



KULTUSMINISTER KONFERENZ

RAHMENLEHRPLAN

for the training occupation

Mechatronics technician

(Resolution of the Standing Conference of the Ministers of Education and Cultural Affairs of 30.01.1998 in the version of 23.02.2018)

Part I Preliminary remarks

This framework curriculum for vocational instruction at vocational schools has been adopted by the Standing Conference of the Ministers and Senators of Education and Cultural Affairs of the Länder (KMK).

The framework curriculum is coordinated with the corresponding federal training regulations (issued by the Federal Ministry of Economics or the competent ministry in consultation with the Federal Ministry of Education, Science, Research and Technology). The coordination procedure is regulated by the Joint Results Protocol of 30 May 1972. The framework curriculum is basically based on the lower secondary school leaving certificate and describes minimum requirements.

In the case of assigned occupations, the framework curriculum is divided into basic training covering a broad range of occupational fields and specialised training building on this.

On the basis of the training regulations and the framework curriculum, which regulate the objectives and contents of vocational training, the final qualifications in a recognised training occupation and - in conjunction with instruction in other subjects - the vocational school leaving certificate are imparted. This creates the essential prerequisites for qualified employment and for entry into school-based and vocational further and continuing education and training courses.

The framework curriculum does not contain any methodological specifications for teaching. Independent and responsible thinking and acting as the overarching goal of training is preferably taught in those forms of teaching in which it is part of the overall methodological concept. In principle, any methodical approach can contribute to achieving this goal; methods which directly promote the competence to act are particularly suitable and should therefore be taken into account appropriately in the lesson design.

The Länder adopt the framework curriculum directly or implement it in their own curricula. In the second case, they ensure that the result of the subject and time coordination with the respective training regulation taken into account in the framework curriculum is maintained.

Part II Educational mission of the vocational school

The vocational school and the training companies fulfil a joint educational mandate in dual vocational training.

The vocational school is an independent place of learning. It works as an equal partner with the other parties involved in vocational education and training. It has the task of imparting vocational and general learning content to the pupils with special consideration of the requirements of vocational training.

The vocational school aims at basic and specialised vocational education and expands the previously acquired general education. In this way, it aims to enable students to fulfil their tasks at work and to help shape the world of work and society in terms of social and ecological responsibility. It follows the regulations of the school laws of the Länder applicable to this type of school. In particular, the vocationally related teaching is also oriented towards the vocational regulations issued for each individual state-recognised training occupation on a uniform federal basis:

- Framework Curriculum of the Standing Conference of the Ministers and Senators of Education and Cultural Affairs of the Länder (KMK)
- Federal training regulations for in-company training.

According to the framework agreement on the vocational school (KMK resolution of 12.03.2015), the aim of the vocational school is,

- to provide a vocational skill that combines professional competence with general skills of a human and social nature;
- develop professional flexibility to cope with the changing demands in the world of work and society, also with regard to the growing together of Europe;
- awaken the willingness to engage in professional development and further education;
- to demand the ability and willingness to act responsibly in shaping individual lives and in public life.

To achieve these goals, the vocational school must

- Orient the teaching to a pedagogy specific to your task, which emphasises hand-orientation;
- impart cross-occupational and cross-field qualifications, taking into account necessary occupational specialisation;
- ensure a differentiated and flexible educational offer in order to meet different abilities and talents as well as the respective requirements of the world of work and society;
- to comprehensively support and promote disabled and disadvantaged persons within the scope of their possibilities;
- point out the environmental threats and accident hazards associated with occupational activities and private lifestyles and show ways to avoid or reduce them.

In addition, the vocational school should, in general lessons and as far as possible in the context of vocationally related lessons, focus on core problems of our time, such as

- Work and unemployment,
- Peaceful coexistence of people, peoples and cultures in a world that preserves cultural identity,
- Conservation of the natural basis of life and
- guaranteeing human rights.

