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VYTAUTO DIDŽIOJO UNIVERSITETAS MCMXXII

CEMIVET

VET CURRICULUM OUTLINE FOR THE MODULES TARGETED TO DEVELOPMENT OF COMPETENCIES RELATED TO CIRCULAR ECONOMY

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REI Reindustria Innovazione

VET CURRICULUM OUTLINE FOR THE MODULES TARGETED TO DEVELOPMENT OF COMPETENCIES RELATED TO CIRCULAR ECONOMY

Referring to the prepared competence profile describing the main competence areas and competence development steps related to sustainable, environment friendly and 'circular' execution of the work processes of welding, it can serve as a basis for VET curriculum design, in particular, for the development of corresponding training modules.
Each competence development step can be regarded as separate training module with the specified learning outcomes-knowledge, skills and attitudes.

1. **Competence area:** Following the design and maintenance of sustainable work process and products.

Competence development steps	**Learning outcomes**		
	Knowledge	**Skills**	**Attitudes**
1.1. To read the drawings and understand the symbols and technological information in order to avoid mistakes and non-conformities.	Principles of technical drawing. Knowledge on the symbols and technological information in the drawings.	To read the technical drawings and schemes of welding. To prepare simple technical drawings and schemes for welding operations.	Attentiveness, attention to details, concentration.
1.2. To clarify the technological requirements and possible practices of sustainable technological work regimes (using of materials,	Knowledge of the consumption of materials and consumables in the welding processes. Knowledge on the	To test the savvy practices, technologies and approaches of preparation of materials for welding, executing welds, surface treatment	Communication skills, analytical and systemic thinking, autonomy and responsibility at the workplace.

applying welding regimes, preparation of materials) with designers and engineers. To discuss possible, from the welder's and his shop's point of view, sustainable resource use practices by arguing one's proposals properly.	environmental impact of procuring and supplying of materials and consumables applied in the welding processes. Knowledge on technological specifications and developments enabling economies and saving of materials and consumables of welding.	and finishing of welds. To formulate technological improvement suggestions on the optimisation of existing operations and processes of materials preparation, welding and finishing of welds.	
1.3. To apply the instructions and suggestions of sustainble usage of materials and consumables in the welding practice.		To adjust own work practices by implementing technological recommendations on the sustainble usage of welding materials and consumables.	Openness to change, patience, attentiveness to details, learning abilities.

2. **Competence area:** Sustainable and circular preparation, maintenance and design of the workplaces in welding

Competence development steps	**Learning outcomes**		
	Knowledge	**Skills**	**Attitudes**
2.1. To keep the workplace tidy (e.g. putting scrap metal in the designated place).	Principles and rules of maintaining the workplace tidy and ready for work.	To prepare the workplace for the work. To clean the workplace after the shift.	Responsibility, attentiveness.
2.2. To verify the parameters of the dust extraction system (the condition of the welding station) and the performance of the welding source (and its changes) by following internal regulations and rules of the enterprise, using control sheets of filtering systems.	Principles of effective functioning of the dust extraction systems. Malfunctions of dust extraction systems. Effective functionning of welding source. Malfunctions of welding source.	To test the parameters of functioning of the dust extraction system. To test the parameters of functioning of the welding source. To identify and repair /adjust the minor deviations and malfunctionings of the dust extraction system and welding source. To report on major deviations and malfunctionings of the dust extraction system and welding source.	Responsibility, decision making skills, attentiveness.

2.3. To sort and dispose the waste at the workplace according to defined waste management procedures and systems (ISO etc.), internal rules of waste management, environmental guides.	Knowledge of the rules and principles of separation and storage of metals used in the production (e.g. ferrous and stainless steels). To apply the knowledge on safe storage and disposal of dangerous chemical materials. Environmental impact and implications of possible contamination of environment with metarials and consumables of welding.	To sort the rests of materials and consumables at the workplace. To dispose the waste produced at the workplace in the safe and environmentally friendly way.	
2.4. To evaluate the rests produced at the workplace and its suitability for further use.	Physical and chemical characteristics of materials used in welding. Principles of measurement.	To evaluate the surface quality of the rest sheet materials. To measure and evaluate the suitability of area and dimensions of the rest sheet materials.	
2.5.To execute and ensure the traceability of the used materials in ensuring economic usage	Principles and rules of traceability of metal sheets in welding operations.	To mark the sheet materials used in welding.	

