |         |         |          |
| KN 11 |      |      |      |      |      |      |      |         | +       | +       |         | +       |         |         |         |         |          |
| KN 12 |      |      |      |      |      |      |      |         |         |         | +       |         |         | +       | +       |         |          |
| KN 13 |      |      |      |      |      |      | +    |         | +       |         |         | +       |         |         | +       |         |          |
| KN 14 |      |      |      |      |      |      |      |         |         |         |         |         | +       |         |         |         |          |
| KN 15 |      |      |      |      |      |      | +    | +       |         |         |         |         | +       |         | +       | +       | +        |
| ...   |      |      |      |      |      |      |      |         |         |         |         |         |         |         |         |         |          |
| SK 1  |      | +    | +    | +    |      |      |      |         |         | +       |         |         | +       | +       | +       |         |          |
| SK 2  |      |      |      | +    |      | +    | +    |         | +       | +       |         |         |         |         |         |         |          |
| SK 3  | +    |      | +    | +    | +    |      | +    |         | +       | +       |         |         |         |         |         |         |          |
| SK 4  |      |      |      |      |      |      |      |         | +       | +       |         |         |         | +       | +       |         |          |
| SK 5  |      |      | +    |      |      |      |      |         |         | +       | +       | +       |         |         | +       |         |          |
| SK 6  |      |      |      | +    |      |      |      | +       |         |         | +       |         | +       |         |         | +       | +        |
| ...   |      |      |      |      |      |      |      |         |         |         |         |         |         |         |         |         |          |

**6.2 The Matrix of providing program educational results via educational program components**  
*(specialization “Hydro-pneumo automatics and hydraulic and pneumatic machines”)*

|       | GR1 | GR2 | GR3 | GR4 | GO1 | GO2 | GO3 | VOU 2.1 | VOU 2.2 | VOU 2.3 | VOU 2.4 | VOU 2.5 | VOU 2.6 | VOU 2.7 | VOU 2.8 | VOU 2.9 | VOU 2.10 | VOU 2.11 |
|-------|-----|-----|-----|-----|-----|-----|-----|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|
| KN 1  | +   | +   |     | +   |     | +   | +   |         | +       |         | +       |         | +       | +       |         |         |          | +        |
| KN 2  |     | +   |     | +   |     |     |     |         | +       |         | +       |         |         |         | +       |         | +        |          |
| KN 3  |     | +   | +   | +   |     |     | +   |         |         |         |         |         |         |         | +       |         |          |          |
| KN 4  |     | +   | +   | +   |     |     |     |         |         | +       | +       |         |         |         |         |         |          |          |
| KN 5  |     |     |     |     | +   | +   |     |         |         |         |         |         |         |         |         |         |          |          |
| KN 6  |     |     |     |     |     |     |     |         |         |         |         | +       |         | +       |         |         |          |          |
| KN 7  |     |     |     |     |     | +   |     |         |         |         |         |         | +       |         |         |         |          |          |
| KN 8  |     | +   | +   | +   |     |     |     |         |         |         |         |         |         | +       |         |         |          |          |
| KN 9  |     | +   | +   | +   |     |     |     |         |         |         |         |         |         |         |         |         |          |          |
| KN 10 |     | +   | +   | +   |     |     | +   |         |         |         |         |         |         |         |         |         |          |          |
| ...   |     |     |     |     |     |     |     |         |         |         |         |         |         |         |         |         |          |          |
| KN 16 |     |     |     |     |     |     |     | +       | +       |         | +       | +       |         | +       |         |         | +        |          |
| KN 17 |     |     |     |     |     |     |     |         |         | +       |         |         |         |         | +       |         |          |          |
| KN 18 |     |     |     |     |     |     |     | +       |         |         |         | +       |         | +       |         | +       |          |          |
| KN 19 |     |     |     |     |     |     |     |         |         |         |         |         |         |         |         |         |          |          |
| KN 20 |     |     |     |     |     |     |     |         | +       |         | +       |         |         |         |         |         |          | +        |
| ...   |     |     |     |     |     |     |     |         |         |         |         |         |         |         |         |         |          |          |
| SK 1  |     |     |     | +   |     |     |     |         | +       |         | +       |         |         |         |         |         | +        |          |
| SK 2  |     |     |     | +   |     | +   |     |         | +       |         | +       |         |         |         |         |         |          |          |
| SK 3  | +   |     |     | +   | +   |     |     |         |         | +       | +       |         | +       |         |         |         |          |          |
| ...   |     |     |     |     |     |     |     |         |         |         |         |         |         |         |         |         |          |          |
| SK 7  |     |     |     |     |     |     |     |         | +       | +       | +       |         |         | +       |         | +       | +        |          |
| SK 8  |     |     |     |     |     |     |     | +       |         | +       |         | +       |         | +       |         |         |          | +        |
| SK 9  |     |     |     | +   |     |     |     | +       |         | +       |         |         | +       |         | +       |         |          |          |

