

**Comparative analyses of curriculum of Mechatronics in EU partners universities**

<b>Subjects of KTH Mechatronics Master Degree</b>	<b>Subjects of KUL Mechatronics Master Degree</b>	<b>Subjects of JKU Mechatronics Master Degree</b>	<b>Subjects of BETI (3 specialty of Master degree)</b>
-	Advanced Robot Control Systems (undefined)	Automatic Control and Robotics (0-23.5 ects.)	Automatic Control and Theoretically the basis regulation
-	Identification and Advanced Control of Mechatronic Systems (5.28 ects)		
MF2007 Dynamics and Motion Control (9.0 credits)	-Mechatronics drive systems (2.41 ects)  -Robotics (4.0 ects)	-Electrical Drive Engineering (0-23.5 ects) -Sensors and Instrumentation (0-23.5 ects) -Automatic Control and Robotics (0-23.5 ects)	Modern control systems based on information and communication systems
MF2030 Mechatronics basic Course (6.0 credits)		Basics of Mechatronics (33 ects)	
MF2042 Embedded Systems for Mechatronics, I (6.0 credits)	Embedded Control Systems (1.6 ects)		Using Computers in electrical power systems
MF2043 Robust Mechatronics (6.0 credits)		Microelectronics and microsystems technology (0-23.5 ects) -Mechatronic Design (0-23.5 ects)	- Theory and methods of calculation and analysis of the steady state electrical power systems - Methods of creation and application of information and communication systems
MF2044 Embedded Systems for Mechatronics, II (6.0 credits)	Embedded Control Systems(1.6 ects)		Technology development of information and communication systems in process control
MF2058 Mechatronics, Advanced Course Spring Semester (9.0 credits)	Optimization of Mechatronic Systems (4.0 ects)	System Analysis and Optimization (0-23.5 ects)	Theory and methods of calculation and analysis of the steady state electrical power systems
MF2059 Mechatronics, Advanced Course, Fall semester (15.0 credits)	Optimization of Mechatronic Systems (4.0 ects)	System Analysis and Optimization (0-23.5 ects)	Theory and methods of calculation and analysis of the steady state electrical power systems
MF2070 Introduction to Engineering Design (3.0 credits)			
MF2071 Research Methodology in Mechatronics (4.5 ects)			
			-Intelligent control systems and making decisions,

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			-Algorithmization and programming of numerical methods for the solution of energy problems

**We finished comparative analysis Mechatronics programs at EU partners universities and we are select following main subjects for new developing Master degree (Mechatronics) of our institute:**

1. Essentials of Mechatronics
2. Rapid-Prototyping with CAD/CAE/CAM application
3. Embedded Systems for Mechatronics
4. Robust Mechatronics
5. Dynamics and Motion Control
6. Mechatronic Drives
7. System Identification and Control of Mechatronic Systems
8. Introduction to Engineering Design and Engineering Research Methodology
9. Robotics

The purpose of the analysis of these curriculums is to prepare undergraduate areas grounds to Bachelor ended this direction could go to Special and "Mechatronics".

Because to include the qualifier "CLASSIFIER OF DIRECTION'S AND SPICALTES OF HIGHER EDUCATION" master specialty "Mechatronics" we have to show what areas of undergraduate is one root.

It shows the students what areas have the right to apply for admission to a master's specialty of "Mechatronics"

