THEME Competence Matrix - Mechatronics with Partial competences/ Learning outcomes

COMPETENCE AREAS	STEPS OF COMPETENCE DEVELOPMENT			
1. Maintaining and assuring the reliability of mechatronic systems.	He/She is able to perform the basic scheduled maintenance on mechatronic machines and systems and adhere to the equipment maintenance plans.	He/She is able to master the maintenance procedures for mechatronic systems such as the use of service documents and maintenance plans and, if faced with new challenges, is able to make the necessary adaptations.	He/She is able to use preventive maintenance to assure the trouble-free operation of mechatronic systems. In addition, he/she is able to modify operational sequences to implement quality-assurance measures.	He/She is able to develop the necessary procedures for maintenance of mechatronic devices and systems, and is able to schedule the maintenance and quality-assurance procedures.
	Partial competences/ Learning outcomes:			
	He/She is able to clean and preserve mechatronic components.			
	He/She is able to grease mechanical parts of mechatronic systems (e.g. slide bearings).			
	He/She is able to check and fill up liquid levels in mechatronic machines (e.g. gear oil, hydraulic oil).			
	He/She is able to replace expendable parts and auxiliary supplies in a mechatronic system (e.g. gaskets, expandable parts of drive components).			
	He/She is able to readjust adjustable parts in a mechatronic system (e.g. chain tension, friction belts).			
	He/She is able to add work results in an existing maintenance plans guided by a supervisor.			

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Partial competences/ Learning outcomes:
He/She is able to perform the scheduled maintenance on a complex mechatronic machine.
He/She is able to deploy occupationally related health, safety and accident prevention measures.
He/She is able to use energy supply and materials in an environmentally friendly manner.
He/She is able to avoid waste and to dispose waste materials in an environmentally friendly manner.
He/She is able to add working results in maintenance plans autonomously.

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Partial competences/ Learning outcomes:
He/She is able to inspect mechatronic systems.
He/She is able to check function of safety systems and execute protocol checks.
He/She is able to maintain mechatronic systems in accordance with maintenance plans.
He/She is able to exchange parts subject to wear and tear as part of preventative maintenance (e.g. belts, roller bearings).
He/She is able to dismantle and assemble devices and subassemblies and label parts with regard to position and functional alignment (e.g. to replace tooth wheels).
He/She is able to identify and to rectify defects and errors and to document them.

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	Partial competences/ Learning outcomes:			
	He/She is able to apply quality assurance procedures in the maintenance and repair of mechatronic systems.			
	He/She is able to select test methods and test equipment.			

2. Installing and dismantling mechatronic systems and facilities	He/She is able to use written instructions to install and dismantle individual components (e.g. sensors, actuators, drives, motors, transport systems, racks) that form a functional group of mechatronic systems.	He/She is able to master the selection of hardware and software for mechatronic systems (e.g. sensors, actuators, interfaces, communication procedures) and is able to provide and test simple programmable logic control programs (PLC) according to production process requirements.	He/She is able to provide independent mechatronic solutions for the construction of production lines, assure their overall ability to function, and, in addition, is able to use both existing and modified standard components.
	Partial competences/ Learning outcomes:		
	He/She is able to identify the length and necessary connection of pneumatic / hydraulic piping systems based on technical drawings.		
	He/She is able to connect electrical sensors (e.g. capacitive, inductive, piezoelectric force sensor) based on technical drawings.		
	He/She is able to realize the power supply of servo drives, asynchronous and d.c. motors under safety and precaution aspects.		
	He/She is able to assemble and adjust mechanical components (e.g. fixing with screws and bolts; welding).		

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	Partial competences/ Learning outcomes:		
	He/She is able to transfer information of wiring and pneumatic / hydraulic schemes into an assembly plan containing the correct step sequences.		
	He/She is able to carry out the correct assembling / dismantling by labelling every mechanical device (e. g. replacing drive components).		
	He/She is able to conduct functional testing by considering the given operational parameters.		
	He/She is able to design, run and document a final acceptance test.		

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	Partial competences/ Learning outcomes:		
	He/She is able to modify an existing device in a mechatronic system by searching for alternative solutions (e.g. coupling, conveyor belt).		
	He/She is able to test the optimized mechatronic system.		
	He/She is able to detect failure modes and suggest possible solutions.		

