Óbuda University Bánki Donát Faculty of Mechanical and Safety Engineering			**Institute of Mechanical Engineering and Technology** **Department of Materials Technology**
Lecture name and Neptun code: Material Science BAXAT11EMNF **Credits: 4** **Course type:** Full-time **Period:** 2024/25 1st semester			
Master course: Mechanical Engineering			
Lecturer:	Prof. Dr. Mihály Réger, full professor Prof. Dr. Maria Berkes Maros, full professor	**Practice:** Prof. Dr. Mihály Réger, full professor Prof. Dr. Maria Berkes Maros, full professor	
Number of sessions/week/term: Weekly	Lecture: 2	Practice: 2	
Exam/ course assignment: Exam		**Language:** English	

Course objective

Goal of the course: Reviewing selected chapters of materials science that support the acquisition of welding technology skills, learning about the structural changes in materials that occur during the most common welding processes of steel and other alloys, and understanding the related metallurgical background.

Thematics: Classification of materials based on their structure at the different – from atomic to macroscopic – length scales. Thermodynamic interpretation of equilibrium and non-equilibrium phase transformation processes in metallic materials with an overview of crystallisation, microstructure evolution, and mechanical properties of ferrous alloys. Materials science aspects of soldering/brazing and welding with attention to the characteristic technological processes applied materials, physical, chemical, and metallurgical processes, equilibrium diagrams and phase transformation. Structural changes and their consequences on the operational performance of the soldered/brazed and welded joints in traditional and advanced metallic materials. Failure analyses of brazed welded joints under different loading conditions (static, dynamic loading, corrosion, fatigue, irradiation, etc.).

	Subjects	
Weeks	**Lectures**	**Practicals**
1	The concept and scope of materials science. Classification and evolution of materials. Characteristics of basic materials. Factors determining the properties of materials	Description of the semester requirements and the mid-termr assignments
2	Types of materials and their structure, bonding forces, alloys, allotropy, diffusion, equilibria and thermodynamic interpretation of equilibrium, non-equilibrium processes I	Repetition – Ferrous alloys I. Crystallisation, structure, mechanical properties. Equilibrium γ-α transfor-mations in Fe-C alloys
3	Theoretical foundations, types of materials and their structure, bonding forces, alloys, allotropy, diffusion, equilibria and thermodynamic interpretation of equilibrium, non-equilibrium processes II.	Repetition – Ferrous alloys II. Non-equilibrium transfor-mations in Fe-C alloys
4	Soldering and its materials, typical phase diagrams, wetting, conventional and lead-free soldering materials.	Analyses of the typical defects and failure modes in soldered joints
5	Welding. Procedures, heat sources, physical, chemical and metallurgical processes of welding	Repetition: Complex analysis of the microstructure and the involved transformations of steels and cast irons
6	Weldable structural steels, characteristics of the base materials, peritectic reaction. Effects and changes due to the thermal process during welding.	Analysis of the microstructure and the involved phase transformations of welded joints in different steels

7	Corrosion-resistant steels, interpretation of phase and microstructure diagrams, segregation processes, structural changes caused by the welding heat process I.	First written test
8	Corrosion-resistant steels, interpretation of phase and microstructure diagrams, segregation processes, structural changes caused by the welding heat process II.	Elaboration of the individual mind-term assignments
9	Welding of Al alloys.	Submission of the Word doc. format mid-term assignments into the Moodle system
10	Welding of AHSS steels.	Evaluation and joint discussion of the personal work submitted in Word format
11	Failure of engineering structures: fracture mechanics	Analysis of typical brittle and ductile fracture surfaces, fractography
12	Failure of engineering structures: low- and high-cycle fatigue	Second written test
13	Failure of engineering structures: corrosion, wear, irradiation and degradation due to other reasons.	Mid-term assignment report of students (ppt presentation)
14	Overview of the semester work, repetition of failed tests	Making up the missed practical lessons

Semester week	**Tests, assignments**
7.	First written test (during the time of the practical lesson)
9.	Submission of the Word doc. mid-term assignment into the Moodle system
10.	PowerPoint presentation of the mid-term assignment
12.	Second written test (during the time of practical lesson)
14.	Repeated tests (outside of class time)

Course assessments:

A condition for obtaining a signature:

- Attendance of lectures and tutorials according to the TVSZ;
- Completion of two 50 minutes mid-term tests of at least satisfactory (min. 50%) level each during the semester (getting 2×50 points out of max. 2×100 points);
- Completion of the two-stage mid-term assignment at a satisfactory (min. 50%) during the term:
    - writing an essay in Word format (min. 35 out of max. of 70 points);
    - PowerPoint presentation (min. 35 out of 70 points).