of the main materials (metal sheets) by moving the remaining materials to the warehouse and using them in further production (when it is a part of work delegated to welder/welding operator).	Marking of sheet metal materials. Usage of information on traceability of materials.	To store the marked sheet materials in order to find easility their location. To register the information on the marked /traced materials.	
2.6. To evaluate the welding position and to apply the possible countermeasures, evaluating the risk of failures or poor welding regimes.	Welding technologies and processes. Reasons of poor performance and non-conformities in welding and their elimination.	To report on the poor wedling performance. To identify the reasons of poor welding performance together with supervisor/tecnician or egnineer. To adjust /imporve the wedling position in order to improve welding performance and to reduce negative environmental impacts.	

3. **Competence area:** Sustainable and circular execution of the technological operations in the field of welding.

Competence development steps	**Learning outcomes**		
	Knowledge	**Skills**	**Attitudes**
3.1. To develop practical skills of welding by using simulator before executing the real operations,	Functioning of welding simulators	To work with welding simulator. To operate test equipment and	Attentiveness, thoroughness, communication skills, ICT skills.

practicing; to use test equipment of the alternative methods, e.g. safety-relevant bolting, tightening torques and bolted connections by hand.	Commands and rules of working with welding simulator. Functions and operating of the test equipment and alternative instruments (safety-relevant bolting, tightening torques and bolted connections).	alternatuive instruments (safety-relevant bolting, tightening torques and bolted connections).	
3.2. To execute quality control of the materials and executed welds: reading and checking the markings of the material to be welded and welding consumables, visual control of the metal sheets and workpieces before the welding in order to spot and remove dirt, slags, rust and other deficiencies potentially having harmful effect on quality and volume of used materials; to execute the self-inspection of weld by using inspection gauges, as	The principles of quality control of materials and executed welds. Quality criteria of welded materials and consumables. Methods of visual control of the surfaces of materials. Methods of inspection of welds by using inspection gauges.	To read and check the markings of wedled materials. To perform visual control of the surface of materials before welding. To remove the identified dirt, slags, rust and other deficiencies of the surface of materials. To inspect the welds by using inspection gauges.	Attentiveness, thoroughness, mathematical literacy.

prevention of non-conformities.			
3.3. To apply savy procedures of the preparation of raw materials for welding permitting to save on the surface treatment operations after welding (metal and sand blasting); to follow the technological requirements and guidelines for selecting and fine-tuning of the composition of welding consumables : shielding gases, welding wire, electrodes etc.; to execute the preparation of the surface and edges of ther workpieces and sheets before welding by using cutters, grinding plates instead of abrasive materials (where possible); to execute the edge preparation in the ways which help to optimize the volume and intensiveness of	Savy procedures of the preparation of raw materials for welding. Technological requirements and guidelines for selecting and fine-tuning of the composition of welding consumables.	To prepare the surface and edges of the workpieces and sheets before welding by using cutters, grinding plates instead of abrasive materials. To prepare the edges of workpieces in the ways which help to optimize the volume and intensiveness of the welding /joining and to minimize the zones of weld area.	Attentiveness, critical thinking, mathematical literacy.

the welding /joining and to minimize the zones of weld area.			
3.4. To follow strictly quality management procedures, requirements of the WPS and welding instructions; visually assess the quality of weld; to evaluate the effect of changing welding parameters on the quality of weld.	Quality management procedures, requirements of the WPS and welding instructions.	To apply quality management procedures, requirements of the WPS and welding instructions. To assess the quality of weld by visual check. To evaluate the effect of changing welding parameters on the quality of weld.	Attentiveness, thoroughness, responsibility.
3.5. To ensure proper quality of cleaning of surface after welding (remaining slags before pickling requires additional pickling operations with negative environmental implications); to follow strictly the requirements of the need of the volume of paint and other surface surface treatment materials by referring to the corrosiveness of the	Quality requirements for the surface of welds. The risks of corrosiveness and other weld surface violations and deficiences. Savvy weld surface treatment techonologies.	The clean the welds surface by applying different technologies and measures (grinding, polishing, pickling, blasting etc.). To protect the welded surfaces by painting, pickling and other technologies. To apply the savvy regimes of consumption of	

