UNIVERSITY OF MISKOLC
FACULTY OF MECHANICAL ENGINEERING AND INFORMATICS

INTERNATIONAL WELDING ENGINEER POSTGRADUATE SPECIALIST TRAINING COURSE

TRAINING PROGRAMME

- DRAFT -

CURRICULUM
SUBJECT ANNOTATIONS
LECTURERS

Miskolc

2022.

University of Miskolc
Faculty of Mechanical Engineering and Informatics
International Welding Engineer Postgraduate Specialist Training Course

2022.11.25.

Subject		*Number of hours per semester (credits)*			*ETF*
code	*name*	*1*	*2*	*3*	
GEMTT401-a	Materials science	23e (5)			-
GEMTT402-a	Welding process I.	38e (7)			-
GEVEE101HS-a	Welding equipment	16e (3)			-
GEMTT403-a	Weldability I.	40e (7)			-
GEMTT404-a	Testing and strength of welded joints I.	28e (5)			-
GEMTT405-a	Welding Practice I.	28t (3)			-
GEMTT406-a	Welding processes II.		31e (6)		-
GEMTT407-a	Weldability II.		42e (8)		-
GEMTT408-a	Testing and strength of welded joints II.		42e (10)		-
GEMTT409-a	Welding practice II.		42t (6)		-
GEVGT608NH-a	Design of welded structures			32e (7)	-
GEMTT410-a	Welding quality management			28e (6)	-
GEMTT411-a	Manufacturing, automation and robotisation			24e (5)	-
GEMTT412-a	Case studies			40t (4)	-
GEMTT413-a	Degree thesis			26t (8)	-
	Exams	5	3	3	
	Term marks	1	1	2	
	Credit	30	30	30	
	Total hours	173	157	150	

e: exam; t: term mark

Final exam subjects:

- Materials and their behaviour during welding
  - Materials Science
  - Weldability I and II
- Welding processes and equipment
  - Welding process I and II
  - Welding equipment
- Construction and design
  - Testing and strength of welded joints I-II
  - Design of welded structures
- Production and quality management
  - Manufacturing, automation and robotization
  - Welding quality management
  - Case studies

Method of evaluation and monitoring:
A minimum attendance of 90% is required for lectures and practical classes. The training requires the completion of a total of 11 exams and 4 term marks, as required by the curriculum. The assessment of the subjects culminating in an exam will be written and/or oral and will be evaluated with a mark of 1 to 5.
The degree thesis is a creative professional (engineering or research) task, corresponding to the specialised qualification, the result of which is written and the solution of which is developed by the student, based on his/her studies, by studying national and international literature, under the guidance of a supervisor and a consultant.

Criteria for passing the final exam:
Meeting the conditions set out in the curriculum, in particular:

- successful completion of the number of exams and term marks set out in the curriculum, and
- a thesis that has been accepted by the reviewer and is ready to be defended.

Parts of the final exam:
The oral examination consists of the subjects set out in the institutional curriculum and the defence of the thesis.
The result of the final examination is the arithmetic mean of the marks awarded by the Final Examination Board to the thesis, as a result of its defence, and the arithmetic mean of the marks awarded to the oral examinations.

Crediting previously acquired knowledge and practice:
Credits obtained in a specialised further training course in welding at another institution may be credited if the content coverage of the course exceeds 80%.
The completion of the practical training may be substituted by the completion of a verifiable qualification in practical training.

Subject Datasheets

(1.) Subject name: **Material Science**	Credit: **5**
Subject category: **mandatory**	
Lesson type: **lecture** / seminar / practice / consultation and hours: **23** Additional (specific) methods and characteristics (if any) to be used in the transfer of the given knowledge: **N/A**	
Requirement (exam / term mark / other): **exam** Additional (specific) methods to be used in the knowledge examination (if any): **N/A**	
Curriculum place of the subject (number of semesters): **1**	
Prerequisites (if any): **N/A**	
Course description: concise and informative description of the knowledge material to be acquired	
Structure and properties of metals with imperfections, furthermore under and after deformation. Structure and properties of pure metals and alloys, focusing on solidification processes, effects of alloying elements and the connection between mechanical properties and microstructure, especially for iron-carbon elements. Determination the fracture type from fracture surface information. Heat treatment of base materials and welded joints, predict the necessity and the expected mechanical property outputs to perform heat treatment after welding.	
A list of the 2-5 most important required or recommended literature (notes, textbooks) with bibliographic data (author, title, publication data, (possibly pages), ISBN)	
1. Callister, W. D.: Materials Science and Engineering, John Wiley & Sons, New York, 2007. ISBN 978-0-471-73696-7, pp. 1-721. 2. Smith, W. F.: Principles of Materials Science and Engineering, McGraw Hill Int. New York, 2006. pp. 1-856. ISBN 0-07-059-169-5 3. Newell, J.: Essentials of Modern Materials Science and Engineering, Wiley, 2009. ISBN 978-0-471-75365-0	
The list of the required professional competences and competence elements (knowledge, ability, etc., KKK point 7) to the development of which the subject typically and substantially contributes	
1. Manage in detail the materials applications and their behaviour due to welding and related technologies in a highly complex context. 2. Act as the responsible person for the definition of the welding personnel tasks. 3. Apply calculations and Failure Assessment Diagrams (FADs) to a fracture case study to determine the condition of the weld and identify the causes. 4. Appraise furnace search data and interpret thermal charts to recommend heat treatment of a welded joint to achieve given requirements.	
Subject responsible (*name, position, scientific degree*): **Dr. Zsuzsanna Simon-Koncsik, PhD, associate professor**	
Involved lecturers (if any) into the subject (*name, position, scientific degree*): **Prof. Dr. János Lukács, full professor, PhD (CSc), welding engineer**	

(2.) Subject name: **Welding processes I.**	Credit: **7**

Subject category: **mandatory**

Lesson type: **lecture** / seminar / practice / consultation and hours: **38**

Additional (specific) methods and characteristics (if any) to be used in the transfer of the given knowledge: **N/A**

Requirement (exam / term mark / other): **exam**

Additional (specific) methods to be used in the knowledge examination (if any): **N/A**

Curriculum place of the subject (number of semesters): **1**

Prerequisites (if any): **N/A**

Course description: concise and informative description of the knowledge material to be acquired

General introduction to welding technology, Definitions, abbreviations. Welding positions, joint designs. History of welding processes. Grouping of welding processes. Fusion welding processes. Oxy-gas Welding and related processes: principles, equipment, welding consumables, applicability. Introduction to gas-shielded arc welding. TIG welding: equipment, consumables, electrodes, arc ignitions, types of currents and polarity, technology, applicability, process variations. MIG/MAG welding: equipment, gas supply, shielding gases, metal transfer modes, technology, applicability, process variants. Flux cored arc welding: consumables, metal transfer modes, technology, applicability. MMA welding: equipment, electrodes, technology, applicability. Submerged-arc welding: equipment, consumables, fluxes, technology, applicability, process variants. Preparation processes: flame cutting, gauging, plasma cutting, laser cutting, waterjet cutting, and others.