Mid-term assignment: Critical evaluation of the materials science aspects of a given professional literature on welding. The deadline is according to the semester schedule of the practicals. Criteria for working out the assignments are described in the guide "Content and format requirements for the mid-term assignment", which can be downloaded from Moodle.

Marking of the written tests and mid-term assignments in the percentage of the maximum achievable points: 0-49%=1 (fail); 50-59%=2 (pass); 60-69%=3 (satisfactory); 70-79%= 4 (good); 80-100%= 5 (excellent).

The teaching materials, learning aids, and descriptions of the semester assignments are available as downloadable electronic materials in the Moodle system. The assignments to be submitted must also be uploaded here.

The examination must be taken in oral form during the examination period. Getting the signature is a prerequisite for taking an exam.

The method of the replacements:

- Failed tests can be made up in the form of a repetition tests once during the semester.

- Failed mid-term assignments can be made up until the end of the semester.
- Signatures can be made up in the first two weeks of the exam-period.

Compulsory literature

1. Tisza M.: **Physical Metallurgy**, ASM International Publisher, Ohio Park, USA, 2001.
2. Callister, *W. D.: **Materials Science and Engineering, an introduction**, 7th Ed. John Wiley, New York, 1994, pp1-975. ISBN:13-978-0-471-73696-7, https://abmpk.files.wordpress.com/2014/02/book_material-science-callister.pdf*
3. Porter, D. A., Easterling, K.E. **Phase Transformation in Metals and Alloys**, Chapman & Hall, 1981, ISBN 0 412 45030 5, *http://dl.iranidata.com/book/daneshgahi/D.%20A.%20Porter,%20K.%20E.%20Easterling%20(auth.)-Phase%20Transformations%20in%20Metals%20and%20Alloys(www.iranidata.com).pdf*
4. **ASM Handbook Volume 6: Welding, Brazing, and Soldering**, ASM International, 1993. https://metallurgynmaterials.files.wordpress.com/2014/03/vol-6-weldingbrazing-and-soldering.pdf

Suggested literature

5. R. W. Hertzberg, R. P. Vinci, J. L. Hertzberg: **Deformation and Fracture Mechanics of Engineering Materials**, 5th edition, John Wiley & Sons. 2012, Hoboken, USA ISBN 978-0-470-52780-1.
6. Tisza M.: Development **of Lightweight Steels for Automotive Applications, DOI: 10.5772/intechopen.91024** https://www.intechopen.com/books/engineering-steels-and-high-entropy-alloys/development-of-lightweight-steels-for-automotive-applications
7. Porter, D. A., Easterling, K. E., Sherif, M. Y.: **Phase Transformation in Metals and Alloys,** 4th edition, CRC Press 2022, ISBN-13 978-0367430344, p556.
8. Ashby, M.F, Jones, D.R.H.: E**ngineering Materials 1-An introduction to Microstructures, Processing and Design** 3rd ed., Elsevier Butterwoth-Heinemann, Oxford, 2006. ISBN 0 7506 63804
9. Ashby, M.F, Jones, D.R.H.: **Engineering Materials 2-An introduction to properties, Applications and Design**, 3rd ed., Elsevier Butterworth-Heinemann, Oxford, 2006. ISBN-13: 978-0-7506-6381-6

Quality assurance methods of the subject:

The standard of theoretical and practical education is annually overviewed at an institution's conference based on the feedback of the teachers and students. They assess the success of the subject and make suggestions for necessary changes to maintain the interaction between theory and practical training.

Budapest, 2024.06.01.

Prof. Dr. Mihány Réger
and
Prof. Dr. Maria Berkes Maros
Subject Leaders
Lecturers