environment of product usage.		the consumables and chemical materials used for the cleaning and protection of welded surfaces.	
3.6.To apply higher pace in executing welding operation in seeking to use fewer materials and save emissions (only for highly experienced welders, not compromising the quality).	Welding regimes and technologies: setting of the pace/speeds of welding.	To perform high speed welding operations.	Dexterity, good movement coordination, attentiveness.
3.7. To apply possible changes in the welding process parameters to optimize the welding process; to apply technological solutions of welding regimes that allow for the reduction of subsequent work expenditure on cleaning the connection; while executing welds to keep within the limits of thermal impact defined in the welding procedure; to execute welds in applying savy	Optimization of the welding processes. Savvy welding regimes. Optimization of the cleaning and surface treatment of welds. Application of CNC equipment in the welding area.	To implement the changes in the wedling process parameters. To keep within the limits of thermal impact defined in the welding procedure. To execute welds in applying pulse regime by controlling the thermal input and	Attentiveness, critical thinking, mathematical literacy.

regimes, such as pulse regime helping to control the thermal input and to regulate the volume of energy, using of synergetic regimes of welding which help to control and optimise the energy consumption; to apply submerged-arc welding or combination of welding regimes with submerged arc welding for the welding of high thickness metal sheets, what permits to reduce the number of welding passes; to apply contact welding (point welding) instead of full joint welding, where possible; to use the CNC machines (plasma cutters, lasers) in seeking to limit the harmful impact of welding processes on the operation of other stations (machining in a closed machine space).		to regulating the volume of energy. To apply synergetic regimes of welding which help to control and optimise the energy consumption. To apply submerged-arc welding or combination of welding regimes with submerged arc welding for the welding of high thickness metal sheets. To apply contact welding (point welding) instead of full joint welding, where possible. To use the CNC machines (plasma cutters, lasers) in seeking to limit the harmful impact of welding processes on the operation of other stations.	

4. Competence area: Sustainable and circular organization of work in welding

Competence development steps	**Learning outcomes**		
	Knowledge	**Skills**	**Attitudes**
4.1. To control issuing of the materials and welding consumables for welders by disciplining the welders and signalling / discussing of the cases of excessive consumption of materials and consumables of welding; to organize proper quality control of the metal sheets, to select and use less „contaminating" welding consumables, like, for example, solid welding wires which produce much less emissions that when using „powder" based welding wire.	Methods of control of issuing of welding materials and consumables. Quality control of the metal sheets surface. Environmental qualities and impacts of the welding consumables.	To execute control of the issued materials and welding consumables. To identify and signal the cases of excessive consumption of materials and welding consumables. To organize quality control of the ‚metal sheet, pipes and other materials. To select and use less „contaminating" welding consumables in the welding operations.	Attentiveness, responsibility, analytical and systemic thinking, critical thinking abilities.
4.2. To ensure the proper division of tasks amongst the welders by	Work organization principles in welding.	To divide the working tasks of welders by	Responsibility, analytical and critical thinking,

considering their qualifications and their fit to the quality requirements related to he complexity of welding processes individual workplaces; to ensure the right following of the sequence of welding operations defined by the technological specifications; to plan all the working operations in the holistic way by taking into consideration their interdependencies.	Technological sequencing of welding operations. Hollistic planning of welding operations by taking into consideration their interdependencies.	considering their qualifications and their fit to the quality requirements related to he complexity of welding processes. To ensure the right following of the sequence of welding operations defined by the technological specifications. To plan all the working operations in the holistic way by taking into consideration their interdependencies.	time management skills.
4.3. To define clear goals and clear work plan of welding process; to support transparent and constant cooperation between welding engineers, technologists, experienced welders and welding operators regarding requirements and environmental preferences; to plan the work and control of work by methods and times to avoid unnecessary tasks.	Work planning in the welding processes. Cooperation and communication at the workplace. Environmental standards and requirements of welding work processes.	To define clear goals and clear work plan of welding process. To plan optimally the welding and control operations in order to avoid unnecessary tasks. To support transparent and constant cooperation between welding engineers, technologists, experienced welders and welding	Planning, communication skills and abilities, analytical and critical thinking.