A list of the 2-5 most important required or recommended literature (notes, textbooks) with bibliographic data (author, title, publication data, (possibly pages), ISBN)

1. Weman, K.: Welding Processes Handbook, second edition, Elsevier, 2011
2. ASM Metals Handbook Volume 6: Welding, Brazing and Soldering, 1993
3. Little, R. L.: Welding and Welding Technology, McGraw-Hill Companies, ISBN 13-978-0070380950
4. Killing, R.: Welding Processes and Thermal Cutting, DVS – Verlag, ISBN 10-387-1557900
5. Kalpakjian, S.; Schmid, S.: Manufacturing Engineering and Technology, 7th Edition, Pearson, ISBN-10-013-3128741
6. Schultz, H.: Electron Beam Welding, Abington Publishing: Cambridge, UK, 1993
7. Davin, J. P.: Welding Technology, Springer, 2021

The list of the required professional competences and competence elements (knowledge, ability, etc., KKK point 7) to the development of which the subject typically and substantially contributes

1. Highly specialized knowledge (able to deduce, detail, and explain) and critical assessment of the principles of welding and cutting processes and applications.
2. Highly specialized problem-solving skills including critical and original evaluation, allowing to define or develop the best technical and economical solutions when applying welding processes and related technologies, in complex and unpredictable

conditions.
3. Manage in detail the welding processes and cutting applications in a highly complex context.
4. Act as the responsible person for the definition of the welding personnel tasks.
5. Appraise a given welded fabrication case study, analyse its specific application and recommend the MMA/TIG/MIG/MAG/FCAW/SAW welding process variables and application conditions and identify if needed alternative solutions.

Subject responsible (*name, position, scientific degree*): **Dr. Raghawendra P. S. Sisodia, associate professor, PhD, EWE/IWE**

Involved lecturers (if any) into the subject (*name, position, scientific degree*): **Prof. Dr. Gerald Wilhelm, full professor, PhD, EWE/IWE; Dr. Ákos Meilinger, associate professor, PhD, EWE/IWE**

(3.) Subject name: **Welding equipment**	Credit: **3**

Subject category: **mandatory**

Lesson type: lecture / seminar / practice / consultation and hours: **15 + 1**

Additional (specific) methods and characteristics (if any) to be used in the transfer of the given knowledge: **N/A**

Requirement (exam / term mark / other): **exam**

Additional (specific) methods to be used in the knowledge examination (if any): **N/A**

Curriculum place of the subject (number of semesters): **1st**

Prerequisites (if any): **N/A**

Course description: concise and informative description of the knowledge material to be acquired

Basics of electricity and electronics (define current, voltage, resistance, capacity, inductivity). Laws of DC and AC circuit. Magnetism in welding. Transformer (equivalent circuit, open circuit, short circuit, power factor)
Semiconductors (diode, transistor, thyristor). Hazard. Health and safety.
Arc physics (producing an electric arc, the main arc areas, stability of the arc, gas ionization, ionization potentials, arc forces). Voltage distribution across the arc. Heat generation at the cathode and anode. Temperature distribution in the arc and effects. Polarity and arc characteristics in AC and DC and its control for the key welding processes. Influence on the welding process. Influence of the magnetic fields on the arc. Limits of application.
Power source classification, types, and characteristics (static and generators, and each sub-group). Power source electrical characteristics (static and dynamic). Relationship between static characteristic and welding process. Control of the electrical static characteristic (flat and drop). Arc stability for the main processes (MMA, TIG, MIG/MAG, SAW, PAW). The operation working point. Inverter technology (overview, in terms of the most important blocks. Power sources controlled by a CPU. Stability of processes in AC and DC. AC (sine wave and square wave) and DC power sources. Duty cycle of a power source and typical values for the most common arc welding processes.

Voltage losses, relationship between welding current value and cable section. Current and voltage setting (electromagnetic and electronic devices). Standards related with welding power sources and their requirements.
Methods of measurement (electrical parameters, gas flow rate, temperature, velocity). Instruments (types, measuring applications). Temperatures (ISO 13916), humidity, wind. Cooling time $t_{8/5}$. Welding parameters (voltage, current, speed, gas flow rate, etc.). Control in heat treatment (heating and cooling rate, ISO/TR 17663). Calibration and validation of equipment (ISO 17662).

A list of the 2-5 most important required or recommended literature (notes, textbooks) with bibliographic data (author, title, publication data, (possibly pages), ISBN)

1. Hambley, A. R.: Electrical Engineering: Principles and Applications 7th Edition Pearson Ltd. New York 2018; pp. 21-178; 479-657; 718-753 (ISBN-10 0134484142; ISBN-13 978-013448414)
2. Thompson, W. B.: An Introduction to Plasma Physics. 2nd Edition Pergamon Press Ltd. Oxford 2013 (reprint) pp. 1-8; 25-42 (ISBN-10 1483132358; ISBN-13 978-1483132358)
3. Jenney, C. L.; O'Brien, A. (eds): Welding Handbook vol 1 American Welding Society 2001. pp. 51-85, 738-739 (ISBN 0-87171-657-7)
4. O'Brien, A. (ed): Welding Handbook vol 2 American Welding Society 2004. pp. 1-49, 60-68 (ISBN 0-87171-729-8)
5. Phillips, D. H.: Welding Engineering: An Introduction, Wiley 2016; pp. 4-74, 270 (ISBN: 978-1-118-76644-6)

The list of the required professional competences and competence elements (knowledge, ability, etc., KKK point 7) to the development of which the subject typically and substantially contributes

1. Apply advanced understanding regarding basics of electricity in relation to the requirements of welding technology and appreciate the key electronic components used in welding power sources.
2. Apply advanced understanding in detail the fundamentals of an electric arc, its characteristics, limitations, and application in welding, including arc stability problems.
3. Apply advanced understanding regarding the characteristics and main components of arc welding power sources
4. Apply understanding of the requirements for measurement, control and recording during welding and allied operations.
5. Demonstrate advanced knowledge and skills in combining all the functions of electric and electronic components in welding power sources and defining the effect of current, voltage and electrical resistance in welding and understand in detail the influence of magnetism in welding.
6. Demonstrate advanced knowledge and skills in formulating a critical explanation regarding the electric arc characteristics, type of current, and the influence of magnetic fields in electric arc, and proposing solutions for magnetic deflection problems.
7. Demonstrate advanced knowledge and skills in differentiating static and dynamic characteristics for each type of power source and welding process and interpreting the various functions and switches on different power sources.
8. Demonstrate advanced knowledge and skills in measurement, control and recording of essential variables in welding.

9. Review the functions of the most important components of welding power sources applying electricity and electronics principles to welding application Discuss the differences between DC and AC current using specific examples of welding application.
10. Explain the fundamental physics used to define the arc characteristics, e.g., the plasma, temperature profiles, radiation and electrical features as all arc welds contain these aspects.
11. Explain in depth the generation of heat in the arc and the arc voltage distribution.
12. Explain in detail the arc characteristics for DC and AC including control and limitations.
13. Describe in detail each type of welding power source, the specific static and dynamic electrical characteristics, operation point and control of arc stability.
14. Explain in detail the methods of measurement used in the control of welding.
15. Interpret the procedures for the calibration, validation, and monitoring of welding operation.
16. Describe in detail and explain the effect of current, voltage and electrical resistance in welding. Interpret and apply knowledge regarding electricity, electronics, magnetism in welding application and power sources.
17. Evaluate and diagnose arc welding stability problems and give solutions for the problems encountered.
18. Design original and alternative solutions to magnetic deflection problems.
19. Explain each type of arc welding power source for both AC and DC, including the most common devices used. Discuss the meaning of concepts such as: open circuit.
20. Apply working procedures for the correct measurement and control of welding parameters and heat treatments operations.
21. Appraise a given welded fabrication case study, analyzing its specific application and discuss the application of type of current, and the effect of magnetism and the welding process electrical parameters and identify if needed alternative solutions.
22. Influence arc welding implementation with the goal to minimize arc instability factors and arc blow.
23. Appraise the effect of thermionic emission during arc initialization, in addition to the type of magnetic flux being either self-induced or as a residual contribution from the type of substrate used.
24. Choose the most suitable power source for a certain arc welding application and/or environment and implement its correct use.
25. Appraise a given welded fabrication case study, define the requirements for calibration, validation and monitoring of welding operations, manage appropriate methods of measurement, to be applied to achieve the required level of control.

