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Development of an aviation aerospace mechatronics technician curriculum

Curriculum

for vocational education and training

OCCUPATION

AVIATION AEROSPACE MECHATRONICS TECHNICIAN

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Content

1. Keynote

The objective of vocational education and training requires teaching to be action-oriented and to enable young people to independently plan, carry out, assess and improve work tasks in the context of their occupation.

Learning in the vocational school takes place in relation to concrete vocational 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 the action (the plan of action, the process, the results). With this mental penetration of vocational work, the prerequisites for learning in and from work are created. Furthermore, vocational education extends the previously acquired general education and lays the foundations for further education. For this curriculum, this means that the description of competences and the selection of contents are related to business and work processes.

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 assessed by the learners as independently as possible.
- Actions should promote a holistic grasp of professional reality, for example including 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, for example of declaring interests or of conflict resolution.

Action-oriented teaching is a concept that interlinks subject and action system structures. It can be realised through different teaching methods. Against the background that adolescents and young adults differ in terms of previous education, cultural background and life-world experiences, the action-oriented teaching pupils - including disadvantaged or particularly gifted ones – according to their individual possibilities.

2. Training objective

The training to become an aviation aerospace mechatronics technician (AMTech) is an initial training that qualifies to work in the aviation industry and specifically to work on advanced air mobility (AAM), unmanned aerial vehicles (UAV) and unmanned aircraft systems (UAS). It is intended to provide students with a of comprehensive understanding of aviation technology, aircraft maintenance, and repair procedures.

It will equip learners with the necessary knowledge and skills required to maintain, repair and troubleshoot electrical and mechatronic systems in aircraft as well as knowledge, skills and

competences to maintain and repair aircraft computer and avionics systems.

The present curriculum is in alignment with the European Qualifications Framework (EQF) and the European Skills, Competences, Qualifications and Occupations (ESCO) classification.

3. EQF and ESCO

3.1 European Qualifications Framework (EQF)[1]

The EQF is a framework based on learning outcomes in which all types of qualifications are classified into 8 levels. It serves to "translate" the qualifications frameworks of individual countries and thus contributes to transparency, comparability and transferability of qualifications. It enables the mapping of different qualifications from different countries.

The EQF covers all types and levels of qualifications. The classification into learning outcomes makes it clear what a person knows, understands and is able to do. The level increases according to the level of competence - 1 is the lowest and 8 is the highest. The EQF is also closely interlinked with national qualifications frameworks, providing a comprehensive picture of all types and levels of qualifications in Europe, which are also increasingly accessible through databases.

The EQF was established in 2008 and revised in 2017. Member States have committed to further developing the EQF and making it more effective so that it facilitates the understanding of national, international and third-country qualifications by employers, employees and learners.

This curriculum is set in EQF level 4, which means, that competences that are required for the independent planning and processing of technical tasks in a comprehensive, changing field of learning or professional field of activity.

Professional competence	Personal competence
Knowledge Possess in-depth general knowledge or specialised theoretical knowledge in a field of learning or vocational activity.	**Social competence** Helping to shape the work in a group and its learning or working environment and offering continuous support. Justify procedures and results. Communicate comprehensively about issues.
Skills Possess a broad spectrum of cognitive and practical skills that enable independent task processing and problem solving as well as the assessment of work results and processes, taking into account alternative actions and interactions with neighbouring areas. Produce transfer performances.	**Independence** Set learning and working goals, reflect on them, realise them and take responsibility for them.

[1] https://europa.eu/europass/de/europass-tools/europaeischer-qualifikationsrahmen

3.2 European Skills, Competences, Qualifications and Occupations classification (ESCO)[2]

ESCO (European Skills, Competences, Qualifications and Occupations) is the European multilingual classification of Skills, Competences and Occupations.

ESCO works as a dictionary, describing, identifying and classifying professional occupations and skills relevant for the EU labour market and education and training. Those concepts and the relationships between them can be understood by electronic systems, which allows different online platforms to use ESCO for services like matching jobseekers to jobs on the basis of their skills, suggesting trainings to people who want to reskill or upskill etc.

ESCO provides descriptions of 3008 occupations and 13.890 skills linked to these occupations, translated into 28 languages (all official EU languages plus Icelandic, Norwegian, Ukrainian, and Arabic). The aim of ESCO is to support job mobility across Europe and therefore a more integrated and efficient labour market, by offering a "common language" on occupations and skills that can be used by different stakeholders on employment and education and training topics.