		operators in optimising the welding processes and strengthening their sustainability.	
4.4. To organise the teamworking of welders with different levels of qualifications, including the organisation of work of experience welders and beginners operators; to execute the mentoring of welders by providing suggestions and recommendations on how to apply more sustainable and economic ways of working in executing different welding operations; to exchange practical and theoretical know-how on the sustainable and circular approaches and ways of welding between welders, welding operators and engineering staff; to collect and evaluate the suggestions from the welders on the improvement of sustainability of the welding processes.	Teamworking and work organization in welding. Mentoring of welders and welding operators. Sustainable and savvy welding operations and processes. Analysis of welding processes and operations focused on the sustainable and savvy ways of work.	To organise the teamworking of welders with different levels of qualifications. To execute the mentoring of welders by providing suggestions and recommendations on how to apply more sustainable and economic ways of working. To facilitate exchange of practical and theoretical know-how on the sustainable and circular approaches and ways of welding between welders, welding operators and engineering staff. To collect and evaluate the suggestions from the welders on the improvement of	Communication, cooperation skills, training and mentorship skills and abilities, learning skills and abilities, analytical and critical thinking.

		sustainability of the welding processes.	
4.5. To establish and maintain tense collaboration between production preparation and programming units in the field of sustainable optimisation of the welding processes.	Sustainable and savvy welding operations and processes. Organization of welding processes and operations.	To set-up the agenda and rules of collaboration between production preparation and programming units in the field of sustainable optimisation of the welding processes. To facilitate and support the collaboration between production preparation and programming units.	

5. **Competence area:** Sustainable and circular digitalization of the work processes in the field of welding.

Competence development steps	**Learning outcomes**		
	Knowledge	**Skills**	**Attitudes**
5.1. To apply the automated welding processes (welding robots, CNC laser cutters used in repeatable processes leading to the reduction of defects).	Automated welding technologies.	To use automated welding equipment in seeking to reduce the non-conformities (welding robots, CNC laser cutters).	Responsibility.
5.2. To monitor and mitigate the consumption of the	Norms of consumption of materials and	To monitor and mitigate the consumption of the	Attentiveness, analytical and critical thinking,

materials and energy in operating welding robots at the initial stages of their implementation by seeking to deal with possible increases in this consumption by following and analysing information about the status and progress of the welding process.	consumables in automated and robot welding.	materials and energy in operating welding robots. To follow and analyse the information about the status and progress of the automatised/robotised welding process.	systemic thinking, mathematical and digital literacy.
5.3. To optimise accessibililty and communication of the production data between the welding cobot, operator and design specialist in seeking to reduce the volume of welding seams and to reduce the volume of emissions.	Management of the data of automatised /robotised welding processes.	To set-up transparent and clear procedures of communication of production data between the welding cobot, operator and design specialist. To monitor and adjust the communication of production data between the welding cobot, operator and design specialist.	

6. **Competence area:** Sustainable and circular design of welding processes and products (welding technicians, engineers and designers, EQF 5-7).

Competence development steps	**Learning outcomes**		
	Knowledge	**Skills**	**Attitudes**
6.1. To apply know-how of the welding quality	Welding quality requirements for the	To decide on the sufficiency of	Analytical and systemic thinking,

requirements for the different constructions and products when deciding about sufficiency (not excessive) of these requirements for welding process; to evaluate possibilities to optimise of yield strengths of the steels in the welding process; to minimise the volume of welded joints in the design of products, taking into consideration the volume of waste and it's management options resulting from the design; to optimise the weld joint design.	different constructions and products. Optimisation of yield strengths of the steels in the welding process. Safe minimisation of the volume of joints in weld joint design.	welding quality requirements for welding process by avoiding excessive requirements. To evaluate possibilities to optimise of yield strengths of the steels in the welding process. To minimise the volume of welded joints in the design of products, taking into consideration the volume of waste and it's management options resulting from the design.	critical thinking, creativity / thinking out of the box, data/information management skills, digital literacy.
6.2. To select the most economic and environmently friendly welding processes, regimes and procedures for the each case by taking into consideration technological and product requirements (not compromising quality but avoiding excessive welding regimes, e.g. very often use of submerged arc welding for thick sheets helps to economise on	Caharcteristics and requirements of environmently friendly welding processes, regimes and procedures. Technological requirements of welded products and welding processes. Principles of sellecting welding regimes.	To analyse the characteristics and requirements of welding regimes and their environmental impact. To identify and select the most economic and environmently friendly welding processes, regimes and procedures by avoiding excessive	

