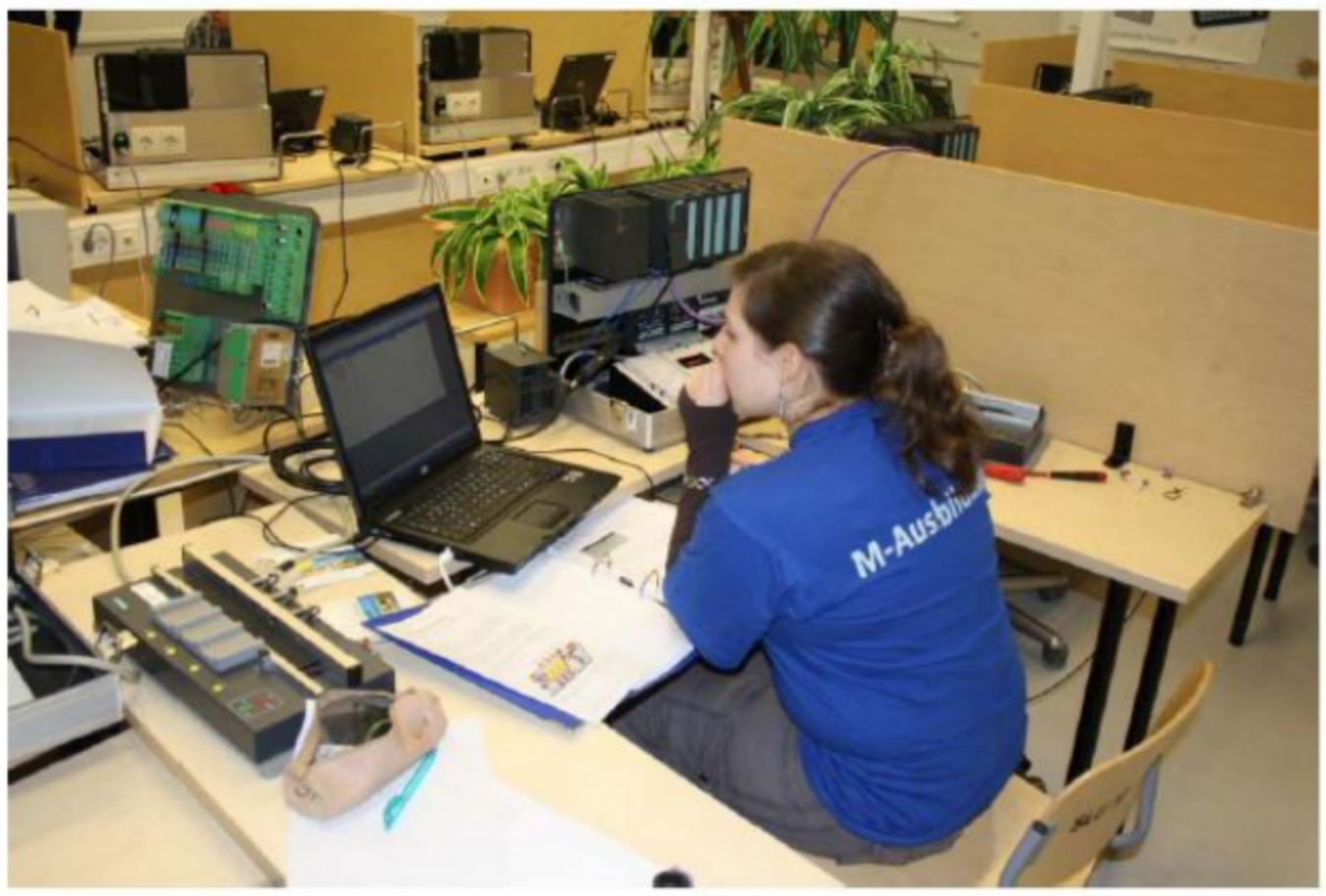
Education and Culture DG

Lifelong Learning Programme

Federal Ministry of Education and Research

MODULE BUS SYSTEMS



The PLC-Module is designed for students which have automation technology as an essential part of their curriculum. Students that take part in the module should have basic knowledge of PLC-programming. In the module student must work mostly in pair's or groups, so good teamwork skills is needed. During the three week training the students will learn basic's of what is the main idea of industrial bus system's and how some of those are configured and build up. In the module there is also fault finding and diagnostic lessons. During the training the students can also see how industrial bus systems are used in local industrial companies and they also have some work to do there.

In the last week there is written test which student must past before he can take part of skills demonstration test.