3. Installing and adjusting mechatronic components in systems and production lines	He/She is able to install and adjust mechatronic components (e.g. individual electro pneumatic standardized valves, sensor and actuator units).	He/She is able to install and adjust components of mechatronic subsystems (e.g. linear drives, measuring systems, transport drives, and transport systems).	He/She is able to install and adjust complex mechatronic facilities that include diverse technologies and instrumentation and control (I&C) equipment, adjust the associated parameters, test the facilities overall functions and assure their reliability.
	Partial competences/ Learning outcomes:		
	He/She is able to assemble mechatronic components (e.g. plug-in modules, housings and circuit unit combinations).		
	He/She is able to wire up and label components for electrical auxiliary and circuit units.		
	He/She is able to adjust single components in an existing mechatronic system.		
	He/She is able to install fluidic components, in particular cylinders and valves.		
	He/She is able to prepare, lay and connect up pipes and hoses.		
	He/She is able to check for leaks.		

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	Partial competences/ Learning outcomes:		
	He/She is able to use bearing assembling sets.		
	He/She is able to assemble and adjust drive elements (e.g. drive axes and bearings, couplings, belt- and chain drives, gearboxes, el. motor reducers).		
	He/She is able to use electrical measurement devices and test equipment.		
	He/She is able to use mechanical measurement devices and test equipment.		
	He/She is able to test and adjust equipment for identification of limit values (e.g. switches and sensors).		

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	Partial competences/ Learning outcomes:		
	He/She is able to assemble and adjust mechatronic system which has several movement functions.		
	He/She is able to install drive- and transportation systems and connect el. motors with frequency invertors.		
	He/She is able to adapt instrumentation and control equipment to the existing facilities.		
	He/She is able to bring in operation mechatronic facilities.		
	He/She is able to monitor and evaluate the operation of mechatronic facilities.		

4. Designing, adapting, and building mechatronic systems and facilities on the basis of client needs and site plans	He/She is able to use machine tools controlled either manually or via a computer program to fabricate (according to production designs and customer requirements) the individual components for mechatronic systems. He/She is able to provide simple designs and descriptions of mechatronic subsystems and is able to use basic CAD applications.	He/She is able to build simple mechatronic subsystems by using engineering drawing and is able to install the devices according to specific production needs. He/She is able to act on extensive knowledge of standards and regulations (e.g. on surface treatments) and is able to use CAD's more advanced functions (e.g. interference check).	He/She is able to build mechatronic systems by using both, original construction techniques and previously signed parts. He/She is able to fully understands CAD functions and is able to document system developments (e.g. parts lists, descriptions of function, operating instructions).	He/She is able to design and build autonomous mechatronic subsystems and, with suitable measuring and testing facilities, is able to assess the necessary production accuracy. He/She is able to document the results with quality-control systems.	He/She is able to make independent adaptations to the various devices (including selection of drives, sensors, PLC) and is able to use CNC programs for building the system. He/She is able to assemble, through a digital mock up, and simulate the functioning system and use computer aided computations (e.g. FEM). He/She is able to perform cost-benefit analyses (e.g. as a basis for deciding whether components should be bought or individually constructed.)	He/She is able to develop independently complex mechatronic systems and is able to calculate the economic usefulness of the system. He/She is able to optimise CNC programs for the manufacturing of complex mechatronic devices and systems and monitor the automated quantity of an open loop control system.
	Partial competences/ Learning outcomes: not covered by consortium					

5. Putting mechatronic systems into operation and providing clients with technical and economic support	He/She is able to put, according to specifications and blueprints, mechatronic devices into operation and provide support to the client in the handover phase.	He/She is able to put, after considering the enterprise's needs and basic conditions, the mechatronic systems into operation, create the necessary documentation, advise the customer on safe operations of the devices, and advise on future technology selection.	He/She is able to master, after considering all basic conditions, the start-up of interconnected mechatronic systems and machines, and is able to provide the necessary documentation including a manual. He/She is able to review client needs and configure machines that provide solutions. He/She is able to train the customer where necessary and provide support for safety operating procedures.	He/She is able to evaluate customer requirements for mechatronic facilities, develop solutions, and is able to plan the system's implementation and operation.	He/She is able to direct, including scheduling and time management, the start-up of the project from the creation of a proposal to the client's acceptance.
	Partial competences/ Learning outcomes: not covered by consortium				

