GD Bildung und Kultur Programm für lebenslanges Lernen / Federal Ministry of Education and Research	Berufsschule für Fertigungstechnik	**Module PLC**	goMOVET.eu

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"MODULES FOR VOCATIONAL EDUCATION AND TRAINING FOR COMPETENCES IN EUROPE"
"MOVET"
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Module PLC

The aim of the training is to enable the apprentices to develop the skills, knowledge and competence for competence area 7 of the competence Matrix Mechatronics from the VQTS model (cf. Karin Luomi-Messerer & Jörg Markowitsch, Vienna 2006)

7.3 He/She can 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.

BSFT Seidenader Group MTU Aero Engines SW//M BMW Technische Universität München

Competence Matrix „Mechatronics“

Competence area	Steps of competence development			
1. Maintaining and assuring the reliability of mechatronic systems	He/She can perform the basic scheduled maintenance on mechatronic machines and systems and adhere to the equipment maintenance plans.	He/She can master the maintenance procedures for mechatronic systems such as the use of service documents and maintenance plans and, if faced with new challenges, can make the necessary adaptations.	He/She can use preventive maintenance to assure the trouble-free operation of mechatronic systems. In addition, he/she can modify operational sequences to implement quality-assurance measures	He/She can develop the necessary procedures for maintenance of mechatronic devices and systems, and can schedule the maintenance and quality-assurance procedures.
2. Installing and dismantling mechatronic systems and facilities	He/She can use written instructions to install and dismantle individual components (sensors, actuators, drives, motors, transport systems, racks) that form a functional group of mechatronic systems.	He/She can master the installation and dismantling of mechatronic systems that use several technologies (mechanics, hydraulics, pneumatics, electricalmechanics, electronics), set up the connexion technology, and check the efficiency of the overall system.	He/She can provide independent mechatronic solutions for the construction of production lines, assure their overall ability to function, and, in addition, can use both existing and modifi ed standard components.	
3. Installing and adjusting mechatronic components in systems and production lines	He/She is able to install and adjust standardized mechatronic components, e.g. individual electro-pneumatic valves, sensor and actuator units.	He/She can install and adjust components of mechatronic subsystems (e.g., linear drives, measuring systems, transport systems).	He/She can 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	
4. Designing, adapting, and building mechatronic systems and facilities on the basis of client needs and site plans	He/She can use machine tools controlled either manually or via computer-program to fabricate (according to production designs and customer requirements) the individual components for mechatronic systems. He/she can provide simple designs and descriptions of mechatronic subsystems and can use basic CAD applications.	He/She can build simple mechatronic subsystems by using eineering drawing and can install he devices according to specific production needs. He/She can 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 can build mechatronic systems by using both original construction techniques and previously designed parts. He/She fully understands CAD functions and can document system developments (parts lists, descriptions of function, operating instructions).	He/She can design and build autonomous mechatronic subsystems and, with suitable measuring and testing facilities, can assess the necessary production accuracy. He/She can document the results with quality-control systems.	He/She can make independent adaptations to the various devices (including selection of drives, sensors, SPS) and can use CNC programs for building the system. He/She can, through a digital mock up, assemble and simulate the functioning system and use computeraided computations (e.g. FEM). He/She can perform cost-benefi t analyses (e.g. as a basis for deciding whether components should be bought or individually constructed.)	He/She can independently develop complex mechatronic systems and can calculate the economic usefulness of the system. He/She can optimise CNC programs for the manufacturing of complex mechatronic devices and systems and monitor the automated quantity of an open loop control system.