Location in VQTS -matrix

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 troublefree 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 qualityassurance procedures.		
2. Installing and dismantling mechatronic systems and facilities	He/She can 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 can master the installation and dismantling of mechatronic systems that use several technologies (e.g., mechanics, hydraulics, pneumatics, electrical-mechanics, electronics), set up the connexion technology, and check the effi ciency 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 electropneumatic 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 computerprogram 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 engineering drawing and can install the devices according to specifi c 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 (e.g., 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 qualitycontrol systems.	He/She can make independent adaptations to the various devices (including selection of drives, sensors, PLC) 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	He/She can,	He/She, after	He/She, after	He/She can	He/She can	

mechatronic systems into operation and providing clients with technical and economic support	according to specifi cations and blueprints, put mechatronic devices into operation and provide support to the client in the hand-over phase	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.	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.	evaluate customer requirements for mechatronic facilities, develop solutions, and can plan the system's implementation and operation.	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-fl ow, 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, confi guring, programming and testing hardware and software components for control and regulation of mechatronic systems and facilities	He/She is able to install and confi gure programs for hardware and software components as well as set up simple programmable logic control programs (PLC).	He/She can master the selection of hardware and software for mechatronic systems (e.g., sensors, actuators, interfaces, communication procedures) and can provide and test simple programmable logic control programs (PLC) according to production process requirements.	He/She can integrate and confi gure program-, control-, and regulationmechanisms in mechatronic systems, program simple devices (in cooperation with developers), and simulate the program sequence before start-up.	**7.4 He/She can develop, test, and confi gure 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 specifi c 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	He/She can diagnose and repair errors and malfunctions on the simple components and devices in the mechatronic systems. He/She can use	He/She can independently correct problems in mechatronic production equipment with the help of (computer-aided) diagnostic systems and the use	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	He/She can develop, through analyses of malfunctions in the mechatronic equipment, a monitoring and diagnostic system	

clients on avoiding malfunctions, and modifying and expanding mechatronic systems	the necessary checking, measuring, and diagnostic tools.	of expert systems, databases, and error documentations.	changes or upgrades in the equipment and system.	

Learning outcomes

Time hours	Content	Learning Outcome What can the Student (S) do
	1. Getting started	
4	Reply: The students will make some basic instructions with PLC control	S is able to explain$_1$ and carry out$_2$ a PLC program, and recall$_3$ previously learned items of PLC controls

BUS SYSTEMS		
	2. Basics of Bus Systems	
2	Difference between wired I/O and bus system	S is able to compare$_4$ wired I/O and bus system concerning the idea and the advantages of a Bus System S is able to differentiate$_5$ and explain$_6$ the differences between wired I/O and Bus
	3. Common Bus Systems	
2	Standard Bus systems: Profibus, AS-I, Ethernet Factory level, cell level, field I/O	S is able to explain$_7$ the function of the standard bus systems. S is able to explain$_8$ the different level's of Bus systems and how they work together.
	4. Cabeling	
4	Cabeling and connections Differences between bus systems, placement in cabelways etc.	S is able to explain$_9$ differents in three different bus system (Ethernet, Profibus, AS-i). S is able to carry out$_{10}$ connections and explain the principes of placing cables
	5. ProfibusDP Building Network	

2	Profibus network Different protocols, cabeling distance's etc). Building a profibus network	S is able to carry out$_{11}$ cabeling and connections in a network consisting of PLC (Master) and a I/O –station (Slave) S is able to explain$_{12}$ the limits of cabeling procedures
6. Profibus Configurations		
2	Configuration of a Profibus DP – Master-Slave network Using a configuration tool (software)	S is able to explain the idea of configuration and carry out$_{13}$ configuration procedure S is able to carry out$_{14}$ configuring
7. Profibus_ Taking over		
4	Taking over the ProfibusDP network Take over test's for PLC-system with Profibus Network. Finding out I/O from substation and using them	S is able to carry out$_{15}$ I/O –test. S is able to explain$_{16}$ the system of addressing in Profibus Network
8. Network expansion		
4	Making the network larger. Adding a new Profibus –module to existing network. Students will now make the whole thing (cabeling, configuring and take over) again	S is able to recognise$_{17}$ and recall$_{18}$ the the network properties and procedures of cabeling and taking over
9. ProfibusDP Fault situations		
4	Possible fault situations and diagnosis tool's Having a fault situation and finding it with using diagnostic tool's	S is able to check$_{19}$ situations with diagnostic tool's. S is able to organize$_{20}$ the procedure of finding out and solving faults
10. AS-I Network		
4	Building an AS-I network Connecting the AS-I network to Profibus network	S is able to carry out$_{21}$ cabeling and connections in a network consisting of PLC (Master) and a I/O –station (Slave)
11. AS-I Taking over		
4	Take over the AS-I network	S is able to carry out$_{22}$ I/O –test. S is

		able to explain$_{23}$ the system of addressing in AS-i Network
	Students will make a little AS-I network and connect it to previously built-up Profibus Network	S is able to compare$_{24}$ the differences between AS-I and Profibus
	12. Ethernet Network	
8	Building an Ethernet network Building a little Ethernet network	S is able to explain $_{25}$ principes of cabeling. S is able to explain$_{26}$ the main features of Ethernet network S is able to carry out$_{27}$ cabeling of Ethernet network
	13. Written test	
4	Written test of central theoretical items Profibus, AS-I and Ethernet network	
	14. Practical test	
8	Student is making a network cabeling to some machine or conveyor.	S is able to organise$_{28}$ network cabeling work. S is able to carry out$_{29}$ connections and is able to check$_{30}$ I/O:s and network functions in taking over. S is able to critic$_{31}$ his own work.

Cognitive Process / Knowledge	Remember	Understand	Apply	Analyze	Evaluate	Create
factual knowledge (knowing WHAT)	17 3 18	4 24 1 6 9 25	10 13	5	19	
causal knowledge (knowing WHY))		7 12			31	
procedural knowledge (knowing HOW)		8 16 23 26	2 11 14 15 21 22 27 29	20 28	30	