ESCO is a European Commission project, run by Directorate General Employment, Social Affairs and Inclusion (DG EMPL). It is available in an online portal and can be consulted free of charge. Its first full version (ESCO v1) was published on the 28th of July 2017.

4. Professional learning as acquisition of competences

Aviation aerospace mechatronics technicians are foreseen to work in companies working in the field of aviation, especially drone manufactures, maintenance companies and electric aircraft operators, etc. Working in this field requires special skills to ensure the understanding of aviation technology as well as safety and operating in the aviation industry.

The competences described in the learning fields are directed towards action. This enables pupils to plan, carry out and assess independently. The ability of the individual to behave responsibly in social, professional and private contexts of action is included.

This skill development framework offers continuous learning opportunities in variety of life situations and establishes the prerequisites for successful learning outcomes. Competences are acquired on subjects, methods self and social aspects of the job:

- Subject-matter competence means the ability to grasp a subject matter appropriately, to apply acquired knowledge in action and new learning contexts, to develop and assess knowledge contexts.
- Methodological competence means the ability to comprehend a subject matter in a result-oriented way using rules and procedures, to have basic working techniques at one's disposal, especially using IT tools.
- Self-competence means the ability to perceive one's own learning situation, i. e. to

[2] https://esco.ec.europa.eu/en/about-esco/what-esco

articulate one's own needs and interests, to plan and carry out learning processes independently, to check learning results, to correct them if necessary and to evaluate them.

- Social competence means the ability to perceive the needs and interests of fellow learners, to deal (self-)critically with their ideas of the learning situation and to cooperate successfully with them.

Subject, methodological, personal and social competences are interrelated, interpenetrating and complementary. Education thus expands in the development of vocationally relevant knowledge and skills, which includes a reflected understanding of connections between vocational practice, technology, science, economics, politics and culture and individual possibilities for action.

5. Structure of the training program

The learning fields are interdisciplinary and represent a vocational qualification process. They can be derived from the vocational action situations. Within these learning fields, learning situations can be created for teaching, in which subject content is arranged in context in terms of subject matter and time.

There are 2 main areas of action that result from the job description:

- The first step is to assess the current state and the future of the aviation industry.
- The second focus of action is to participate as a specialist for new aircraft models, manned and unmanned, to understand aviation technology, aircraft maintenance, and repair procedures.

The future of the aviation industry holds several potential developments, emerging technologies and trends that the professional profile of an aviation aerospace mechatronics technician is foreseen to be the specialist who can work in this field:

Sustainable Aviation: The aviation industry is expected to place a greater emphasis on sustainability. Airlines will likely continue to invest in more fuel-efficient aircraft and explore alternative fuels such as sustainable aviation fuels (SAF). The development and adoption of electric or hybrid-electric aircraft may also gain traction, especially for shorter regional flights.

Technological Advancements: Advances in technology will likely shape the future of aviation. Artificial intelligence (AI) and machine learning can optimize flight routes, improve maintenance processes, and enhance safety. Autonomous aircrafts, although still in early stages of development and regulatory considerations, may become more prominent in the long term.

Digital Transformation: The aviation industry is undergoing a digital transformation. The integration of digital technologies throughout the travel journey, from booking to post-flight experiences, will continue to improve efficiency and enhance the passenger experience.

It's important to note that the future of the aviation industry is subject to various factors, including technological advancements, economic conditions, regulatory changes, and global events. As the industry evolves, it will likely continue to adapt to emerging trends and

challenges to meet the needs and expectations of passengers while striving for sustainability and efficiency.

The focus of action can be assigned to the basic technical competences which are necessary for this qualification, which are acquired in simple learning situations and then transferred to entire, complex systems.

For this qualification, competences for the installation, operation and maintenance of aviation devices and systems are necessary. A practical structure results from the work fields of aviation and aerospace to safety and operations. The conclusion is a curriculum in which the students combine their competences of all 4 learning fields.

Occupation-relevant methods and procedures, communication and working methods result in the learning fields from the concrete learning situations in which work is done cooperatively in a team. The interlocking of theory and practice is of great importance, which must be reflected in the workshops and laboratories according to the material equipment of the schools.

	Learning Area
LA 1	Aviation & Aerospace
LA 2	Electrical & Mechatronics
LA 3	Computer Science & Avionics
LA 4	Safety & Operations

The contents of the inter-occupational subjects as well as safety-related, economic or business management and ecological aspects can be developed in line with the learning fields.

Networking between school and practice as a place of learning

Part of the training should be a work placement of at least four weeks in a relevant company. The internship should be supervised by the teachers of the class within the framework of their teaching duties. The organisation and timing of the internship should be at the discretion of the school. The school should also decide on the concrete organisation and other aspects, such as the internship report and its inclusion in the performance assessment. An exchange of experiences between school and company is recommended.