The listed goals are directed towards the development of action competence. This is understood here as the readiness and ability of the individual to behave appropriately, thoughtfully and in an individually and socially responsible manner in social, professional and private situations.

H a n d l i n g c o m p e t e n c y	unfolds in the dimensions of professional competence, human competence (personal competence) and social competence
F a c h c o m p e t e n c y	describes the willingness and ability to solve tasks and problems in a goal-oriented, appropriate, methodical and independent manner on the basis of technical knowledge and skills and to assess the result.
H u m a n c o m p e t e n c y	(Personal competence) refers to the willingness and ability as an individual personality to clarify, think through and assess development opportunities, requirements and restrictions in family, work and public life, to develop one's own talents and to make and develop life plans. It includes personal qualities such as independence, critical faculties, self-confidence, reliability, sense of responsibility and duty. In particular, it also includes the development of well thought-out values and self-determined commitment to values.
S o z i a l c o m p e t e n c y	describes the willingness and ability to live and shape social relationships. The ability to grasp and understand attitudes and tensions as well as to deal with and communicate with others rationally and responsibly. This includes in particular the development of social responsibility and solidarity.
M e t h o d - a n d L e r n c o m p e t e n c y	arise from a balanced development of these three dimensions.

Competence refers to the learning success in relation to the individual learner and his or her ability to act independently in private, professional and social situations.

In contrast, qualification is understood as learning success in relation to usability, i.e. from the point of view of demand in private, professional and social situations (cf. Deutscher Bildungsrat. Recommendations of the Education Commission on the Reorganisation of Secondary Level II).

Part III Didactic Principles

The objective of vocational education and training requires that teaching be geared to a pedagogy tailored to the tasks of the vocational school, which emphasises action orientation and enables young people to plan, carry out and assess work tasks independently within the framework of their occupation.

Learning in the vocational school basically takes place in relation to concrete, professional action as well as in diverse mental operations, including mental comprehension of the actions of others. This learning is primarily linked to the reflection on the execution of actions (the plan of action, the process, the results). With this mental penetration of vocational work, the prerequisites are created for learning in and from work. This means for the framework curriculum that the description of the objectives and the selection of the contents are occupation-related.

On the basis of learning theory and didactic findings, the following points of orientation are mentioned in a pragmatic approach for the design of action-oriented lessons:

- Didactic reference points are situations that are significant for professional practice (learning for action)
- The starting point of learning is action, if possible carried out by oneself or mentally reproduced (learning by doing).
- Actions must be planned, carried out, checked, corrected if necessary and finally evaluated by the learners as independently as possible.
- Actions should demand a holistic grasp of professional reality, e.g. include technical, safety, economic, legal, ecological, social aspects.
- Actions need to be integrated into learners' experiences and reflected upon in relation to their social impact.
- Actions should also include social processes, e.g. the declaration of interests or conflict resolution.

Action-oriented teaching is a didactic concept that interlinks subject and action system structures. It can be realised through different teaching methods.

The teaching offered by the vocational school is aimed at young people and adults who differ in terms of previous education, cultural background and experience from the training companies. Vocational schools can only fulfil their educational mandate if they take these differences into account and support pupils - including disadvantaged or particularly gifted pupils - according to their individual potential.

Part IV Job-related preliminary remarks

This framework curriculum for vocational training as a mechatronics technician is coordinated with the Ordinance on Vocational Training as a Mechatronics Technician of 4 March 1998 (BGBl. I p 408) ^{1,2}

The material of the vocational school that is essential for the examination area of economics and social studies is taught on the basis of the "Elemente für den Unterricht der Berufsschule im Bereich Wirtschafts- und Sozialkunde gewerblich-technischer Ausbildungsberufe" (Elements for the Teaching of Economics and Social Studies in Industrial-Technical Training Occupations at Vocational School) (resolution of the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder of 07 May 2008) mediated.