Subject responsible (*name, position, scientific degree*): **Dr. Gábor Kozsely, senior lecturer, PhD, senior lecturer, engineering teacher, EWE/IWE**

Involved lecturers (if any) into the subject (*name, position, scientific degree*): **N/A**

(4.) Subject name: **Weldability I.**	Credit: **7**
Subject category: **mandatory**	
Lesson type: **lecture** / seminar / practice / consultation and hours: **40** Additional (specific) methods and characteristics (if any) to be used in the transfer of the given knowledge: **N/A**	
Requirement (exam / term mark / other): **exam** Additional (specific) methods to be used in the knowledge examination (if any): **N/A**	
Curriculum place of the subject (number of semesters): **1st**	
Prerequisites (if any): **N/A**	
Course description: concise and informative description of the knowledge material to be acquired	
Manufacture and classification of steels: introduction to metallurgy of steels, steel making processes, processing of steel products, chemical composition and impurities, properties of steels, discontinuities and defects, classification of steel (ISO/TR 15608), designation of steels, inspection certificate (i.e. EN 10204). **Behaviour of structural steels in fusion welding:** thermal field, heat input and efficiency of heat input, peak temperature $t_{8/5}$ cooling time, heat-affected zone, carbon equivalent, weld pool and weld shape, dilutions, structure of weld metal, effect of multi-pass welding, solidification of weld pool. **Cracking phenomena in welded joints:** hot cracking, cold cracking and lamellar tearing; causes of crack formation and avoidance possibilities; methods for the determination of preheating temperature. **Weldability of structural (unalloyed) steels:** chemical composition, steel grades, carbon equivalent, welding processes, filler materials, heat-affected zone properties, post-weld heat treatment, applications and standards. Normalized steels. **Weldability of high strength steels:** thermomechanically rolled steels, quenched and tempered steels, grain size reduction, steel processing routes, $t_{8/5}$ conception, HAZ properties, automotive high strength steel sheets (TRIP, TWIP, DP-steels etc.), selection of filler material (mismatch). **Application of structural and high strength steels:** bridges, cranes, buildings, ships, pipelines, pressure vessels, automotive industry, standards. **Creep and creep resistant steels:** creep mechanism, creep sensitivity tests, tempering embrittlement, applicable welding processes, filler materials, welding problems, post-weld heat treatment possibilities, quality assurance, standards. **Steels for cryogenic applications:** requirements for low temperature applications, effect of nickel alloying, applicable welding processes, filler materials, welding problems, applications, quality assurance, standards.	
A list of the 2-5 most important required or recommended literature (notes, textbooks) with bibliographic data (author, title, publication data, (possibly pages), ISBN)	
1. ASM Metals Handbook, Volume 6. Welding, Brazing, Soldering (ISBN 13 978-0871703828) 2. Porter, D. A.; Easterling, K. E.; Abdelraouf Sherif, M, Y.: Phase Transformations in Metals and Alloys (Revised Reprint) 3rd Edition, CRC Press, United Kingdom (ISBN 978-1-4200-6210-6) 3. Lippold, J. C.: Welding Metallurgy and Weldability, Wiley, USA, 2015, (ISBN 978-1-118-23070-1)	
The list of the required professional competences and competence elements (knowledge,	

ability, etc., KKK point 7) to the development of which the subject typically and substantially contributes
1. Manage in detail the materials applications and their behaviour due to welding and related technologies in a highly complex context. 2. Act as the responsible person for the definition of the welding personnel tasks. 3. Appraise a non-complex structural steel joints involving single pass and multi pass welds and recommend the heat input and thermal management required to minimise residual stress and avoid cold-cracking. 4. Appraise a welded joint and recommend the methods that may be applied to determine and control the welding variables to avoid cracking. 5. Have knowledge about the properties, applications and weldability of unalloyed, normalized, high strength, creep resistant and cryogenic steels, furthermore, know the aspects of welding technology design.
Subject responsible (*name, position, scientific degree*): **Dr. Raghawendra P. S. Sisodia, associate professor, PhD, EWE/IWE**
Involved lecturers (if any) into the subject (*name, position, scientific degree*): **Dr. Marcell Gáspár, associate professor, PhD, EWE/IWE; Dr. Ákos Meilinger, associate professor, PhD, EWE/IWE**

(5.) Subject name: **Materials testing and strengths of welded joints I.**	Credit: **5**
Subject category: **mandatory**	
Lesson type: **lecture** / seminar / **practice** / consultation and hours: **22 + 6** Additional (specific) methods and characteristics (if any) to be used in the transfer of the given knowledge: **N/A**	
Requirement (exam / term mark / other): **exam** Additional (specific) methods to be used in the knowledge examination (if any): **N/A**	
Curriculum place of the subject (number of semesters): **1st**	
Prerequisites (if any): **N/A**	
Course description: concise and informative description of the knowledge material to be acquired	
Basic theory of structural systems – Combination and resolution of forces. Equilibrium of forces and torques. Bearings, constraints, and basic types of connections. Equilibrium of structural systems. Statically determinate and indeterminate systems. Stress in structural systems resulting from external actions. Relationship between external loads and internal forces. Calculation and determination of the internal forces and moments of simple statically determinate systems. **Destructive testing of materials and welded joints** – Destructive testing: tensile tests, bend tests, impact tests, hardness tests, fatigue tests, fracture mechanics tests (CTOD, etc.), creep tests, corrosion tests. Chemical analysis, determination of hydrogen content. Metallographic examination of materials and their welded joint: preparation of specimens (grinding, polishing, etching), equipment for preparation (manual, mechanical,	

automatic), microscopes for examination (optical, electron), microscopic and macroscopic examination of welds. Standards for testing.

Fundamentals of the strength of materials – Types of stresses (normal stress, shear stress). Types of deformation (axial strain, shear strain). Stress-strain relationship, yielding theories. Elastic and plastic deformation. Young's modulus, shear modulus, transverse contraction coefficient. Characteristic material properties. Different stresses resulting from internal forces and moments. Different types of section properties. Cross section variables. Calculation of stresses. Limit states of failures: ductile, brittle, fatigue, creep.

Joint design for welding and brazing – Introduction (importance of welding joint design and groove shapes, influence on welding stresses and distortion). Types of welded/brazed joints (ISO 9692, CEN). Importance of weld joint design and groove shapes, types of welded joints, design of welded joints. Classification of groove shapes (by material type, thickness, welding process, accessibility). Tolerance requirements (ISO 13920). Welding symbols on drawings, symbols for groove shapes. Symbolic representation of welded, brazed and soldered joints according to ISO 2553.