Subject curriculum

The acquisition of the formulated competences is the binding target perspective of learning. The possible contents listed in the individual learning fields represent an exemplary selection. The design of the learning fields is oriented towards the work and production processes in operational reality. They are to be implemented didactically and methodically in such a way

that they lead to vocational competence. The learning situations and the associated contents should be coordinated in corresponding committees to adapt them to the specific structure and profile of the respective school. Appropriate didactic and methodological considerations are to be made and, if necessary, special emphases are to be set. The school therefore can decide independently, within the scope of its possibilities, on the content of the learning fields.

6. Vocational learning area

The starting point for learning and the didactic-methodical design of the learning situations in the individual learning fields are the concrete occupation-specific actions. In the competence descriptions of the individual learning fields, actions are therefore described in all learning fields that are to be planned, carried out, evaluated and, if necessary, improved by the learners themselves in the sense of complete work processes. When planning is mentioned in the competence descriptions, it does not necessarily mean the complete design of systems or system components.

The mathematical and scientific contents of the learning fields are oriented towards occupation specific situations. Teaching in learning fields enables the pupils to acquire mathematical competences that correspond to the requirements for taking up studies at a university of applied sciences.

The learning field components take into account in particular the vocational areas of application in their holistic tasks. Complex tasks make it possible, on the one hand, to use and deepen competences and qualifications that have already been taught in a summarized and project-oriented manner and, on the other hand, to develop additional specific objectives and contents in coordination with company practice.

The practical part of the vocational learning area is given a high priority through this didactic methodical design and is integrated accordingly into the learning fields. The practical phases in the workshops and laboratories of the school are part of the respective learning situation. They are part of the didactic-methodical concept and are developed with the subject teachers in a team.

The subject-related contents of the individual learning fields are only generally named and not listed in a differentiated manner. They do not claim to be complete. Rather, it is a selection from all conceivable learning contents. It is particularly important to link the cross-occupational subject English with all occupational learning areas. In addition to global communication, foreign language skills are necessary to be able to follow future technical developments. The bilingual lessons taught can therefore be additionally assigned to the subject English.

6.1 Learning area 1: Aviation & Aerospace

Learning Area	**Aviation & Aerospace**

Goals:

1. To provide students with a comprehensive understanding of aviation technology, aircraft maintenance, and repair procedures.
2. To develop the necessary professional competencies required for successful employment as an aircraft technician in the aviation and aerospace industries.

Professional competences to be achieved:

- Ability to read and interpret technical manuals and schematics related to aircraft maintenance and repair.
- Proficiency in the use of hand and power tools and equipment required for aircraft maintenance and repair.
- Understanding of aviation regulations and safety protocols.
- Ability to diagnose and troubleshoot mechanical and electrical systems in aircraft.
- Familiarity with various aircraft systems, including hydraulic, pneumatic, electrical, and fuel systems.
- Proficiency in conducting routine maintenance tasks such as engine inspections, oil changes, and tire replacements.
- Ability to work efficiently and safely as part of a team of aircraft maintenance professionals.
- Effective communication skills necessary for collaborating with other maintenance and flight crew personnel.

Modules und possible content:

Module 1: Introduction to Aviation Maintenance and Repair
History of aviation
Aircraft design and construction
Aviation regulations and safety protocols
Aviation maintenance organizations and career paths

Module 2: Tools and Equipment for Aviation Maintenance and Repair
Hand tools and power tools used in aviation maintenance
Safety protocols for tool use and maintenance
Calibration and certification requirements for tools and equipment

Module 3: Aircraft Systems
Aerodynamics and flight mechanics
Aircraft electrical systems
Hydraulic and pneumatic systems
Fuel systems
Landing gear and braking systems

Module 4: Maintenance Procedures

Routine maintenance tasks Inspection procedures Troubleshooting and diagnosis of aircraft systems Repair procedures for various aircraft components Documentation and record keeping Module 5: Professionalism and Safety Safety protocols and procedures Hazard identification and risk management Effective communication and teamwork Customer service and professionalism Module 6: Specializations in Aviation Maintenance and Repair Aircraft avionics Composite repair and fabrication Aircraft painting and refinishing Advanced maintenance procedures and certifications