**6.3 The Matrix of providing program educational results via educational program components**  
*(specialization “Automated logistics systems”)*

|       | GR<br>1 | GR<br>2 | GR<br>3 | GR<br>4 | GO<br>1 | GO<br>2 | GO<br>3 | VOU<br>3.1 | VOU<br>3.2 | VOU<br>3.3 | VOU<br>3.4 | VOU<br>3.5 | VOU<br>3.6 | VOU<br>3.7 | VOU<br>3.8 |
|-------|---------|---------|---------|---------|---------|---------|---------|------------|------------|------------|------------|------------|------------|------------|------------|
| KN 1  | +       | +       |         | +       |         | +       | +       |            |            | +          | +          |            | +          | +          |            |
| KN 2  |         | +       |         | +       |         |         |         | +          | +          |            |            | +          |            |            |            |
| KN 3  |         | +       | +       | +       |         |         | +       | +          |            |            |            |            | +          |            |            |
| KN 4  |         | +       | +       | +       |         |         |         |            |            | +          | +          | +          |            |            |            |
| KN 5  |         |         |         |         | +       | +       |         |            |            | +          |            |            |            |            |            |
| KN 6  |         |         |         |         |         |         |         |            | +          |            |            | +          |            |            |            |
| KN 7  |         |         |         |         |         | +       |         |            |            | +          |            |            |            | +          |            |
| KN 8  |         | +       | +       | +       |         |         |         |            | +          |            |            | +          |            |            |            |
| KN 9  |         | +       | +       | +       |         |         |         |            |            |            |            |            |            |            |            |
| KN 10 |         | +       | +       | +       |         |         | +       |            |            |            |            |            | +          |            |            |
| ...   |         |         |         |         |         |         |         |            |            |            |            |            |            |            |            |
| KN 21 |         |         |         |         |         |         |         |            |            | +          |            |            |            | +          |            |
| KN 22 |         |         |         |         |         |         |         |            |            |            | +          |            |            |            |            |
| KN 23 |         |         |         |         |         |         |         |            |            | +          |            |            | +          | +          | +          |
| KN 24 |         |         |         |         |         |         |         |            |            | +          |            | +          |            | +          |            |
| KN 25 |         |         |         |         |         |         |         | +          |            | +          |            |            |            | +          | +          |
| ...   |         |         |         |         |         |         |         |            |            |            |            |            |            |            |            |
| SK 1  |         |         |         | +       |         |         |         |            | +          |            |            |            |            |            |            |
| SK 2  |         |         |         | +       |         | +       |         |            |            | +          |            |            |            |            |            |
| SK 3  | +       |         |         | +       | +       |         |         |            |            | +          |            |            |            |            |            |
| ...   |         |         |         |         |         |         |         |            |            |            |            |            |            |            |            |
| SK 10 |         |         |         |         |         |         |         |            |            | +          | +          |            |            |            |            |
| SK 11 |         |         |         |         |         |         |         |            |            | +          | +          | +          |            | +          | +          |
| SK 12 |         |         |         |         |         |         |         |            |            | +          | +          |            | +          | +          | +          |