A list of the 2-5 most important required or recommended literature (notes, textbooks) with bibliographic data (author, title, publication data, (possibly pages), ISBN)

1. W. D. Callister, Jr.; D. G. Rethwisch: Materials Science and Engineering – AN INTRODUCTION. John Wiley & Sons, Inc., 9th Edition, 2014. p. 990. (ISBN: 978-1-118-32457-8)
2. J. Schijve (Ed.): Fatigue of Structures and Materials. Springer Dordrecht, 2009. p. 623. (ISBN 978-1-4020-6807-2)
3. P. P. Milella: Fatigue and Corrosion in Metals. Springer-Verlag Italia, 2013. p. 853. (ISBN 978-88-470-2335-2)
4. D. A. Scott: Metallography and microstructure of ancient and historic metals. The J. Paul Getty Trust, 1991. p. 185. (ISBN 0-89236-195-6)
5. G. F. Vander Voort: Metallography, principles and practice. ASM International, 1999. p. 773. (ISBN-13: 978-0-87170-672-0)

The list of the required professional competences and competence elements (knowledge, ability, etc., KKK point 7) to the development of which the subject typically and substantially contributes

1. Manage in detail the materials applications and their behaviour due to welding and related technologies in a highly complex context.
2. Recommend special testing to achieve specified quality requirements.
3. Undertake destructive testing tasks in accordance with given schedules.
4. Manage in detail the construction and design of welded products applications in a highly complex context.
5. Appraise, autonomously, a certain welded fabrication case study, analysing it to define the type and size of weld.
6. Produce a drawing to communicate the weld design required to achieve a specified performance.
7. Act as the responsible person for the definition of the welding personnel tasks.

Subject responsible (*name, position, scientific degree*): **Dr. János Lukács, full professor, PhD (CSc), welding engineer**

Involved lecturers (if any) into the subject (*name, position, scientific degree*): **Dr. Károly Jármai, full professor, PhD (CSc), DSc and Dr. Máté Petrik, senior lecturer, PhD, in**

the part of "Basic theory of structural systems"; Dr. Zsuzsanna Simon-Koncsik, associate professor, PhD

(6.) Subject name: **Welding Practice I.**	Credit: **3**
Subject category: **mandatory**	
Lesson type: lecture / seminar / **practice** / consultation and hours: **28** Additional (specific) methods and characteristics (if any) to be used in the transfer of the given knowledge: **N/A**	
Requirement (exam / term mark / other): **term mark** Additional (specific) methods to be used in the knowledge examination (if any): **N/A**	
Curriculum place of the subject (number of semesters): **1st**	
Prerequisites (if any): **N/A**	
Course description: concise and informative description of the knowledge material to be acquired	
Practical exercises of manual fusion welding processes. Practical exercises showing the effect of each main welding parameter on the weld bead shape. Discussion of results to help future evaluation and diagnosis. Exercises cover: MMA, TIG, MIG/MAG, Flux Cored wires, SAW, Oxy-gas. Practical exercises showing the effect of each main cutting parameter on the cut surface. Exercises cover: Oxy-cutting, Arc-Air, Plasma, Arc-Cutting. Welding simulation.	
A list of the 2-5 most important required or recommended literature (notes, textbooks) with bibliographic data (author, title, publication data, (possibly pages), ISBN)	
1. ASM Metals Handbook, Volume 6: Welding, Brazing and Soldering American Society for Metals. Metals Park Ohio, 2010. 2. Little, R. L.: Welding and Welding Technology, McGraw-Hill Companies, ISBN 13-978-0070380950 3. Killing, R.: Welding Processes and Thermal Cutting, DVS - Verlag, ISBN 10-387-1557900	
The list of the required professional competences and competence elements (knowledge, ability, etc., KKK point 7) to the development of which the subject typically and substantially contributes	
1. Know about the practical execution of the fusion welding processes. 2. Capable for the setting of welding equipment. 3. Capable for the evaluation of welding task and the related special application. 4. Appraise a given welded fabrication case study, analyse its specific application and prevent the incorrect weld bead shapes, morphologies and cutting surfaces.	
Subject responsible (*name, position, scientific degree*): **Mariann Zsuzsa Fodorné Cserépi, assistant lecturer, EWE/IWE**	
Involved lecturers (if any) into the subject (*name, position, scientific degree*): **Judit Kovács, PhD student, EWE/IWE; Dr. Raghawendra P. S. Sisodia, associate professor, PhD, EWE/IWE**	

(7.) Subject name: **Welding processes II.**	Credit: **6**

Subject category: **mandatory**

Lesson type: **lecture** / seminar / practice / consultation and hours: **31**

Additional (specific) methods and characteristics (if any) to be used in the transfer of the given knowledge: **N/A**

Requirement (exam / term mark / other): **exam**

Additional (specific) methods to be used in the knowledge examination (if any): **N/A**

Curriculum place of the subject (number of semesters): **2nd**

Prerequisites (if any): **N/A**

Course description: concise and informative description of the knowledge material to be acquired

Pressure welding processes: grouping, general information. Resistance welding: spot-, seam-, projection welding, applicability, Joule effect, equipment, shunt effect, Peltier effect, electrodes, parameters, monitoring. Other welding processes: electro-slag, friction; friction stir, magnetically impelled arc butt (MIAB); magnetic pulse welding, ultrasonic; explosive; diffusion; aluminothermic; high-frequency; stud, cold-pressure welding. technologies, applicability, and properties. Plasma- and Plasma-MIG welding processes. Laser- and electron beam welding processes: equipment, applicability, properties, technology. Surfacing and spraying: principles, applicability, equipment, technology. Brazing and soldering: fundamentals, applicability, equipment, technology. Joining processes for plastics: Hot plate welding, butt fusion, hot gas welding, extrusion welding, induction welding, resistance welding, implant welding, high frequency, friction, electro-fusion welding, ultrasonic welding, vibration welding, adhesive bonding. Joining processes for ceramics and composites.

A list of the 2-5 most important required or recommended literature (notes, textbooks) with bibliographic data (author, title, publication data, (possibly pages), ISBN)

1. Weman, K.: Welding Processes Handbook, second edition, Elsevier, 2011
2. ASM Metals Handbook Volume 6: Welding, Brazing and Soldering, 1993
3. Welding and Welding Technology, Richard L. Little, McGraw-Hill Companies, ISBN 13-978-0070380950
4. Killing, R.: Welding Processes and Thermal Cutting, DVS – Verlag, ISBN 10- 387-1557900
5. Kalpakjian, S.; Schmid, S.: Manufacturing Engineering and Technology, 7th Edition, Pearson, ISBN 10-013-3128741
6. Schultz, H.: Electron Beam Welding, Abington Publishing: Cambridge, UK, 1993
7. Davin, J. P.: Welding Technology, Springer, 2021

The list of the required professional competences and competence elements (knowledge, ability, etc., KKK point 7) to the development of which the subject typically and substantially contributes

1. Highly specialized knowledge (able to deduce, detail, and explain) and critical assessment of the principles of welding, brazing, soldering, and bonding processes and applications.
2. Highly specialized problem-solving skills including critical and original evaluation,

allowing to define or develop the best technical and economical solutions when applying welding processes and related technologies, in complex and unpredictable conditions.
3. Manage in detail the welding, soldering, brazing, and adhesive joining applications in a highly complex context.
4. Act as the responsible person for the definition of the welding personnel tasks.
5. Appraise a given welded fabrication case study, analyse its specific application and recommend the plasma, electron beam, laser, resistance, and other pressure welding processes variables and application conditions and identify if needed alternative solutions.