6.2 Learning area 2: Electrical & Mechatronics

Learning Area	**Electrical & Mechatronics**
Goals: The goal of the Aircraft Technicians training in Electrical & Mechatronics is to equip learners with the necessary knowledge and skills required to maintain, repair and troubleshoot electrical and mechatronic systems in aircraft. The training will enable them to understand and work with various systems such as avionics, power generation, lighting, communication, and navigation systems.	
Professional competences to be achieved: ▪ Understand the principles of electricity, electronics, and mechatronics. ▪ Read and interpret technical drawings and schematics. ▪ Use various testing equipment and tools to diagnose and repair electrical and mechatronic systems. ▪ Conduct routine maintenance and inspections on electrical and mechatronic systems. ▪ Install and replace electrical and mechatronic components/Line Replaceable Units (LRU). ▪ Work safely and efficiently with electrical and mechatronic systems in accordance with industry standards.	
Modules und possible content: Module 1: Basic Electrical and Electronics Theory Introduction to electrical and electronic systems in aircraft Electrical and electronic theory and principles	

Electrical safety and regulations
Electrical and electronic circuits and components

Module 2: Mechatronics and Control Systems
Introduction to mechatronics
Control systems and feedback mechanisms
Actuators and sensors
Electronic control systems and programming

Module 3: Avionics Systems
Introduction to avionics systems
Navigation and communication systems
Flight control systems
Instrumentation and display systems

Module 4: Aircraft Electrical Power Generation and Distribution
Electrical power generation systems
Aircraft electrical power distribution systems
Electrical load management and control
Battery systems and charging

Module 5: Aircraft Lighting Systems
Types of aircraft lighting systems
Electrical and optical principles of aircraft lighting
Installation and maintenance of aircraft lighting systems

Module 6: Aircraft Electrical Maintenance and Inspection
Routine maintenance and inspections of aircraft electrical and mechatronic systems
Troubleshooting and diagnosis of electrical and mechatronic faults
Repair and replacement of electrical and mechatronic components
Electrical and mechatronic system testing and verification

Module 7: Safety and Quality Assurance
Safety standards and procedures for working with aircraft electrical and mechatronic systems
Quality assurance processes and procedures for aircraft maintenance and repair
Documentation and record-keeping for aircraft electrical and mechatronic maintenance and repair

6.3 Learning area 3: Computer Science & Avionics

Learning Area	**Computer Science & Avionics**
Goals: The goal of the Aircraft Technicians training in Computer Science & Avionics is to equip the technicians with the necessary knowledge, skills, and competencies to effectively maintain, repair, and troubleshoot aircraft computer and avionics systems. This training will provide the technicians with the ability to identify, diagnose and resolve issues in avionics systems that use computer-based technologies.	

Professional competences to be achieved:

- Ability to diagnose and troubleshoot avionics systems using computer-based technologies.
- Proficiency in using diagnostic tools and software used in the avionics industry.
- Ability to analyse and interpret technical data related to avionics systems.
- Knowledge of safety regulations and procedures in the avionics industry.
- Knowledge of computer systems and programming languages used in the avionics industry.

Modules und possible content:

Module 1: Fundamentals of Computer Science
Basic principles of computer science
Programming languages and algorithms
Data structures and databases

Module 2: Aircraft Computer Systems
Computer architecture and components
Operating systems and software applications used in avionics
Aircraft data networks and communication protocols
Computer troubleshooting and maintenance

Module 3: Aircraft Communication Systems
Principles of communication systems
Types of communication systems
Aircraft voice and data communication systems
Communication systems troubleshooting and maintenance

Module 4: Avionics Integration and Testing
Avionics system integration
Testing and certification of avionics systems
Safety procedures during testing
Practical exercises in troubleshooting and testing avionics systems

Module 5: Programming for Avionics Systems
Introduction to programming languages used in avionics
Programming techniques for avionics systems
Simulation of avionics systems using software tools
Programming troubleshooting and maintenance

6.4 Learning area 4: Safety & Operations

Learning Area	**Safety & Operations**

Goals:

The goal of this curriculum is to provide comprehensive training to aircraft technicians in safety and operations, covering all aspects of aircraft maintenance, inspection, repair, and troubleshooting. The curriculum aims to equip technicians

with the necessary skills and knowledge to ensure the safety and efficiency of aircraft operations, minimize the risk of accidents, and comply with regulatory requirements.