5. Putting mechatronic systems into operation and providing clients with technical and economic support	He/She can, according to specifications and blueprints, put mechatronic devices into operation and provide support to the client in the handover phase.	He/She, after considering the enterprise's needs and basic conditions, can put 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, after considering all basic conditions, can master the start-up of interconnected mechatronic systems and machines, and can provide the necessary documentation including a manual. He/She can review client needs and confi gure machines that provide solutions. He/She can train the customer where necessary and provide support for safe operating procedures.	He/She can evaluate customer requirements for mechatronic facilities, develop solutions, and can plan the system's implementation and operation.	He/She can direct, including scheduling and time management, the start-up of the project from the creation of a proposal to the client's acceptance.
6. Supervising and evaluating both the process sequences of mechatronic systems and facilities and the operational sequence (including quality assurance	He/She can supervise process sequences according to specifi cations as well as implement any requested quality-control measures.	He/She can independently supervise the process sequences, evaluate the results, operate an accompanying statistic process control (SPC) for the quality control plan, and prepare simple work schedules, including production schedule and time management.	He/She can 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 can 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 fl ow analysis, and scheduling.	He/She can 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).
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 software control programs (SPS).	He/She can master the selection of hardware and software for mechatronic systems (sensors, actuators, interfaces, communication procedures) and can provide and test simple software control programs (SPS) according to production process requirements.	He/She can integrate and confi gure 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 can develop, test, and configure hardware and software solutions for networked mechatronic systems; and can monitor system conditions with suitable measuring and visualisation tools.	
8. Preparing and distributing the technical information for adjustment of each enterprise's mechatronic systems	He/She can provide descriptions and designs of mechatronic subsystems and is familiar with the basic CAD applications.	He/She can fully understand the management of technical information documents for mechatronic systems and can 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 can understand that the system parameters are important for the equipments' functions and can independently assess and document the wear and general conditions of the mechatronic equipment.		
9. Diagnosing and repairing malfunctions with mechatronic systems and facilities, advising clients on avoiding malfunctions, and modifying and expanding mechatronic systems	He/She can diagnose and repair errors and malfunctions on the simple components and devices in the mechatronic systems. He/She can use the necessary checking, measuring, and diagnostic tools.	He/She can independently correct 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 can 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 can 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.	

Berufsschule für Fertigungstechnik	**Contents / Learning Outcome**	PLC-Module

This table can be used

a) to locate the learning outcomes in the contents of the PLC-Module
b) and also the allocation within the Taxonomy Table

Example:

a) In Chapter 2.1 Hardware Config. Information the verbs understand and interpret are used to describe the learning outcomes.
b) The verbs indicate complexity 2 in the cognitive process dimensions, the types of knowledge are F which stands for factual knowledge and Ca which stands for causual knowledge.

Contents		Learning Outcomes		Taxonomy Table
1. Introduction PLC				
1.1	History of PLC	1.1.1	The S. is able to recognize important steplandmarks of the history of PLC	1F,
		1.1.2	S is able to recognize the reasons for the development of the PLC	1Ca
1.2	Difference of CPC-PLC	1.2.1	S is able to to recognize the difference between CPC-PLC	1F, 1Ca
2. Modular PLC				
2.1	Hardware Config. Information	2.1.1	S is able to understand and interpret the meaning of hardware configuration	2F, 2Ca
2.2	Puzzle Modular PLC	2.2.1	S is able to carry out a standard hardware configuration by means of a puzzle	3P
2.3	Worksheet Modular PLC	2.3.1	S is able to recall the modules and their functions	1F, 1Ca
2.4	Hardware Configuration Station	2.4.1	S is able to make a list of modules mounted at their station (exemplify)	2F
2.5	Hardware Configuration	2.5.1	S is able to carry out HWK with SIMATIC Manager	3Ca
3. Addressing				
3.1	Addressing Information	3.1.1	S is able to execute the addressing of DI and DO-modules	3Ca
		3.1.2	S is able to differentiate between DI and DO-modules and the necessary addresses,	4Ca
		3.1.3	S is able to check the addressing by means of the hardware configuration and the information given	5F