The objectives and contents of the learning fields of the framework curriculum are to be implemented in such a way that they lead to professional competence. With a view to technical change, the contents shown in the framework curriculum are formulated functionally. They are to be updated in accordance with technical change.

In the implementation of the framework curriculum, methods are to be used which promote manual competence.

Mathematical, scientific and foreign language content as well as aspects of economics, ecology and occupational health and safety are to be taught in an integrative manner.

The present framework curriculum is based on the following school objectives:

The pupils

- work together with other people in the context of their professional activities and communicate with them in English. They also work in an interdisciplinary manner and use current information and communication tools in a virtual environment;
- apply technical rules and regulations when working in mechatronic systems. They also use audiovisual and virtual aids;
- take into account the data and information security associated with the digitalisation of work;
- carry out basic calculations taking into account technical and economic variables. They use tables and formulas for this purpose;
- take ergonomic, economic, ecological and social aspects into account when organising and carrying out work;
- minimise the negative impact of the work process on the environment by using suitable materials, acting responsibly and observing environmental protection regulations;
- ensure the trouble-free operation of plants and systems by complying with maintenance instructions. Their quality awareness enables them to comply with quality standards and identify cost-effective solutions;
- describe the functioning, production and organisational processes as well as the integration of cyber-physical systems, also taking into account logistical process steps;
- plan and configure networks taking into account current standards;
- program and configure systems as well as intelligent sensors and actuators in compliance with standards;
- install and expand mechatronic systems, set them up and network them using suitable interfaces and protocols;

¹ The Mechatronics Training Ordinance of 21.07.2011 (BGBl. I. p. 1516) on the occasion of the introduction of the examination form "extended final examination" has not necessitated any changes in the framework curriculum of the Standing Conference of the Ministers of Education and Cultural Affairs.

² Based on the First Ordinance Amending the Ordinance on Vocational Training for Mechatronics Technicians of 07.06.2018 (BGBl. I p. 818), the framework curriculum has been amended with regard to the topic of "Digitalisation of work, data protection and information security" have been adapted.

- use programmes and systems to collect, process and analyse process-related data and information;
- develop justified procedures for troubleshooting and eliminating faults and derive conclusions for troubleshooting and process optimisation from fault diagnoses and process-related data;
- use various software for process planning, control and analysis;
- take into account the information technology protection goals of availability, integrity, confidentiality and authenticity;
- analyse descriptions, operating instructions and other information typical for the profession in German and English and prepare them in a way that customers can understand.

Part V Learning fields

Overview of the learning fields for the training occupation of mechatronics technician				
Learning fields		Time reference value in hours		
		1. Training year	2. Training year	3. and 4. train- ditional year
1	<i>Analysing functional interdependencies in mechatronic systems</i>	40		
2	<i>Manufacture of mechanical subsystems</i>	80		
3	Installing electrical equipment in compliance with safety aspects	100		
4	Examining the energy and information flows in electrical and hydraulic assemblies	60		
5	Communicating with the help of data processing systems	40		
6	Planning and organising work processes		40	
7	Realisation of mechatronic subsystems		100	
8	Design and create mechatronic systems			140
9	Investigating the flow of information in complex mechatronic systems			80
10	Planning assembly and disassembly			40
11	Commissioning, troubleshooting and installation			160
12	Preventive maintenance			80
13	Handover of mechatronic systems to customers			60
Totals		320	280	420

Learning Area 1:	Analysing functional interdependencies in mechatronic systems	1st year of training Time reference value in hours: 40
<p>Target setting:</p> <p>The pupils apply rules and regulations when investigating technical systems. They work with technical documents and use their statements for the solution. They master procedures for analysing and documenting functional interrelationships and discuss technical implementation options in a team.</p> <p>They work with block diagrams and use these diagrams to recognise the signal flow, the material flow, the energy flow and the basic mode of operation.</p> <p>They recognise the possibilities of current data processing for the preparation of work results.</p> <p>The students are sensitised to problems of ecology and economy of these systems. They are aware of the importance of the English language for technical communication.</p>		
<p>Contents:</p> <p>Requirement profiles of technical systems System parameters</p> <p>Block diagrams</p> <p>Signal. Material and energy flows</p> <p>Significance of customer-specific requirements for technical realisation</p> <p>Significance and possibilities of data processing and software application</p> <p>Information retrieval with the help of flexible IT hardware and software</p> <p>Documentation and presentation of work results</p> <p>Ecological and economic aspects</p>		