Subject responsible (*name, position, scientific degree*): **Dr. Ákos Meilinger, associate professor, PhD, EWE/IWE**

Involved lecturers (if any) into the subject (*name, position, scientific degree*): **Dr. Raghawendra P. S. Sisodia, associate professor, PhD, EWE/IWE and Dr. Marcell Gáspár, associate professor, PhD, EWE/IWE**

(8.) Subject name: **Weldability II.**	Credit: **8**

Subject category: **mandatory**

Lesson type: **lecture** / seminar / **practice** / consultation and hours: **40+2**

Additional (specific) methods and characteristics (if any) to be used in the transfer of the given knowledge: **N/A**

Requirement (exam / term mark / other): **exam**

Additional (specific) methods to be used in the knowledge examination (if any): **N/A**

Curriculum place of the subject (number of semesters): **2nd**

Prerequisites (if any): **N/A**

Course description: concise and informative description of the knowledge material to be acquired

Introduction to corrosion: type and appearance of corrosion, fundamentals of electrochemistry, protection possibilities, corrosion testing. **Stainless and heat resistant steels:** binary diagrams, austenite and ferrite formers, Schaeffler diagram, DeLong diagram, measuring of ferrite content, $t_{12/8}$ cooling time, type and welding of stainless steel and heat resistant steels: welding processes, filler material selection, shielding gas, joint preparation, post-weld heat treatment. **Introduction to wear and protective layers:** wear mechanism, wear tests, surface welding, cladding, corrosion and wear resistant layers, coating technologies. **Properties and welding of cast irons and steels:** definition and classification, weldability, applicable welding processes and filler materials, applications and standards. **Weldability of copper and copper alloys:** classification system, physical and mechanical properties, deoxidation, weldability, applicable welding processes, filler materials, shielding gas, standards, quality assurance. **Weldability of nickel and nickel alloys:** classification system, weldability, applicable welding processes and filler materials, welding problems, standards, quality assurance. **Weldability of aluminium and aluminium alloys:** classification system,

weldability, oxide layer cleaning, applicable welding processes, filler material selection, shielding gas, design aspects, joint design and preparation, applications. **Weldability of titanium and other non-ferrous materials:** classification system, titanium alloys, magnesium alloys, tantalum, zirconium, applicable welding processes and filler materials, special problems. **Joining dissimilar materials:** application of Schaeffler, DeLong, WRC diagrams during the preparation of dissimilar joints; selection of welding process; ratio of dilution; buttering; filler materials; intermetallic alloys; service failures; typical applications: austenitic stainless steels, alloyed and low alloyed steels, copper alloys, nickel alloys, aluminium alloys. **Repair welding:** qualification of welding procedure, welding repair plan, NDT examinations, precautions.

A list of the 2-5 most important required or recommended literature (notes, textbooks) with bibliographic data (author, title, publication data, (possibly pages), ISBN)

1. ASM Metals Handbook, Volume 6. Welding, Brazing, Soldering (ISBN 13 978-0871703828)
2. Porter, D. A.; Easterling, K. E.; Abdelraouf Sherif, M, Y.: Phase Transformations in Metals and Alloys (Revised Reprint) 3rd Edition, CRC Press, United Kingdom (ISBN 978-1-4200-6210-6)
3. Lippold, J. C.: Welding Metallurgy and Weldability, Wiley, USA, 2015, (ISBN 978-1-118-23070-1)

The list of the required professional competences and competence elements (knowledge, ability, etc., KKK point 7) to the development of which the subject typically and substantially contributes

1. Manage in detail the materials applications and their behaviour due to welding and related technologies in a highly complex context.
2. Act as the responsible person for the definition of the welding personnel tasks.
3. Appraise a case study and demonstrate which filler metals and process controls are required to prevent embrittlement and solidification cracking of welded stainless and heat resistant steels.
4. Appraise a case study and recommend protective layer solutions to achieve requirements, providing alternatives where appropriate.
5. Appraise a case study and recommend consumable types, preparation methods and thermal management procedures to minimise hardness and prevent cracking for different types of cast iron and cast steel.
6. Appraise a case study and recommend the necessary heat inputs, filler materials and shielding gases to achieve quality requirements in copper and copper alloy for a selection of joining processes.
7. Appraise a case study and recommend the process, consumable type, preparation method and shielding gas to avoid hot cracking and solid-state microcracks in welding of various nickel and nickel alloys, providing alternatives where necessary.
8. Appraise a case study and recommend the process, consumable type, preparation method and shielding gas to avoid hot cracking and solid-state microcracks in welding of various aluminium alloys, providing alternatives where necessary.
9. Appraise a case study and recommend the process and consumable type to achieve weld quality requirements for various applications of titanium and other special metals and alloys.
10. Appraise a case study and recommend the process and consumable type to achieve weld quality requirements for various applications of dissimilar metal welds.
11. Appraise a given weld repair case study, define the procedure and welder

qualification requirements. Monitor the safety requirements applications and predict any impact on weld quality.
Subject responsible (*name, position, scientific degree*): **Dr. Marcell Gáspár, associate professor, PhD, EWE/IWE**
Involved lecturers (if any) into the subject (*name, position, scientific degree*): **Prof. Dr. Gerald Wilhelm, full professor, PhD; EWE/IWE Dr. Zsuzsanna Simon-Koncsik, associate professor, PhD**

(9.) Subject name: **Materials testing and strengths of welded joints II.**	Credit: **10**
Subject category: **mandatory**	
Lesson type: **lecture** / seminar / **practice** / consultation and hours: **32 + 10** Additional (specific) methods and characteristics (if any) to be used in the transfer of the given knowledge: **N/A**	
Requirement (exam / team mark / other): **exam** Additional (specific) methods to be used in the knowledge examination (if any): **N/A**	
Curriculum place of the subject (number of semesters): **2nd**	
Prerequisites (if any): **N/A**	
Course description: concise and informative description of the knowledge material to be acquired	
Basics of weld design – Stresses in butt welds, stresses in fillet welds. Stress concentration, factor-k, SCF elastic, strain concentration factor. Constraint factor. Experimental elasticity: strain gauges, photoelasticity, method Moiré, holography. **Behaviour of welded structures under different types of loading** – Static strength. Elevated temperature strength. Low-temperature strength. Creep resistance. Impact behaviour. Influence of notches and weld defects. Types of failure (ductile fracture, fatigue fracture, brittle fracture, lamellar tearing). Selection of steel quality groups, Z-quality. Typical data for common steels. Use of standards and specifications. Collecting and processing experimental stress/strain data. **Behaviour of welded structures under cyclic loading** – Types and variables of cyclic loading, stress distribution, stress collective. Statistical stress analysis on real structures. S-N diagram, Palmgren-Miner rule. Fatigue strength (low cycle, and others). Effect of mean stress including residual stresses. Effect of stress range. Influence of notches. Influence of weld imperfections. Fatigue improvement technique (needle peening, TIG dressing, burr grinding, hammering, stress relieving, etc.). Standards. **Design of aluminium alloys structures** – Comparison of design between steel and aluminium structures. Standard alloys for practical use and relevant stresses and strains. Significance of defects. **Introduction to fracture mechanics** – Viewpoint of fracture mechanics. Application of fracture mechanics. Linear elastic fracture mechanics (LEFM). Fundamentals of elastic-plastic fracture mechanics (EPFM). Critical flaw size, K_{Ic}-value. Fracture mechanics	