BETI Specialty and subject name, Total hours	Learning Outcomes	Main Content of the Course	Topics of Practical Works	Topics of Lab Works
<p><b>“5111000- Professional Education: Computer Science and Information technology”</b></p> <p><b>“Theoretically bases of Control”</b></p> <p><b>Total hour: -54 h</b></p>	<p><b>Objectives:</b> teaching rules and principles of creation automatic and automated control systems</p>	<ul style="list-style-type: none"> <li>▪ Concepts about Control. Main principles of Control.</li> <li>▪ Architecture of automatic system and its elements.</li> <li>▪ Classification of Automatic Control Systems (ACS). Automatic Regulation Systems and other ACSs.</li> <li>▪ Mathematical views of Linear ACS. Transient and Frequency response of link.</li> <li>▪ Frequency response of Links</li> <li>▪ Definite of Transient Function of ACS on Transient Function link.</li> <li>▪ Definite of Frequency Function of ACS on Frequency Function link.</li> <li>▪ Stability of Linear ACS.</li> <li>▪ Criteria’s of Stability of ACS.</li> </ul>	<p>Definition Transient Response of Automatic Control Systems (ACS).            Methods of learning the structural schemes of ACS            Construction of the frequency response of automatic control systems            Construction of the logarithmic-frequency response of automatic control systems            Definition of stability of automatic control systems . Criteria’s Raus            Definition of stability of automatic control systems . Criteria’s Gurvits.            Definition of stability of automatic control systems. Criteria’s Michailov.            Definition of stability of automatic control systems. Criteria’s Naykvist.</p>	<ul style="list-style-type: none"> <li>▪ Methods of learning the structural schemes of ACS</li> <li>▪ Construction of the frequency response of automatic control systems</li> <li>▪ Definition of stability of automatic control systems . Criteria’s Raus</li> <li>▪ Definition of stability of automatic control systems . Criteria’s Gurvits.</li> <li>▪ Definition of stability of automatic control systems. Criteria’s Michailov.</li> <li>▪ Definition of stability of automatic control systems. Criteria’s Naykvist.</li> </ul>
<p><b>“5111000- Professional Education: Computer Science and Information technology”</b></p> <p><b>“Technology of Programming (Software)”</b></p> <p><b>Total hour: -90 h</b></p>	<p><b>Objectives:</b> teaching levels and principles of to develop software, methods of testing, architecture and methods of designing of software</p>	<ul style="list-style-type: none"> <li>▪ Introduction</li> <li>▪ Levels of designing of software</li> <li>▪ Designing of software</li> <li>▪ External designing of software</li> <li>▪ Documents of Software</li> <li>▪ Algorithms. The document “External specification”</li> <li>▪ To develop of Software</li> </ul>	<ul style="list-style-type: none"> <li>▪ Preliminary design of the software. Determination of requirements</li> <li>▪ Making a list of the characteristics of the operation of the software</li> <li>▪ Stages of development</li> <li>▪ creation schedule of software</li> <li>▪ The interface and the screen form</li> </ul>	<ul style="list-style-type: none"> <li>▪ The writing algorithm in block diagram form and in the form of text.</li> <li>▪ Document internal and external specifications.</li> <li>▪ The document "Terms of Reference"</li> <li>▪ Creating software architecture: Create functional circuits and software architecture.</li> </ul>

			<ul style="list-style-type: none"> <li>▪ Methods detailed step-by-step</li> <li>▪ Stages of development of the software. Life cycle. Their model. Creating a schedule document.</li> <li>▪ Preliminary design of the software. Create a document "Statement of the Problem"</li> <li>▪ Functional diagram of the software. Implementation of functional decomposition.</li> <li>▪ Conducting an external design software</li> <li>▪ Methods of designing. Processing software architecture.</li> <li>▪ Modules and their properties</li> <li>▪ Creation of the software at a high programming language.</li> <li>▪ Testing of software</li> <li>▪ Creating a manual for use of the software</li> </ul>	<ul style="list-style-type: none"> <li>▪ Testing and application software.</li> </ul>
<p><b>“5111000- Professional Education: Computer Science and Information technology”</b></p> <p><b>“Computer Architecture”</b></p> <p><b>Total hour: -72 h</b></p>	<p><b>Objectives:</b> teaching arithmetic and logic devices, memory, parallelism, working principles of sequential circuits.</p>	<ul style="list-style-type: none"> <li>▪ Processing of information</li> <li>▪ Sequential circuits</li> <li>▪ Architecture concept</li> <li>▪ Von Neumann architecture</li> <li>▪ Instructions set</li> <li>▪ Memory</li> <li>▪ Parallelism</li> </ul>	<ul style="list-style-type: none"> <li>▪ Arithmetic calculations and rounding of floating point numbers.</li> <li>▪ Basics of Boolean algebra. Performing Boolean calculations</li> <li>▪ Construction of logic device schemes according to true table.</li> <li>▪ Modern computer architecture</li> <li>▪ Network classification</li> <li>▪ Von Neumann computer concept</li> <li>▪ Instructions set</li> <li>▪ R2000 (MIPS) instructions set</li> <li>▪ Memory architecture</li> <li>▪ Cache architecture</li> <li>▪ Application of parallelism</li> <li>▪ VLIW-architecture</li> </ul>	<ul style="list-style-type: none"> <li>▪ Arithmetic calculations and rounding of floating point numbers.</li> <li>▪ Basics of Boolean algebra. Performing Boolean calculations</li> <li>▪ Construction of logic device schemes according to true table.</li> <li>▪ Instructions set</li> <li>▪ Application of parallelism</li> <li>▪ Designing construction of logic device schemes according to true table in FPGA</li> </ul>