Learning Area 2:	Manufacture of mechanical subsystems	1st year of training Time reference value in hours: 80
Target setting: The pupils describe the structure, properties and areas of application of the materials and auxiliary materials used. They plan their economic use and consider environmental and health aspects. They read construction drawings and are able to sketch sections of them and incorporate changes, also in computer-aided systems. They select the mechanical working procedures required for production and evaluate the result of the production process. They use typical English technical terms. They observe occupational health and safety regulations when preparing and carrying out work. You can organise the work in a team as well as interdisciplinary.		
Contents: Individual and assembly drawings, parts lists, also in digital form Machine elements, fits and tolerances Assembly tarpaulin, connecting elements Technological basics of manual and mechanical machining and forming Manufacture of mechanical connections by frictional locking, form locking, material locking Operation-specific materials and auxiliary materials Assembly tools and auxiliary equipment Storage suitable for assembly, safety aspects, occupational health and safety Testing and measuring equipment, measuring errors Ecological and economic aspects		

Learning Area 3:	Installing electrical equipment under consideration of safety aspects	1st year of training Time reference value in hours: 100
<p>Target setting:</p> <p>The pupils have a sound knowledge of the effect of electrical energy in manageable technical processes. They know basic circuits of electrical engineering, represent them and examine their mode of operation. They apply their knowledge to the selection of electrical equipment. To do this, they carry out calculations and use tables, also in digital form, and formulas to solve the task.</p> <p>They know the dangers that arise from the use of electrical energy for people and technology. result.</p> <p>They are familiar with the measures for the protection of people and technical systems and apply the regulations. They select and use the necessary testing and measuring equipment. They incorporate changes into the working documents. They also take information from English working documents.</p>		
<p>Contents:</p> <p>Electrical quantities, their interrelationships, representation options and calculations Components in DC and AC circuits Electrical measurement methods Selection of cables and wires for energy and information transmission Electrical networks Hazards due to overload, short circuit and overvoltage as well as the calculation of the required protection elements. Handling tables and formulas Effect of current on the organism, safety rules, assistance measures in case of accidents Measures against dangerous body currents according to applicable regulations Testing electrical equipment Causes of overvoltages and interference voltages, their effects, countermeasures Electromagnetic compatibility</p>		

Learning Area 4:	Investigating the energy and information flows in electrical and hydraulic assemblies	1st year of training Time reference value in hours: 60
<p>Target setting:</p> <p>The pupils master basic control technology circuits. They read circuit diagrams, make sketches and incorporate modifications. They are familiar with the technical parameters for the operation of electrical, pneumatic and hydraulic assemblies.</p> <p>They know procedures for generating the required auxiliary energies. They use basic measuring procedures safely and are aware of the dangers when handling electrical, pneumatic and hydraulic systems.</p> <p>You understand English product descriptions and use the English technical terms that occur.</p> <p>They comply with occupational health and safety and environmental protection regulations.</p>		
<p>Contents:</p> <p>Pneumatic and hydraulic variables, their interrelationships. Representation possibilities and calculations</p> <p>Supply units of electrical engineering, pneumatics and hydraulics Basic circuits of control engineering</p> <p>Technical documentation</p> <p>Signals and measured values in control systems</p> <p>Hazards when handling electrical, pneumatic and hydraulic power assemblies</p> <p>Economic aspects, energy management, occupational safety and environmental protection, recycling</p>		