6. Supervising and evaluating both the process sequences of mechatronic systems and facilities and the operational sequence (including quality assurance)	He/She is able to supervise process sequences according to specifications as well as implement any requested quality control measures.	He/She is able to supervise independently the process sequences, evaluate the results, operate an accompanying statistical process control (SPC) for the quality control plan, and prepare simple work schedules, including production schedule and time management.	He/She is able to operate and supervise mechatronic facilities, choose testing and monitoring plans, set up the accompanying SPC, seek the optimal results of the production line according to material flow, and provide work schedules including standard production times.	He/She is able to master the monitoring of complex mechatronic systems using virtual instruments and PPS systems as well as open loop control for the optimisation of machinery arrangement, material flow analysis, and scheduling.	He/She is able to optimise the process cycles of mechatronic production lines, provide instructions on modifying the PPS systems (e.g. adjustment to SAP systems) and introduce quality systems for continuous improvement processes (CIP/KVP).
	Partial competences/ Learning outcomes: not covered by consortium				

7. Installing, configuring, programming and testing hardware and software components for control and regulation of mechatronic systems and facilities	He/She is able to install and configure programs for hardware and software components as well as set up simple programmable logic control programs (PLC).	He/She is able to master the selection of hardware and software for mechatronic systems (e.g. sensors, actuators, interfaces, communication procedures) and is able to provide and test simple programmable logic control programs (PLC) according to production process requirements.	He/She is able to integrate and configure program-, control- and regulation mechanisms in mechatronic systems, program simple devices (in co-operation with developers), and simulate the program sequence before start-up.	He/She is able to develop, test, and configure hardware and software solutions for networked mechatronic systems, and is able to monitor system conditions with suitable measuring and visualisation tools.
	Partial competences/ Learning outcomes:			
	He/She is able to identify the most important hardware-modules of a PLC.			
	He/She is able to carry out the hardware configuration of a PLC with an established PLC-Software.			
	He/She is able to transfer PLC programs to automation units.			
	He/She is able to enter and amend control programs for a module of a mechatronic device (e.g. pick-and-place units).			

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	Partial competences/ Learning outcomes:			
	He/She is able to use technical drawings and specifications in order to select software and hardware components (e.g. proximity switches, pneumatic valves, cylinders).			
	He/She is able to assemble hardware components into modules of mechatronic devices.			
	He/She is able to install sensors and actuators.			
	He/She is able to check the correct function of sensors and actuators for an existing control system.			
	He/She is able to implement a linear program for a mechatronic system (e.g. with timer functions, counters).			
	He/She is able to test the application programs in process.			

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	Partial competences/ Learning outcomes:			
	He/She is able to design PLC-programs for a mechatronic system with different modes of operation (e.g. single step, automatic mode).			
	He/She is able to process analogue and digital signals (e.g. with temperature sensors or encoders).			
	He/She is able to implement PLC-programs in order to control the speed of electrical drives (e.g. frequency inverter, servo drive).			
	He/She is able to simulate robot moves in virtual environment via control circuits.			
	He/She is able to map real robot setting to virtual robot setting.			

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	Partial competences/ Learning outcomes:			
	He/She is able to connect PLCs in an automated system for data exchange (e.g. by using a bus-system).			
	He/She is able to assemble networking components into a control system.			
	He/She is able to control networked peripheral devices (e.g. servo motor drives, frequency inverters).			
	He/She is able to adjust measuring tools.			

8. Preparing and distributing the technical information for adjustment of each enterprise's mechatronic systems	He/She is able to provide descriptions and designs of mechatronic subsystems and is familiar with the basic CAD applications.	He/She is able to fully understand the management of technical information documents for mechatronic systems and is able to prepare and adapt these documents according to an enterprise's specific operating requirements.	He/She is able to analyse complex operational sequences separately in order to understand the connections and draw up maintenance and production procedures. He/She is able to understand that the system parameters are important for the equipments' functions and is able to independently assess and document the wear and general conditions of the mechatronic equipment.	
	Partial competences/ Learning outcomes: not covered by consortium			
9. Diagnosing and repairing malfunctions with mechatronic systems and facilities, advising clients on avoiding malfunctions, and modifying and expanding mechatronic systems	He/She is able to diagnose and repair errors and malfunctions on the simple components and devices in the mechatronic systems. He/She is able to use the necessary checking, measuring and diagnostic tools.	He/She is able to correct independently problems in mechatronic production equipment with the help of (computer-aided) diagnostic systems and the use of expert systems, databases and error documentations.	He/She is able to diagnose and repair errors and disturbances in complex mechatronic equipment and is able to advise clients on how to avoid sources of malfunctions through changes or upgrades in the equipment and system.	He/She is able to develop, through analyses of malfunctions in the mechatronic equipment, a monitoring and diagnostic system.
	Partial competences/ Learning outcomes: not covered by consortium			

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