<p><b>“5111000- Professional Education: Computer Science and Information technology”</b></p> <p><b>“Circuit and System Design on Programmable Logic Devices”</b></p> <p><b>Total hour: -70 h</b></p>	<p><b>Objectives:</b> Teaching Circuit and System Design on Programmable Logic Devices: programmable memory, Simple Programmable Logic Devices, Complex Programmable Logic Devices, Circuit Design, Programming to VHDL, working with FPGA boards.</p>	<ul style="list-style-type: none"> <li>▪ Introduction. Classification of schemes</li> <li>▪ Programmable memory (PROM)</li> <li>▪ Simple PLD</li> <li>▪ Complex PLD</li> <li>▪ Circuit Design</li> <li>▪ Test</li> <li>▪ <b>FPGA</b></li> <li>▪ Applications</li> </ul>	<ul style="list-style-type: none"> <li>▪ ISE-Toolchain and training Altera DE0 boards</li> <li>▪ Combinatory schemes</li> <li>▪ Simulation</li> <li>▪ Sequential circuits</li> <li>▪ Complex application: code blocking</li> </ul>	<ul style="list-style-type: none"> <li>▪ Laboratory work 1: Implement a combinational circuit for recoding a 4-bit binary input for its hexadecimal output on 7-segment display.</li> <li>▪ Laboratory work 2: Implement a combinational circuit for recoding a 3-bit binary number into a one-hot code. How many code digits are required?</li> <li>▪ Laboratory work 3: create expression VHDL schemes using of operator port map</li> <li>▪ Laboratory work 4: create expression VHDL schemes using of operator generic</li> </ul>
<p><b>“5111000- Professional Education: Computer Science and Information technology”</b></p> <p><b>“Circuit Design”</b></p> <p><b>Total hour: -54 h</b></p>	<p><b>Objectives:</b> signals, analog and digital devices, logic algebra, triggers, schemes and operation, parallel and serial adders, registers, transistors, combinational logic devices, encoders</p>	<ul style="list-style-type: none"> <li>▪ The signals and their spectra. Analog and digital devices</li> <li>▪ Arithmetic and logical bases of numerical machines. Physical mapping information. The basic laws of logic algebra.</li> <li>▪ Classification of numeric elements. Integrated circuits and their parameters</li> <li>▪ Circuitry trigger circuits. Synchronous RS flip-flop. Single-ended and two stroke synchronous RS flip-flops.</li> <li>▪ D, T and JK flip-flops. Their schemes and operation.</li> <li>▪ Encoders and decoders. Codes and node relatively stable.</li> </ul>	<ul style="list-style-type: none"> <li>▪ The research work of diodes and transistors.</li> <li>▪ Display information in numerical machines. Alphabet numerical machines.</li> <li>▪ Expressions numbers in computers.</li> <li>▪ Showing the laws of Boolean algebra in the function diagrams.</li> <li>▪ Displaying charts time working principle triggers.</li> <li>▪ Analysis and synthesis of combinational logic devices in the integrated elements.</li> <li>▪ Analysis and synthesis of sequential knots of typical computers.</li> <li>▪ Research work of integrated devices.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Study of electric chains.</li> <li>▪ Research work logic devices.</li> <li>▪ Research work triggers.</li> <li>▪ Research work encoders.</li> <li>▪ Research work decoders.</li> <li>▪ Research work codes converters.</li> <li>▪ Research work registers.</li> <li>▪ Research work calculators</li> </ul>