Learning Area 5:	Communicating with the help of data processing systems	1st year of training Time reference value in hours: 40
Target setting: The pupils describe the use of data processing systems and their integration into operational processes as well as the structures of networked systems and the resulting security requirements. They analyse work orders. They obtain operational information for this purpose and can process and document this using standard industry software. You can take solution aids from English-language manuals.		
Contents: Operating systems Network systems, components and topologies Data protection and data security Access rights, network and communication security Processing of information using industry-standard software Control of operational processes with the help of data use, analysis and processing Ergonomic aspects of computer workstations		

Learning Area 6:	Planning and organising work processes	2nd year of training Time guideline value in hours: 40
<p>Target setting:</p> <p>The pupils describe the company's organisational structures and also organise teamwork in an interdisciplinary manner and according to functional, technical production and economic criteria.</p> <p>They know the requirements for establishing the operational readiness of all technical means necessary for the work process and apply quality control procedures. They use the possibilities of data processing systems for planning the process and for documenting all necessary control and organisational steps.</p> <p>They take into account the aspects of health and safety at work when preparing the work. English technical terms are used.</p>		
<p>Contents:</p> <p>Material planning and calculation Analysis of workflows Evaluation and documentation of results Ergonomics and preventive accident protection Simple time and cost calculation Representation procedures of work processes Process data acquisition, storage and processing Efficiency, organisational and production processes Quality management</p>		

**Learning
Area 7:**

Realisation of mechatronic subsystems

**2nd year of training
Standard time in hours: 100**

Target setting:

The pupils describe the structures of mechatronic subsystems. They explain the mode of operation of sensors and transducers and adjust sensors.

They know possibilities for the realisation of linear and rotary movements by means of electrical, pneumatic and hydraulic components and apply knowledge of open and closed-loop control systems to influence the path and direction of movement.

They use signal investigations and data analysis to check the function of components and eliminate errors. They design basic circuits and describe their mode of operation in English.

Simple programming procedures are mastered.

Contents:

Control chain and control loop, block diagrams

Characteristics of control systems and controls

Effectiveness of sensors and transducers Signal
behaviour of sensors and transducers

Programming of simple motion sequences and control functions Design of circuits, also
by using industry-standard software Graphical representations of control and
regulation sequences

Measuring signals

Read out, process and interpret process data Basic
circuits and mode of operation of drives Representation
of drive units and function diagrams

**Learning
Area 8:****Design and create mechatronic systems****2nd year of training
Time reference value in
hours: 140****Target setting:**

The pupils describe the structure and the signal course of a mechatronic system consisting of several components. They analyse the influence of changing operating conditions on the process sequence. They recognise errors by examining signals at interfaces and eliminate the causes of errors. They use methods to measure control and regulation processes, prepare and document the results.

They apply knowledge of open- and closed-loop control technology to influence the speed and rotational speed of movements. They are able to connect drive units, select coupling variants between drive units and working machines and use these in a targeted manner. They know the causes and effects of overload situations. They determine the technical parameters of necessary protective devices and select them.

Circuit changes are incorporated into the technical documents. They are aware of sources of danger. They observe health and safety regulations. They are able to describe control and regulation correlations and the mode of operation of selected drive units in English.

Programming procedures are mastered.

Contents:

Operating parameters and characteristics of drives

Limit values

Function, selection and adjustment of protective devices Control and regulation of drives

Positioning processes, degrees of freedom

Test and measurement methods for position determination Gearboxes, clutches

Incorporating changes to existing documentation Programming motion sequences and control functions Computer simulation