testing (CTOD, etc.). Different assessment method. Sub-critical crack growth. Standards.
Residual stresses and distortions – Influencing factors. Thermal data of the materials. Origin of the residual stresses and deformation. Relationship between the material at a certain temperature and its mechanical characteristics. Magnitude of longitudinal and transverse shrinkage stresses. Distribution of the residual stresses at weld (parallel to the weld axis, perpendicular, and through thickness, influence of the material thickness). Relationship between heat input, shrinkage stresses and distortion. Methods of residual stress measurement. Welding sequence techniques. Effects of residual stresses on the behaviour of the structure in service. Methods of reducing residual stresses or distortion. Examples to prevent and control of distortion. Weld straightening, correction and removal of welding deformation (pressing, rolling, local heating, etc.).
Reinforcing-steel welded joints – Reinforcing-steel types, properties. Direct and indirect loading. Types of joints used (lap, cruciform). Calculation. Weldability with respect to weld joint strength. Preheating in respect to bar diameter. Application of welding processes. Standards and specifications (ISO 17660 series).
Non-Destructive Testing – Fundamentals of NDT methods (visual, dye penetrant, magnetic particle, eddy current, acoustic emission, radiography, digital RT, ultrasonic, etc.). Field of application and imitations. Design in respect of NDT. Calibration. Interpretation (IIW radiographic reference). Recording of data. Correct selection of the NDT methods versus application (e.g. CEN/TR15135). Qualification and certification of NDT personnel (EN ISO 9712). NDT procedures. Automation of NDT (computer aided evaluation, etc.). Use of standards and specifications. Health and safety aspects. Review of documents and protocols from NDT test sites.

A list of the 2-5 most important required or recommended literature (notes, textbooks) with bibliographic data (author, title, publication data, (possibly pages), ISBN)

1. J. Schijve (Ed.): Fatigue of Structures and Materials. Springer Dordrecht, 2009. p. 623. (ISBN 978-1-4020-6807-2)
2. P. P. Milella: Fatigue and Corrosion in Metals. Springer-Verlag Italia, 2013. p. 853. (ISBN 978-88-470-2335-2)
3. N. S. Trahair, M. A. Bradford, D. A. Nethercot, L. Gardner: The Behaviour and Design of Steel Structures to EC3. Taylor & Francis, 4th Edition, 2008. p. 513. (ISBN10: 0-415-41865-8)
4. C. J. Hellier: Handbook of Nondestructive Evaluation. McGraw Hill, 2nd Edition, 2012. p. 720. (ISBN13: 978-0071777148)
5. API Recommended Practice 577: Welding Processes, Inspection, and Metallurgy. 3rd Edition, October 2020.
6. WELDER'S Visual Inspection HANDBOOK. May 2013. https://supplier.huntingtoningalls.com/sourcing/docs/NNS_Technical_Documents/Welders_Visual_Inspection_Handbook-2013_WEB.pdf

The list of the required professional competences and competence elements (knowledge, ability, etc., KKK point 7) to the development of which the subject typically and substantially contributes

1. Manage in detail the construction and design of welded products applications in a highly complex context.
2. Appraise, with full autonomy, a certain welded metallic structure fabrication case study, analysing it, and justifying the methods to be applied to improve its fatigue performance
3. Appraise, with full autonomy, if needed alternative solutions for a certain welded

fabrication case study, giving information.
4. Appraise, with full autonomy, a certain welded fabrication case study, using the fracture mechanics principles to evaluate the weld joints performance and to determine the tests that are needed for evaluation.
5. Appraise autonomously a given welded fabrication case study, by determining the magnitude of residual stress and distortion, and propose solutions to achieve the required level of weld quality and geometrical tolerances.
6. Appraise a given reinforcing steel fabrication case study, define the type of joint and appropriate welding process. Determine the joint length, and the preheat required.
7. Appraise a given welded fabrication case study, determine the NDT requirements, define the appropriate method(s) and relevant safety requirements.
8. Define weld design and/or fabrication sequencing to support inspection and monitor the reports.
9. Act as the responsible person for the definition of the welding personnel tasks.

Subject responsible (*name, position, scientific degree*): **Dr. János Lukács, full professor, PhD (CSc), welding engineer**

Involved lecturers (if any) into the subject (*name, position, scientific degree*): **Dr. Zsuzsanna Simon-Koncsik, associate professor, PhD**

(10.) Subject name: **Welding practice II.**	Credit: **6**

Subject category: **mandatory**

Lesson type: lecture / seminar / **practice** / consultation and hours: **42**

Additional (specific) methods and characteristics (if any) to be used in the transfer of the given knowledge: **N/A**

Requirement (exam / term mark / other): **term mark**

Additional (specific) methods to be used in the knowledge examination (if any): **N/A**

Curriculum place of the subject (number of semesters): **2nd**

Prerequisites (if any): **N/A**

Course description: concise and informative description of the knowledge material to be acquired

Practical exercises of manual fusion welding processes by the application of special setting possibilities of the equipment: Other welding and allied processes: Gouging, Brazing, Plasma welding, Plasma cutting, Submerged-arc Welding, Resistance Welding, Friction Welding, Electron Beam Welding, Laser Beam Welding.

A list of the 2-5 most important required or recommended literature (notes, textbooks) with bibliographic data (author, title, publication data, (possibly pages), ISBN)

1. ASM Metals Handbook, Volume 6: Welding, Brazing and Soldering American Society for Metals. Metals Park Ohio, 2010.
2. Weman, K.: Welding Processes Handbook, ISBN 0857095102
3. Welding handbook – Welding and cutting Science and Technology, Miami FL 33166,

The list of the required professional competences and competence elements (knowledge, ability, etc., KKK point 7) to the development of which the subject typically and substantially contributes
1. Know the welding processes and their application. 2. Know about the practical execution of fusion and pressure welding processes. 3. Capable for the setting of welding equipment.
Subject responsible (*name, position, scientific degree*): **Mariann Zsuzsa Fodorné Cserépi, assistant lecturer, EWE/IWE**
Involved lecturers (if any) into the subject (*name, position, scientific degree*): **Judit Kovács, PhD student, EWE/IWE; Dr. Raghawendra P. S. Sisodia, associate professor, PhD, EWE/IWE**

(11.) Subject name: **Design of welded structures**	Credit: **7**
Subject category: **mandatory**	
Lesson type: **lecture** / seminar / practice / consultation and hours: **32** Additional (specific) methods and characteristics (if any) to be used in the transfer of the given knowledge: **N/A**	
Requirement (exam / term mark / other): **exam** Additional (specific) methods to be used in the knowledge examination (if any): **N/A**	
Curriculum place of the subject (number of semesters): **3rd**	
Prerequisites (if any): **N/A**	
Course description: concise and informative description of the knowledge material to be acquired	
Steel structures, including lightweight structures: materials, sections, types of structures (braces, nodes, columns, beams, frames, trusses), design and dimensioning for static and dynamic loads. Structural elements (cables, bars, beams, plates, slabs, shells). Theory of forces. Combination and resolution of forces. Equilibrium of forces and torques. Bearings, constraints and basic types of connections. Equilibrium of structural systems. Statically determinate and indeterminate systems. Stress in structural systems resulting from external actions. Relationship between external loads and internal forces. Calculation and determination of the internal forces and moments of simple statically determinate systems. Types of stresses in welded joints (nominal stress, hot spot stress, notch stress). Stresses in butt welds, stresses in fillet welds. Calculation of cross section variables of welded joints. Determination of nominal stresses in single welded joints. Worked examples of calculation of nominal stresses in welded joints. Principal stresses, nominal/normal stress, shear stress, Mohr circle. Static strength. Strength at high temperatures. Stability calculation, Standards and design specifications. The use of different types of welds in relation to joint types. Optimum design: load carrying capacity, manufacturability, economy. Examples of structural layout and design. Welded I-sections and box sections; thin-walled bars; stiffened plates; tubular lattice girders; frame structures; design considerations for cranes, tanks, silos,	

bunkers, machinery structures, and vehicles.
Types and variables of cyclic loading. Fatigue curves (Eurocode3, International Institute of Welding, CIDECT recommendations) fatigue classes, their application to simple welded joints.
Application of fatigue repair techniques with post-weld treatment (edge grinding, hammering, ultrasonic impact, needle peening, HFMI, TIG treatment, etc.). Application: bridges, cranes, machinery, ships and offshore structures, chimneys, towers, vehicles, etc. Dimensioning according to different standards and specifications. Numerical examples.
Construction design of pressure vessels, boilers, pressure vessels, pipelines, etc. High and low temperature applications. Calculation of welds. Design details (flanges, nozzles, shells, expansion plates, etc.). Legislation and design codes, application of standards and specifications. Construction and design examples. Standards (ISO, CEN and national standards).
Design of welded structures made of aluminium and aluminium alloys. Lightweight structural design, applications.