		<ul style="list-style-type: none"> <li>▪ Parallel and serial adders. Their species principle. The arithmetic-logic unit.</li> <li>▪ Typical components of computers. Registers. Their function and operation of the scheme. The calculator.</li> <li>▪ Circuitry integrated memory</li> <li>▪ Circuit design of integrated operational amplifiers and stabilizers.</li> </ul>	<ul style="list-style-type: none"> <li>▪ The research of integrated operational amplifiers and stabilizers.</li> </ul>	
<p><b>“5321700- Information-communication systems in a control of technological processes”</b></p> <p><b>“Theory of machines and mechanisms”</b></p> <p><b>Total hour: -54 h</b></p>	<p><b>Objectives:</b> Teaching main structure of types of mechanisms, controlled kinematic chain and etc.</p>	<ul style="list-style-type: none"> <li>▪ Requires of creating machines. Parameters, Analyze of mechanisms, Syntheses of Mechanisms</li> <li>▪ Main types of Machines and mechanisms.</li> <li>▪ Structure of Mechanisms</li> <li>▪ Classification of kinematic pair.</li> <li>▪ Kinematic Chains and its types.</li> <li>▪ Classification of Mechanisms</li> <li>▪ graphical and analytical methods in the kinematics of mechanisms moving plane</li> <li>▪ Learning kinematics of mechanisms with the help of kinematic diagrams.</li> <li>▪ Dynamics of mechanisms.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Requires of creating machines. Parameters, Analyze of mechanisms, Syntheses of Mechanisms</li> <li>▪ Main types of Machines and mechanisms.</li> <li>▪ Structure of Mechanisms</li> <li>▪ Classification of kinematic pair.</li> <li>▪ Kinematic Chains and its types.</li> <li>▪ Classification of Mechanisms</li> <li>▪ graphical and analytical methods in the kinematics of mechanisms moving plane</li> <li>▪ Learning kinematics of mechanisms with the help of kinematic diagrams.</li> <li>▪ Dynamics of mechanisms.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Requires of creating machines. Parameters, Analyze of mechanisms, Syntheses of Mechanisms</li> <li>▪ Main types of Machines and mechanisms.</li> <li>▪ Structure of Mechanisms</li> <li>▪ Classification of kinematic pair.</li> <li>▪ Kinematic Chains and its types.</li> <li>▪ Classification of Mechanisms</li> <li>▪ graphical and analytical methods in the kinematics of mechanisms moving plane</li> <li>▪ Learning kinematics of mechanisms with the help of kinematic diagrams.</li> <li>▪ Dynamics of mechanisms.</li> </ul>
<p><b>“5321700- Information-communication systems in a control of technological processes”</b></p>	<p><b>Objectives:</b> Teaching Classification of Information systems (IS), hardware of IS , software of IS, architecture of</p>	<ul style="list-style-type: none"> <li>▪ Introduction</li> <li>▪ Classification of Instrumental tools</li> <li>▪ Hardware of IS</li> <li>▪ Software of IS</li> </ul>	<ul style="list-style-type: none"> <li>▪ Hardware of IS</li> <li>▪ Software of IS</li> <li>▪ Automatizing tools data processing.</li> <li>▪ DBMS</li> <li>▪ SQL-language</li> </ul>	<ul style="list-style-type: none"> <li>▪ Hardware of IS</li> <li>▪ Software of IS</li> <li>▪ Automatizing tools data processing.</li> <li>▪ DBMS</li> <li>▪ SQL-language</li> </ul>

<p><b>“Instrumental tools of Information systems”</b>  <b>Total hour: -72 h</b></p>	<p>modern instrumental tools and etc.</p>	<ul style="list-style-type: none"> <li>▪ Architecture and problems of modern instrumental tools</li> <li>▪ Automatizing tools data processing.</li> <li>▪ SQL-language</li> <li>▪ IEC -61131 programming languages</li> <li>▪ SCADA systems</li> </ul>	<ul style="list-style-type: none"> <li>▪ Security Tools of DB</li> </ul>	<ul style="list-style-type: none"> <li>▪ Security Tools of DB</li> </ul>
<p><b>“5321700- Information-communication systems in a control of technological processes”</b>   <b>“Identification of technological processes”</b>  <b>Total hour: -40 h</b></p>	<p><b>Objectives:</b> Teaching to identify and formation methods control objects on based different approaches in a form identification tasks</p>	<ul style="list-style-type: none"> <li>▪ Introduction. Automation and identification processes.</li> <li>▪ Automatic control systems, observability and controllability</li> <li>▪ Statistical identification of dynamic objects</li> <li>▪ Frequency classification process</li> <li>▪ The transfer function of the ACS</li> <li>▪ Methods of correlation functions</li> <li>▪ The frequency response of objects based on the correlation function</li> <li>▪ Identification of statistical systems with a single input and output signals</li> <li>▪ Identification of statistical systems with a single line input and output signals</li> <li>▪ Identification of statistical systems with non-linear input and output signals</li> <li>▪ Identification systems with the method stochastic approximation</li> <li>▪ Identification systems with the method sequential study</li> </ul>	<ul style="list-style-type: none"> <li>▪ -</li> <li>▪ -</li> </ul>	<ul style="list-style-type: none"> <li>▪ The transfer function of the ACS</li> <li>▪ Methods of correlation functions</li> <li>▪ The frequency response of objects based on the correlation function</li> <li>▪ Identification of statistical systems with a single input and output signals</li> <li>▪ Identification of statistical systems with a single line input and output signals</li> <li>▪ Identification of statistical systems with non-linear input and output signals</li> <li>▪ Automatic control systems, observability and controllability</li> <li>▪ Static identification of dynamic objects</li> <li>▪ Frequency classification process</li> </ul>