Measured value acquisition at interfaces

Learning Area 9:	Investigating the flow of information in complex mechatronic systems	3rd year of training Time reference value in hours: 80
<p>Target setting:</p> <p>The pupils can read circuit diagrams and describe information structures in systems on the basis of these. They represent links between electrical, mechanical, pneumatic and hydraulic components and also use audiovisual and virtual aids for this purpose. They have mastered the measurement and information technology procedures for examining information flows and are able to analyse signals and draw conclusions about possible sources of error. They use diagnostic procedures with the application of data processing. They incorporate changes into existing records. They also modify documents in English.</p>		
<p>Contents:</p> <p>Signal characteristics on systems Signal structures Bus systems Test and measurement methods Investigation at interfaces between system components Networking between subsystems Hierarchies in networked systems Data acquisition, analysis and processing Process visualisation, simulation, optimisation Information technology protection goals Availability, integrity, confidentiality and authenticity Documentation of measurement results</p>		

**Learning
Area 10:**

Planning assembly and disassembly

**3rd year of training
Time guideline value in
hours: 40**

Target setting:

The pupils master the planning and preparation of the assembly and disassembly of mechatronic systems. They explain the sequence of work processes and can assess work results.

They already include health and safety aspects in their considerations during the preparation phase.

They check the assembly conditions at the installation site and take them into account. They plan the use of the necessary aids.

You organise the work in the team.

They communicate in English about assembly instructions.

Contents:

Operational assembly documents

Conditions for working at the installation site taking into account the regulations

Supply and disposal facilities of mechatronic systems

Means of transport. Lifting gear and assembly aids

Safety measures and their testing Tests during
assembly

Shape and position tolerances

Adjustment work

Disposal and recycling during dismantling

Learning Area 11:	Commissioning, troubleshooting and installation	3rd year of training Standard time in hours: 160
<p>Target setting:</p> <p>The pupils describe the overall function and the partial function of a system including its protective devices. To do this, they take information from technical documents. They explain the influence of components on the overall system and check by means of interface examinations of their function. They have mastered the necessary measurement procedures and apply them in a targeted manner. The pupils explain the procedures for commissioning mechatronic systems and determine the procedure for commissioning an entire system. They use the possibilities of diagnostic systems and interpret function and error logs. They check the effectiveness of protective measures. They adjust sensors and actuators, check system parameters and set them. The results are documented in documents. You systematically limit errors and eliminate faults. She could communicate in English.</p>		
<p>Contents:</p> <p>Block diagrams, action and function plans of mechatronic systems Checking and setting sensors and actuators System parameters BUS Parameterisation Software application Procedures for troubleshooting electrical, pneumatic and hydraulic systems Process data-related fault analysis Troubleshooting strategy, typical causes of errors Electrical and mechanical protective measures, protective regulations Electromagnetic compatibility Process visualisation, diagnostic systems, remote diagnostics Commissioning protocol, error documentation, repair protocol Quality assurance procedures Elimination of programme errors Consideration of customer requirements Influences of mechatronic systems on economic, ecological and social conditions</p>		

**Learning
Area 12:**

Preventive maintenance

**4th year of training
Time reference value in
hours: 80**

Target setting:

The pupils describe influences on the operational safety of technical systems and the necessity of preventive maintenance. They use maintenance plans and apply procedures to determine the need for maintenance. They can check, set and adjust safety devices. Health and safety regulations are observed.

They create error analyses and prepare the results statistically. Results of maintenance work are incorporated into the documents. The results are also prepared in English.

Contents:

Contamination, fatigue, consumption, wear and their impact System reliability
Creation and adaptation of maintenance plans Inspections
Procedure for checking safety devices Adaptation of system
components to changed requirements
Diagnostic procedures and maintenance systems, also process data-related Quality
management
Documentation
Incorporating changes to technical documents

Learning Area 13:	Handover of mechatronic systems to customers	4th year of training Standard time in hours: 60
Target setting: The pupils prepare and present information about mechatronic systems textually and graphically, also in digital form. You plan and carry out the instruction of operating and operating personnel in the plant. You exchange information in English. They take into account the principles of shaping customer relations and the branding strategies of their company.		
Contents: Use of internal communication systems Teamwork, also interdisciplinary Oral and written communication and current communication media Moderation, presentation Customer/supplier relationship Operating instructions, operating manuals		