Professional competences to be achieved:

- Understand the principles of aircraft safety and operations
- Identify potential hazards and risks associated with aircraft maintenance and operations
- Apply best practices in aircraft maintenance, inspection, repair, and troubleshooting
- Interpret technical manuals and schematics to diagnose and solve problems
- Use specialized tools and equipment for aircraft maintenance and repair
- Comply with regulatory requirements and industry standards related to aircraft safety and operations
- Communicate effectively with other members of the aircraft maintenance team and with pilots and other aviation personnel

Modules und possible content:

Module 1: Introduction to Aircraft Safety and Operations
Overview of aircraft safety and operations
Regulatory requirements for aircraft maintenance and operations
Safety management systems and risk assessment
Human factors in aircraft maintenance and operations
Safety reporting and investigation

Module 2: Aircraft Inspection and Maintenance
Types of aircraft inspections and their frequency
Inspection procedures and checklists
Aircraft maintenance programs and schedules
Preventive maintenance and predictive maintenance techniques
Record-keeping and documentation

Module 3: Aircraft Systems and Components
Basic principles of aircraft systems (e. g. hydraulic, pneumatic, electrical, avionics)
Aircraft components and their functions
Troubleshooting techniques for aircraft systems and components
Reading and interpreting technical manuals and schematics

Module 4: Aircraft Repair and Modification
Aircraft repair techniques and procedures
Component removal and installation
Welding and sheet metal repairs
Aircraft modification and upgrade programs
Quality control and assurance

Module 5: Safety in Aircraft Operations
Aircraft ground handling and safety procedures
Fueling procedures and safety

Cabin safety and emergency procedures
Fire safety and firefighting
Weather and environmental factors affecting aircraft safety

Module 6: Communication and Teamwork in Aircraft Maintenance
Effective communication within the aircraft maintenance team
Communication with pilots, air traffic control, and other aviation personnel
Teamwork and collaboration in aircraft maintenance operations
Conflict resolution and problem-solving skills

7. Interdisciplinary learning area

The extent and depth of the possible dovetailing of inter-occupational content with the learning fields, for example in the implementation of projects, depend on the learning situations concretely planned or to be developed in each case. The competences aimed at in the teaching of inter-occupational subjects should serve both the vocational educational goal and the desired study ability. The corresponding lesson plan is contained in the school's internal subject curriculum.

8. Performance and its assessment

The promotion of readiness and ability to perform is of great importance for the individual development of the pupils as well as for society. Achievement is determined and evaluated according to professional and pedagogical principles. Performance assessment is understood as the assessment and documentation of individual learning development and the respective level of achievement. It takes into account both the results and the processes of learning and working at school. Performance assessment serves as feedback for pupils, parents and teachers and is an important basis for planning and designing further lessons as well as counselling and support.

The requirements for performance and assessment should be based on previous lessons and the specifications of this curriculum. The teachers working in the training program should agree on the binding form of performance assessment in the learning fields and subjects.

8.1 Assessment criteria

Performance assessment is understood as a continuous process. To holistically assess the achievements made in connection with the lessons, the pupils should be given the opportunity in class to learn about the corresponding requirements in terms of scope and demands and to prepare for them. In addition to the performance in subject and methodological competence, the status and development of the self-competence and social competence taught in class must also be assessed. This includes such skills and attitudes that are important for independent learning and learning in groups.

Criteria and procedures of performance assessment should be disclosed and explained to the

students at the beginning of each school semester in each subject or course. A pupil's self-assessment or the assessment by fellow pupils should also be included in the assessment process. However, this does not release the teacher from the sole responsibility of assessing individual performance.

8.2 Assessment areas

In performance assessment, a distinction is made between two areas: lesson contributions and class work.

Teaching contributions

Teaching contributions include all performances that relate to participation and contribution in lessons and in the teaching context. They include

- oral performances,
- practical achievements,
- written performances, as far as they are not class tests.

For example, the following can be assessed in detail:

- Contributions in class and group discussions
- Lecture and design
- Contributions to collective work and to project work
- Completing individual and group tasks
- Homework, workbooks
- Practical development of teaching content
- written checks
- Minutes, papers, work reports
- Project presentations
- Media productions

Classwork

Class tests are all written performance assessments in the learning fields or subjects. Their number and duration should be determined by the responsible committees of the school. It must be ensured that in each subject or learning field at least one performance record is provided in the form of a class test per school semester.

Other teaching services

Other teaching achievements are learning achievements that should meet academic criteria

and require a longer period of preparation. This also includes interdisciplinary term papers or subject-specific papers as well as papers developed from possible projects or project-like activities. Possible required performances (products, presentations, colloquia, written papers, etc.) and assessment criteria to be included in the assessment are to be set out in the subject curriculum.

8.3 Grade finding

The grade in the learning fields or subjects is formed from the grades for the lesson contributions and the class tests after subject-related and pedagogical consideration. In the overall assessment, lesson contributions should have a greater weight than class tests.