COURSE SYLLABUS AND COURSE REQUIREMENTS
ACADEMIC YEAR 2025/2026 SEMESTER AUTUMN

Course title	*Materials Science*
Course Code	MSB021ANEP
Hours/Week: le/pr/lab	200
Credits	2
Degree Programme	Civil Engineering BSc
Study Mode	Full-time schedule
Requirements	Mid-semester grade
Teaching Period	1. semester
Prerequisites	-
Department(s)	Civil Engineering Department
Course Director	Dr Anita Dolgosné Kovács
Teaching Staff	Dr Adél Len

COURSE DESCRIPTION

The course provides fundamental knowledge about the structure of materials across atomic, mesoscopic, and macroscopic levels. It introduces destructive and non-destructive methods for characterising materials and covers the most important construction materials, including concrete, steel, plastics, glass, stone, and wood. Topics build up from the smallest material units to full-scale applications, with emphasis on composition, mechanical behaviour, and performance in construction contexts. Several novel and sustainable materials will also be discussed, along with practical testing approaches and real-world engineering relevance. The course connects material science principles with current developments and future challenges in civil engineering.

SYLLABUS

1. GOALS AND OBJECTIVES

By the end of the course, students will:

- Understand the chemical composition, structure, and physical–mechanical properties of major construction materials such as concrete, steel, glass, plastics, wood, and stone.
- Gain familiarity with classical and modern techniques used to study material structure and performance, including destructive and non-destructive testing methods.
- Develop awareness of novel and sustainable materials emerging in civil engineering, including composites, foamed polymers, advanced coatings, and bio-based solutions.
- Be able to critically read, interpret, and discuss scientific literature related to materials science.
- Acquire skills in oral presentation and visual communication by preparing and presenting a construction material topic based on individual or group research.
-

2. COURSE CONTENT

	TOPICS
LECTURE	1. *Introduction to Materials Science. From subatomic particles to atoms. Atomic structure. Bonding fundamentals in materials* 2. *Periodic table. Elements. Compounds. Mixtures* 3. *Chemical bonding. Phases of matter. Amorphous and crystalline structure* 4. *Real crystals. Lattice types. Crystallographic defects* 5. *Mechanical properties of materials (Stress-strain behaviour, ductility, hardness, elastic and plastic deformation; comparison across metals, polymers, ceramics)* 6. *Construction materials I: Traditional materials (Cement-based materials, bricks, wood, stone, steel; Composition, structure, uses)* 7. *Construction materials II: Modern and sustainable materials (Plastics, insulating materials, coatings, pigments, self-cleaning and solar-control technologies)*

8. *Testing methods for materials properties (destructive, semi-destructive, non-destructive techniques)*
9. *Material characterization techniques (microscopy, diffusion tests, indicator-based testing, carbonation of concrete, chloride ion penetration, corrosion risk)*

DETAILED SYLLABUS AND COURSE SCHEDULE

LECTURE

week	**Topic**	**Compulsory reading; page number (from … to …)**	**Required tasks (assignments, tests, etc.)**	**Completion date, due date**
1.	Course description. Orientation. Explanation of students' tasks. **Introduction to Materials Science** From subatomic particles to atoms; atomic structure and bonding fundamentals in materials. **Elements, Compounds, and Mixtures** Periodic table, types of elements, common compounds and mixtures in construction materials. **States of Matter and Structural Types** Chemical bonding; phases of matter; amorphous and crystalline structures; comparison of structural types.	[1.] page 1-59	Choice of the individual task according to the orientation given in the class.	Choice of the task by the 5th week class.
5.	**Crystallographic Structure and Defects** Real crystals, lattice types, point and line defects; dislocations and their role in deformation. **Mechanical Properties of Materials** Stress–strain behaviour, ductility, hardness, fracture, elastic and plastic deformation; comparison across metals, polymers, ceramics.	[1.] pages 104-125, 152-172	Work on the individual task.	
9.	**Construction Materials I: Traditional Materials** Cement-based materials (concrete, mortar), bricks, asphalt, wood, stone, glass; composition, structure, uses.	[1] 173-204 [2.] pages 139-141, 155-156, 168-170	Work on the individual task.	
11.	**Construction Materials I: Traditional Materials** Steel; phase diagram **Construction Materials II: Modern and Sustainable Materials** Plastics (thermoplastics, thermosets, foams), insulating materials, coatings, pigments, self-cleaning and solar-control technologies.	[2.] pages 121-132, 207-216 [.] pages 4-28, 56-57, 61-63, 67-68, 100-101, 112-116, 129-132, 137 [3.] - website	Upload the ppt presentation to the Microsoft Teams group.	Completion of the task by the end of the 13th week.