A list of the 2-5 most important required or recommended literature (notes, textbooks) with bibliographic data (author, title, publication data, (possibly pages), ISBN)

1. Farkas,J.; Jármai, K.: Analysis and optimum design of metal structures, Balkema Publishers, Rotterdam, Brookfield, 1997, 347 p. ISBN 9789054106692/90 5410 669 7.
2. Farkas,J.; Jármai, K.: Economic design of metal structures, Millpress Science Publisher, Rotterdam, 2003. 340 p. ISBN 90 77017 99 2
3. Farkas,J.; Jármai, K.: Design and optimization of metal structures, Horwood Publishers, Chichester, UK, 2008. 328 p. ISBN: 978-1-904275-29-9
4. Recommendations: Recommendations on fatigue of welded components of the IIW, XIII-1823-07, 149 p. 2008.
5. P. J. Haagensen and S. J. Maddox: IIW Recommendations on Post Weld Improvement of Steel and Aluminium Structures, XIII-2200r3-07, 47 p.

The list of the required professional competences and competence elements (knowledge, ability, etc., KKK point 7) to the development of which the subject typically and substantially contributes

1. Manage in detail the construction and design of welded products applications in a highly complex context. Act as the responsible person for the definition of the welding personnel tasks.
2. Appraise, with full autonomy, a certain welded fabrication case study, analysing it, defining or checking if the materials that will be used in the fabrication are according to the requirements.
3. Appraise, with full autonomy, if needed alternative solutions for a certain welded fabrication case study, giving information
4. Appraise, with full autonomy, a certain case study of welded metallic structure fabrication, analysing it and calculating the weld geometries and relevant weld stresses
5. Appraise, with full autonomy, a certain welded metallic structure fabrication case study, analysing it, and justifying the methods to be applied to improve its fatigue performance.
6. Appraise, with full autonomy, a certain case study of welded metallic structure fabrication, analysing it and designing weld joints, justifying the output against the

minimum design criteria.
7. Appraise, with full autonomy, a certain pressure vessel fabrication case study, analysing it and designing weld joints, justifying the output against the minimum design criteria.

Subject responsible (*name, position, scientific degree*): **Dr. Károly Jármai, full professor, PhD (CSc), DSc**

Involved lecturers (if any) into the subject (*name, position, scientific degree*): **Dr. Máté Petrik, senior lecturer, PhD**

(12.) Subject name: **Manufacturing, automation and robotization**	Credit: **5**

Subject category: **mandatory**

Lesson type: **lecture** / seminar / practice / consultation and hours: **24**

Additional (specific) methods and characteristics (if any) to be used in the transfer of the given knowledge: **N/A**

Requirement (exam / term mark / other): **exam**

Additional (specific) methods to be used in the knowledge examination (if any): **N/A**

Curriculum place of the subject (number of semesters): **3rd**

Prerequisites (if any): **N/A**

Course description: concise and informative description of the knowledge material to be acquired

Survey of welding mechanisation for higher productivity. Robotics, mechanisation, and automation: differences, advantages disadvantages and applications. Robotics (on-line and off-line programming, simulation, flexible manufacturing systems), CAD/CAM systems. Virtual factory (factory simulation). Seam tracking, types and typical applications. Gas nozzle sensor, arc sensing, magnetic induction, vision system. Narrow gap welding (SAW, MIG/MAG, TIG). Orbital welding (MIG/MAG, TIG). Additive manufacturing (3D printing). Typical robot type depending upon application field. Application, typical problems. Plant facilities, welding jigs and fixtures. Layout of production line. Operational environment. Auxiliary equipment. Health and safety. Hazards, risk assessment, protection, standards. Economics and Productivity. Analysis of welding costs. Deposition rate. Costs of labour, welding consumables, equipment, energy. Return on investment. Calculation of welding costs. Cost awareness (of labour, consumables, equipment, gases, energy, etc.).

A list of the 2-5 most important required or recommended literature (notes, textbooks) with bibliographic data (author, title, publication data, (possibly pages), ISBN)

1. Weman, K.: Welding Processes Handbook, second edition, Elsevier, 2011
2. Blomsjo, G.: Welding robots, Springer, 2005, NJÖHHIKB
3. Timing, R.: Fabrication and welding engineering, Taylor and Francis, 2008

The list of the required professional competences and competence elements (knowledge, ability, etc., KKK point 7) to the development of which the subject typically and

substantially contributes
1. Apply highly specialized understanding in detail the principles and industrial application of welding mechanization and the use of robotics in welding, including application and systems. 2. Appraise a given welded fabrication case study, analyze its specific application and justify mechanized or automation or robotic application solution and identify if needed alternative solutions. 3. Highly specialized problem-solving skills, including critical evaluation, allowing to define or develop the best technical and economical solutions for quality assurance and quality control of welded products in complex and unpredictable conditions. 4. Apply advanced understanding of the need for, and function of, auxiliary equipment, jigs and fixtures from the viewpoint of quality, economics and the environment. 5. Apply understanding of the health and safety hazards associated with welding and fabrication processes, including techniques to minimize them. 6. Apply understanding of the economics of welding operations applied to welded fabrications.
Subject responsible (*name, position, scientific degree*): **Dr. Ákos Meilinger, associate professor, PhD, EWE/IWE**
Involved lecturers (if any) into the subject (*name, position, scientific degree*): **Dr. Marcell Gáspár, associate professor, PhD, EWE/IWE.**