		<ul style="list-style-type: none"> <li>▪ Identification systems with the method quasi-linearity and invariance</li> <li>▪ Assessment of the status and parameters of dynamical systems</li> <li>▪ Setting targets identification</li> <li>▪ The classic method of identification</li> <li>▪ Typical identification of linear objects</li> <li>▪ Identification frequency characteristics</li> </ul>		
<p><b>“5321700- Information-communication systems in a control of technological processes”</b></p> <p><b>“Theoretically bases of Control”</b>  <b>Total hour: -72 h</b></p>	<p><b>Objectives:</b> teaching rules and principles of creation automatic and automated control systems</p>	<ul style="list-style-type: none"> <li>▪ Concepts about Control. Main principles of Control.</li> <li>▪ Architecture of automatic system and its elements.</li> <li>▪ Classification of Automatic Control Systems (ACS). Automatic Regulation Systems and other ACSs.</li> <li>▪ Mathematical views of Linear ACS. Transient and Frequency response of link.</li> <li>▪ Frequency response of Links</li> <li>▪ Definite of Transient Function of ACS on Transient Function link.</li> <li>▪ Definite of Frequency Function of ACS on Frequency Function link.</li> <li>▪ Stability of Linear ACS.</li> <li>▪ Criteria’s of Stability of ACS.</li> </ul>	<p>Definition Transient Response of Automatic Control Systems (ACS).  Methods of learning the structural schemes of ACS  Construction of the frequency response of automatic control systems  Construction of the logarithmic-frequency response of automatic control systems  Definition of stability of automatic control systems . Criteria’s Raus  Definition of stability of automatic control systems . Criteria’s Gurvits.  Definition of stability of automatic control systems. Criteria’s Michailov.  Definition of stability of automatic control systems. Criteria’s Naykvist.</p>	<ul style="list-style-type: none"> <li>▪ Methods of learning the structural schemes of ACS</li> <li>▪ Construction of the frequency response of automatic control systems</li> <li>▪ Definition of stability of automatic control systems . Criteria’s Raus</li> <li>▪ Definition of stability of automatic control systems . Criteria’s Gurvits.</li> <li>▪ Definition of stability of automatic control systems. Criteria’s Michailov.</li> <li>▪ Definition of stability of automatic control systems. Criteria’s Naykvist.</li> </ul>



<p><b>“5321700- Information-communication systems in a control of technological processes”</b></p> <p><b>“Technology of Programming (Software)”</b></p> <p><b>Total hour: -54 h</b></p>	<p><b>Objectives:</b> teaching levels and principles of to develop software, methods of testing, architecture and methods of designing of software</p>	<ul style="list-style-type: none"> <li>▪ Introduction</li> <li>▪ Levels of designing of software</li> <li>▪ Designing of software</li> <li>▪ External designing of software</li> <li>▪ Documents of Software</li> <li>▪ Algorithms. The document “External specification”</li> <li>▪ To develop of Software</li> </ul>	<ul style="list-style-type: none"> <li>▪ Preliminary design of the software. Determination of requirements</li> <li>▪ Making a list of the characteristics of the operation of the software</li> <li>▪ Stages of development</li> <li>▪ creation schedule of software</li> <li>▪ The interface and the screen form</li> <li>▪ Methods detailed step-by-step</li> <li>▪ Stages of development of the software. Life cycle. Their model. Creating a schedule document.</li> <li>▪ Preliminary design of the software. Create a document "Statement of the Problem"</li> <li>▪ Functional diagram of the software. Implementation of functional decomposition.</li> <li>▪ Conducting an external design software</li> <li>▪ Methods of designing. Processing software architecture.</li> <li>▪ Modules and their properties</li> <li>▪ Creation of the software at a high programming language.</li> <li>▪ Testing of software</li> <li>▪ Creating a manual for use of the software</li> </ul>	<ul style="list-style-type: none"> <li>▪ The writing algorithm in block diagram form and in the form of text.</li> <li>▪ Document internal and external specifications.</li> <li>▪ The document "Terms of Reference"</li> <li>▪ Creating software architecture: Create functional circuits and software architecture.</li> <li>▪ Testing and application software.</li> </ul>
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