	Testing Methods for Material Properties Destructive tests (compressive strength, slump test); non-destructive and semi-destructive techniques (ultrasound, GPR, Schmidt hammer, IR thermography). **Material Characterisation Techniques** Carbonation of concrete, chloride ion penetration, corrosion risk, pH, electrochemical measurements, microscopy (SEM), diffusion tests, indicator-based testing			
14.	Students presentations		Multiple choice test in Neptun.	

3. ASSESSMENT AND EVALUATION

ATTENDANCE

*In accordance with the Code of Studies and Examinations of the University of Pécs, Article 45 (2) and Annex 9. (Article 3) a student may be refused a grade or qualification in the given full-time course if the number of class absences exceeds **30% of the contact hours** stipulated in the course description.*

In case of illness, it is necessary to present a medical certificate. In case of absence, the student makes up for the missed class material.

Method for monitoring attendance *(e.g.: attendance sheet / online test/ register, etc.)*

Attendance sheet

ASSESSMENT

Type	Assessment	Ratio in the final grade
Kahoot tests during the classes	*100 (min. 40 points need to be reached)*	*30 %*
Students presentations	*100 (min. 40 points need to be reached)*	*40%*
Multiple choice test	*100 (min. 40 points need to be reached)*	*30 %*

Opportunity and procedure for re-takes (PTE TVSz 47§(4))

Unsuccessful presentations and failed multiple choice tests can be repeated once in the first week of the examination period. Kahoot tests are part of the classes, therefore they cannot be repeated.

Grade calculation as a percentage

based on the aggregate performance according to the following table

Course grade	Performance in %
excellent (5)	85 % …
good (4)	70 % ... 85 %
satisfactory (3)	55 % ... 70 %
pass (2)	40 % ... 55 %
fail (1)	below 40 %

The lower limit given at each grade belongs to that grade.

4. SPECIFIED LITERATURE

In order of relevance. (In Neptun ES: Instruction/Subject/Subject details/Syllabus/Literature)

COMPULSORY READING AND AVAILABILITY

[1.] James F. Shackelford, 2015, *Introduction to materials science for engineers*, Pearson Higher Education Inc., Upper Saddle River https://industri.fatek.unpatti.ac.id/wp-content/uploads/2019/03/060-Introduction-to-Materials-Science-for-Engineers-James-F.-Shackelford-Edisi-8-2015.pdf

[2.] Ash Ahmed, John Sturges, 2015, *Materials Science in Construction: An Introduction*, Routledge Taylor and Francis Group, London and New York https://www.slideshare.net/slideshow/materials-science-in-construction-an-introduction-1st-edition-ahmed/277790288#6

[3.] IAEA: 2019, *Guidebook on Non-Destructive Testing of Concrete Structures,* International Atomic Energy Agency, Vienna https://www-pub.iaea.org/MTCD/Publications/PDF/TCS-17_web.pdf?utm_source=chatgpt.com

[4.] *What is the difference between non destructive testing & destructive testing?* online article, published on 24-Mar-2023, https://www.onestopndt.com/ndt-articles/what-is-the-difference-between-ndt-destructive-testing

RECOMMENDED LITERATURE AND AVAILABILITY

[5.] A. Mukherjee, Deepmala, P. Srivastava et al., *Application of smart materials in civil engineering: A review*, Materials Today: Proceedings, Volume 81, Part 2, 2023, Pages 350-359 https://doi.org/10.1016/j.matpr.2021.03.304

[6.] A. Tabrizikahou, M. Kuczma, P. Nowotarski, M. Kwiatek, M, A. Javanmardi, *Sustainability of Civil Structures through the Application of Smart Materials: A Review*, Materials 2021, 14, 4824. https://doi.org/10.3390/ma14174824

[7.] William D. Callister Jr., 2007, *Material Science and Engineering*, John Wiley and Sons Inc., New York

[8.] U.S. Department of Energy, 1993, *DOE FUNDAMENTALS HANDBOOK, Material Science*, Vol.1, US Department of Energy, Washington DC

[9.] J. W. Morris Jr., 2007, *A Survey of Materials Science*, Department of Material Science and Engineering, Berkley

[10.] Slides of the lectures – uploaded to Microsoft Teams group