4. Programming				
4.1	Basic Bit Logic	4.1.1	S is able to recall the logic of OR, AND, SR and differentiate between them, using also the help function of the SIMATIC Manager	1F, 1Ca 4Ca
4.2	Program Exercise 1	4.2.1	S is able to understand why and how she/he use the logic functions	2P
		4.2.2	S is able to implement and organize simple programming	3Ca 4Ca, 4P
4.3	CPU Cycle Information	4.3.1	S is able to explain the CPU-cycle	2F, 2Ca, 2P
4.4	CPU Information	4.4.1	S is able to recall the modes of the CPU	1F, 1Ca
		4.4.2	S is able to choose and carry out the correct mode of the CPU	3Ca
4.5	Using the Glossary	4.5.1	S is able to understand how to use the Glossary of the SIMATIC Manager	2F
4.6	Using the Help Instruction	4.6.1	S is able to interpret the use of the Help Instruction.	2F, 2Ca, 2P
		4.6.2	S is able to carry out (work with) the information given in the help instruction.	3Ca, 3P
5. Analysing				
5.1	Variable Table	5.1.1	S is able to interpret the instruction for the use of the Variable Table	2F, 2Ca, 2P
		5.1.2	S is able to implement (use) the Variable Table to monitor and modify in- and outputs	3F, 3Ca, 3P
5.2	Symbol Table	5.2.1	S is able to recall the difference between the Variable and a Symbol Table	1P
		5.2.2	S is able to implement a Symbol Table in the existing programme	3P
5.3	Analyse Outputs	5.3.1	S is able to recall how to draw a pneumatic diagram	1F, 1Ca, 1P
		5.3.2	S is able to implement a pneumatic diagram	3Ca, 3P
		5.3.3	S is able to organise the movement of cylinders in a correct order manually, and with the Variable Table	4F, 4Ca, 4P
		5.3.4	S is able to complete and check the complete Symbol Table with the help of the Variable table	5F, 5Ca, 5P
5.4	Electrical circuit	5.4.1	S is able to understand (summarize) an electrical circuit	2F, 2Ca, 2P
		5.4.2	S is able to carry out the drawing of an electric circuit by means of an simulation program	3F, 3Ca, 3P
		5.4.3	S is able to differentiate between the functions of the parts of the electric circuit	4Ca, 4P

6. Sequence Chain				
6.1	Structured Program	6.1.1	S is able to recall the structure of a program	1F, 1Ca, 1P
		6.1.2	S is able to exemplify why a program should have a structure and how it can be structured	2Ca
6.2	Sequence chain	6.2.1	S is able to exemplify the principles of o a sequence chain	2P
		6.2.2	S is able to implement a sequence chain into FC 2	3Ca, 3P
		6.2.3	S is able to organize a program in different FCs	4P
		6.2.4	S is able to check and evaluate his own program	5F, 5Ca, 5P
6.3	Pushbuttons and switches	6.3.1	S is able to implement a standard set of pushbuttons and switches	3Ca, 3P
		6.3.2	S is able to organize the different functions of the mechatronic system by means of the switches and pushbuttons	4P
6.4	FC1 Modes of operation	6.4.1	S is able to compare the different modes of operation	2P
		6.4.2	S is able to carry out and organize the programming of the necessary networks for the modes of operation.	3P 4P
		6.4.3	S is able to check the correct operation of the modes of operation	5F, 5Ca, 5P
6.5	FC4 indication	6.5.1	S is able to carry out and organize the programming of the necessary networks for the indication lamps.	3P 4P
		6.5.2	S is able to check the programming of a network that Indicates an error	5F, 5Ca, 5P

Taxonomy Table for the PLC Module

		Cognitive Process					
		Remember (1)	Understand (2)	Apply (3)	Analyze (4)	Evaluate (5)	Create (6)
knowledge	Factual knowledge (F)	1.1.1 1.2.1 2.3.1 4.1.1 4.4.1 5.3.1 6.1.1	2.1.1 2.4.1 4.3.1 4.5.1 4.6.1 5.1.1 5.4.1	5.1.2 5.4.2	5.3.3	3.1.3 5.3.4 6.2.4 6.4.3 6.5.2	
	Casual knowledge (Ca)	1.1.2 1.2.1 2.3.1 4.1.1 4.4.1 5.3.1 6.1.1	2.1.1 4.3.1 4.6.1 5.1.1 5.4.1 6.1.2	2.5.1 3.1.1 4.2.2 4.4.2 4.6.2 5.1.2 5.3.2 5.4.2 6.2.2 6.3.1	3.1.2 4.1.1 4.2.2 5.3.3 5.4.3	5.3.4 6.2.4 6.4.3 6.5.2	
	Procedural knowledge (P)	5.2.1 5.3.1 6.1.1	4.2.1 4.3.1 4.6.1 5.1.1 5.4.1 6.2.1 6.4.1	2.2.1 4.6.2 5.1.2 5.2.2 5.3.2 5.4.2 6.2.2 6.3.1 6.4.2 6.5.1	4.2.2 5.3.3 5.4.3 6.2.3 6.3.2 6.4.2 6.5.1	5.3.4 6.2.4 6.4.3 6.5.2	

Contents of the PLC-Module
e. g. Chapter 5.3 Analyse Outputs can be found in different Cognitive processes and different types of knowledge.