the preparatory edge cutting of sheets and to reduce emissions from this process); to control the selection of welding regimes in order to avoid applying excessive regimes in terms of thermal impact.		ones in terms of thermal impact.	
6.3. To combine the theoretical know-how and engineering expertise with the practical (tacit) know-how of welding processes possessed by welders and welding operators, especially when making decisions about optimal technological processes, procedures, regimes and design; to engage in consultations with welders when preparing technical documents and procedures, collecting of their feedback and practical recommendations on the optimisation of welding processes.	Welding technologies and processes. Solution of technological problems of welding at the workplaces. Optimal technological processes in the field of welding.	To identify and codify the tacit knowledge of welding at the workplace. To compare the theoretical knowlegde of welding engineeering with the tacit knowledge of welding processes from the workplaces. To make decisions on optimal welding processes on the basis of both theoretical and tacit (workplace) knowledge. To consult welders when preparing technical documents and procedures, collecting of their feedback and practical	Analytical and systemic thinking, critical thinking, creativity / thinking out of the box, data/information management skills, digital literacy, constructive communication skills.

		recommendations on the optimisation of welding processes.	
6.4. To design clear and transparent order in the field of collecting, sorting and processing of wastes and prevention of emissions of the welding processes; to develop the transparent and clear technical documentation for welding (drawings and technical specifications).	Organisation and standardization of collecting, sorting and processing of wastes and prevention of emissions of the welding processes. Preparation of technical documentation for welding (drawings and technical specifications).	To design clear and transparent order in the field of collecting, sorting and processing of wastes and prevention of emissions of the welding processes. To develop the transparent and clear technical documentation for welding.	Analytical and systemic thinking, critical thinking, creativity / thinking out of the box, data/information management skills, digital literacy.
6.5. To evaluate the possibilities for applying alternative procedures of welding; to consider and foresee partial replacement welding with other technological processes having lower impact on environment (e.g. screwing and riveting), where possible.	Technological requirements and characteristics of welding procedures. Environmental impact of welding procedures. Replacement of welding with other joining technologies.	To identify the possibilities for applying alternative procedures of welding. To consider and foresee partial replacement welding with other technological processes having lower impact on environment.	
6.6. To design the customer-oriented and environmentally friendly welded products, leading to CO_2 savings; to consider the	Environmentaly friendly product design.	To design the customer-oriented and environmentally friendly welded	

increasing of repairability of products in the design process (USP special vehicle construction, vertical range of manufacturing, applying lightweight design and modular construction of products (vehicle units).	Circular economy principles in the product design.	products, leading to CO_2 savings. To develop design solutions leading to increasing repairability of products.	

Assessment of learning outcomes

Assessment of learning outcomes can be performed in the different ways, depending on the concrete situation of the application of the presented outline of curriculum:

1) Competence-based modular assessment, when there are assessed learning outcomes typical for concrete steps of competence development by developing related tasks for self-assessment, summative and formative assessment. Here it is recommended to integrate the assessment of knowledge, skills and attitudes into the tasks oriented to practical performance at the real or imitated workplace.
2) Integration of the indicated learning outcomes in the existing instruments and tasks of assessment by expanding/modifying them.

The assessment criteria should be developed by analysing application of indicated knowledge and skills in the work process and they should refer to the fit of performance to the full range of requirements: technological requirements of the work process, company requirements (e.g., related to work organisation), quality requirements posed by the customers/users, environmental requirements.

Technological requirements of the work process: following and optimisation of the technological specifications and procedures of welding, especially those, which help to limit, reduce or eliminate the negative impact of welding and usage of welded products to the natural environment, climate and depletion of natural resources.

Company requirements (e.g., related to work organisation): following and optimisation of the established order and procedures of work organisation in welding, which enable and promot savvy and more environmentaly friendly execution of welding operations.

Quality requirements posed by the customers/users: satisfying the requirements and expectations of customers realted to functionality of welded products, their usage safety and service life, considering their provided opportunities for optimisatioin of technological processes and work organisation.

Environmental requirements: consideration and following of environment protection requirements in the performance, planning and design of the welding processes.

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