(13.) Subject name: **Quality management of welding**	Credit: **6**
Subject category: **mandatory**	
Lesson type: **lecture** / seminar / **practice** / consultation and hours: **24+4** Additional (specific) methods and characteristics (if any) to be used in the transfer of the given knowledge: **N/A**	
Requirement (exam / team mark / other): **exam** Additional (specific) methods to be used in the knowledge examination (if any): **N/A**	
Curriculum place of the subject (number of semesters): **3rd**	
Prerequisites (if any): **N/A**	
Course description: concise and informative description of the knowledge material to be acquired	
Introduction to quality assurance in welded fabrication: conception of quality assurance and quality control, weldability, testing inspection plan, audit, personnel and equipment, maintenance, inspection, responsibilities according EN ISO 14731, EN ISO 9000, EN ISO 3834, EN ISO 10005, software applications. **Quality control during manufacture:** quality requirements of brazed and welded constructions, welding sequence, welding coordination, welding procedure specifications – WPS (EN ISO 15607 and 15609), qualification of the welding technology – WPQR (EN ISO 15610, 15611, 15612, 15613, 15614), brazer and welder qualification (EN ISO 9606), operator qualification, traceability. **Imperfections and acceptance criteria:** EN ISO 6520, EN ISO 5817, EN ISO 10042, EN ISO 13919, EN ISO 9013, EN ISO 17635, significance of	

imperfections, introduction to ISO/TR 15235, engineering critical assessment techniques.
A list of the 2-5 most important required or recommended literature (notes, textbooks) with bibliographic data (author, title, publication data, (possibly pages), ISBN)
1. ASM Metals Handbook, Volume 6. Welding, Brazing, Soldering (ISBN 13 978-0871703828) 2. Burgess, N.: Quality Assurance of Welded Construction, 2nd Edition, CRC press 1989 (ISBN 9780367884222) 3. Phillips, D. A.: Welding Engineering – An introduction, Wiley, 2016 (111876644X)
The list of the required professional competences and competence elements (knowledge, ability, etc., KKK point 7) to the development of which the subject typically and substantially contributes
1. Manage and transform the welding applications concerning the quality assurance and quality control of welded products in a highly complex context. 2. Act as the full responsible person for the definition of the welding and related personnel's tasks. 3. Appraise a given welded fabrication case study, analyse its specific quality requirements. 4. Formulate a quality assurance solution, identifying alternatives where appropriate. 5. Create a quality audit plan and undertake a case study audit of a pre-defined welding fabrication identifying shortfalls and non-conformities. 6. Appraise a given welded fabrication case study, define its specific requirements, and create a WPS, identifying alternatives where appropriate. 7. Appraise a given welded fabrication case study, evaluate the WPS and welder/welding 8. operator documents against relevant standards and modify to demonstrate full compliance with requirements. 9. Appraise a given welded fabrication case study, define appropriate acceptance criteria, monitor the results and make the fitness for service decision.
Subject responsible (*name, position, scientific degree*): **Dr. Marcell Gáspár, associate professor, PhD, EWE/IWE**
Involved lecturers (if any) into the subject (*name, position, scientific degree*): **Dr. Ákos Meilinger, associate professor, PhD, EWE/IWE**

(14.) Subject name: **Case studies**	Credit: **4**
Subject category: **mandatory**	
Lesson type: **lecture** / seminar / practice / consultation and hours: **40** Additional (specific) methods and characteristics (if any) to be used in the transfer of the given knowledge: **N/A**	
Requirement (exam / term mark / other): **term mark** Additional (specific) methods to be used in the knowledge examination (if any): **N/A**	
Curriculum place of the subject (number of semesters): **3rd**	

Prerequisites (if any): **N/A**
Course description: concise and informative description of the knowledge material to be acquired
Case studies involving industry professionals: steel and light structures, boilers and pressure vessels, chemical plants and pipelines, shipbuilding and marine applications, transport (automotive, railways), aerospace and aeronautics. The case studies cover standards and other specifications, material selection and filler material selection, welding technology, field welding and assembly, joint preparation and tolerances, post-treatment and non-destructive testing. Visual inspection of damaged welded joints: filler inspection and filler surface analysis.
A list of the 2-5 most important required or recommended literature (notes, textbooks) with bibliographic data (author, title, publication data, (possibly pages), ISBN)
1. ASM Metals Handbook, Volume 6. Welding, Brazing, Soldering (ISBN 13 978-0871703828) 2. Lippold, J. C.: Welding Metallurgy and Weldability, Wiley, USA, 2015, (ISBN 978-1-118-23070-1) 3. Little, R. L.: Welding and Welding Technology, McGraw-Hill Companies, ISBN 13-978-0070380950
The list of the required professional competences and competence elements (knowledge, ability, etc., KKK point 7) to the development of which the subject typically and substantially contributes
1. Ability to comprehensively evaluate welding tasks from a manufacturing perspective. 2. Has full responsibility for welding related tasks.
Subject responsible (name, position, scientific degree): **Dr. Marcell Gáspár, associate professor, PhD, EWE/IWE**
Involved lecturers (if any) into the subject (name, position, scientific degree): **Dr. Ákos Meilinger, associate professor, PhD, EWE/IWE**

(15.) Subject name: **Degree thesis**	Credit: **8**
Subject category: **mandatory**	
Lesson type: lecture / seminar / **practice** / consultation and hours: **26** Additional (specific) methods and characteristics (if any) to be used in the transfer of the given knowledge: **N/A**	
Requirement (exam / term mark / other): **term mark** Additional (specific) methods to be used in the knowledge examination (if any): **N/A**	
Curriculum place of the subject (number of semesters): **3rd**	
Prerequisites (if any): **N/A**	
Course description: concise and informative description of the knowledge material to be	

acquired

Comprehensive application of the learning acquired during the training. Development of a thesis work assigned to the student in accordance with the prescribed formal requirements, with the assistance of a thesis supervisor and a consultant.

A list of the 2-5 most important required or recommended literature (notes, textbooks) with bibliographic data (author, title, publication data, (possibly pages), ISBN)

1. ASM Metals Handbook, Volume 6. Welding, Brazing, Soldering (ISBN 13 978-0871703828)
2. Lippold, J. C.: Welding Metallurgy and Weldability, Wiley, USA, 2015, (ISBN 978-1-118-23070-1)
3. Little, R. L.: Welding and Welding Technology, McGraw-Hill Companies, ISBN 13-978-0070380950

The list of the required professional competences and competence elements (knowledge, ability, etc., KKK point 7) to the development of which the subject typically and substantially contributes

1. Ability to comprehensively evaluate welding tasks from a manufacturing perspective.
2. Has full responsibility for welding related tasks.
3. Ability to solve problems encountered in welding.
4. Able to develop welding technology depending on the properties and loading of the welded structure, its stresses and the requirements of the fabrication.

Subject responsible (*name, position, scientific degree*): **Dr. Ákos Meilinger, associate professor, PhD, EWE/IWE**

Involved lecturers (if any) into the subject (*name, position, scientific degree*): **Dr. Marcell Gáspár, associate professor, PhD, EWE/IWE**

International Welding Engineer Postgraduate Specialist Training Course Lecturers

Faculty of Mechanical Engineering and Information Technology, Institute of Materials Science and Materials Technology:

Mariann Zsuzsa Fodorné Cserépi assistant lecturer, EWE/IWE
Dr. Marcell Gáspár, associate professor, PhD, EWE/IWE
Prof. Dr. János Lukács, full professor, PhD (CSc), welding engineer
Dr. Ákos Meilinger, associate professor, PhD, EWE/IWE
Judit Kovács, PhD student, EWE/IWE
Dr. Raghawendra P. S. Sisodia, associate professor, PhD, EWE/IWE
Dr. Zsuzsanna Simon-Koncsik, associate professor, PhD

Curriculum vitae and list of publications available:

http://geik.uni-miskolc.hu/intezetek/ATI/staff.en.php

Faculty of Mechanical Engineering and Information Technology, Physics and Electronic Engineering:

Dr. Gábor Kozsely, senior lecturer, EWE/IWE, engineering teacher

Curriculum vitae and list of publications available:

http://geik.uni-miskolc.hu/intezetek/FEI/staff.en.php

Faculty of Mechanical Engineering and Information Technology, Institute of Energy Engineering and Chemical Machinery:

Prof. Dr. Károly Jármai, full professor, PhD (CSc), DSc
Dr. Máté Petrik, senior lecturer, PhD

Curriculum vitae and list of publications available:

http://geik.uni-miskolc.hu/intezetek/EVG/staff.php