Introduction to Strength of Materials - BMEEOTMAT42

I. Subject Specification

1. Basic Data

1.1 Title

Introduction to Strength of Materials

1.2 Code

BMEEOTMAT42

1.3 Type

Module with associated contact hours

1.4 Contact hours

Type	Hours/week / (days)
Seminar	5

1.5 Evaluation

Midterm grade

1.6 Credits

6

1.7 Coordinator

name	Dr. Kovács Flórián
academic rank	Associate professor
email	kovacs.florian@emk.bme.hu

1.8 Department

Department of Structural Mechanics

1.9 Website

https://epito.bme.hu/BMEEOTMAT42
https://fiek2.mywire.org/course/view.php?id=452

1.10 Language of instruction

hungarian and english

1.11 Curriculum requirements

Compulsory in the Civil Engineering (BSc) programme

1.12 Prerequisites

Strong prerequisites:

- Basics of Statics and Dynamics (BMEEOTMAT41)

Weak prerequisites:

- Mathematics A1a - Calculus (BMETE90AX00)

1.13 Effective date

2 February 2022

2. Objectives and learning outcomes

2.1 Objectives

The aim of the subject is to introduce the fundamental concepts of strength of materials, the concepts of loads, stresses, strains, and displacements, as well as the relationships between them using which the basic problems, sizing, and checks can be carried out. Particular emphasis is made on the calculation of stresses and strains due to simple and complex internal forces of bars and beams. The presented methods enable the solution of certain statically indeterminate problems.

2.2 Learning outcomes

Upon successful completion of this subject, the student:

A. Knowledge

1. knows the concepts of loads, stresses, strains, and displacements,
2. knows the concept of a bar and a bar element,
3. knows the geometric quantities characterizing the cross-section of a beam, and the calculation methods,
4. knows the linearly elastic and the linearly elastic and perfectly plastic material models,
5. knows the internal forces arising in cross-sections of a beam, the resulting stresses, and the formulas for the calculation,
6. knows the deformations of cross-sections of a beam, the relationships to the internal forces and the strains in individual points,
7. knows how temperature affects the strains,
8. knows the stresses acting on an elementary cube and the concept of stress state,
9. clearly understands the dependance of stresses on direction, the concepts of principal stresses and principal directions,
10. knows the deformations of the elementary cube, the concept of strain state,
11. clearly understands the dependance of strains on direction, the concepts of principal strains and principal directions,

B. Skills

1. calculates the stresses and strains in bars under tension-compression, solves the sizing and checking problems,
2. calculates the stresses and strains arising from pure shearing, solves the sizing and checking problems,
3. calculates the stresses and strains arising from torsion for simple cross-sections, solves the basic sizing and checking problems,
4. calculates the stresses and strains arising from uniaxial bending, solves the sizing and checking problems,
5. recognizes the biaxial bending and calculates the associated stresses and strains, solves the sizing and checking problems,
6. calculates the stresses arising from shearing coupled with simultaneous bending,
7. calculates the stresses in cross-sections subjected to eccentric tension-compression in the cases of linearly elastic material and no-tension material,
8. determines the principal stresses and principal directions in any material point of a cross-section,

C. Attitudes

1. aims at accurate and flawless problem solving,
2. elaborates the solution such that it is clear to understand or possibly to continue,

D. Autonomy and Responsibility

1. is prepared to recognize and correct errors,

2.3 Methods

Lectures and calculation practices based on the electronically distributed workbook, solving home works and practice problems in individual or team work.

2.4 Course outline

Week	**Topics of lectures and/or exercise classes**
1.	Internal force diagrams (repetition). Introduction: the subject matter of strength of materials, fundamental concepts, the linearly elastic material model
2.	The concept of a beam and beam element, its internal forces and deformations. The concept of centric tensioncompression, basic equations, introductory numerical examples, calculation of deformations: homogeneous and inhomogeneous beams, the effect of temperature change
3.	The concept of pure shearing, screws, rivets, basic examples. Checking of simple connections for centric tensioncompression and pure shearing
4.	Torsion of cross-sections with rotational symmetry, the concept of polar moment of inertia, calculation of deformations. Torsion of thin-walled open and closed cross-sections, rectangular cross-sections, examples
5.	Calculation of stresses arising from torsion, examples.
6.	Basic equations of uniaxial bending, the concept of moments of inertia. The fundamentals of calculation of inertia, examples
7.	Uniaxial bending, calculation of normal stresses and deformations. Uniaxial bending of inhomogeneous cross-sections, calculation of normal stresses and deformations
8.	Simple problems for the calculation of displacements in the cases of cantilever beams and simply supported beams. Biaxial bending. Eccentric tension-compression: fundamental relationships for the calculation of stresses,

	the concept of neutral axis
9.	The concept of Cullmann's kernel. Cross-section with no-tension material, calculation of stresses in structures (column, wall)
10.	The reciprocity of shear stresses. Bending and shearing: Zhuravskii's theory, introductory examples
11.	Calculation of stresses in beams with solid cross-sections under simultaneous bending and shearing. Simultaneous bending and shearing of thin-walled cross-sections, the concept of shear centre
12.	Calculation of internal forces in characteristic cross-sections of spatial bar structures, examples. The concept of principal stresses and principal directions, introductory examples. Bending and shearing, complex internal forces
13.	Bending, tension, shearing, torsion, numerical examples. Determination of principal stresses and principal directions
14.	Determination of principal stresses and principal directions in points of beams, examples. Stress states of points of beams.

The above programme is tentative and subject to changes due to calendar variations and other reasons specific to the actual semester. Consult the effective detailed course schedule of the course on the subject website.

2.5 Study materials

Books:

- Kaliszky S., Kurutzné Kovács M., Szilágyi Gy.: Szilárdságtan, 2000;
- Beer, Johnston: Mechanics of materials;
- Budynas: Advanced Strength and Applied Stress Analysis;
- Popov: Mechanics of materials;
- Gere – Goodno: Mechanics of Materials. Cengage Learning, 2015

2.6 Other information

Students attending checks must not communicate with others during the check without explicit permission, and must not hold any electronic or other communication device switched on.

2.7 Consultation

The instructors are available for consultation during their office hours, as advertised on the department website. Special appointments can be requested via e-mail: kovacs.florian@epito.bme.hu.

This Subject Datasheet is valid for:

2023/2024 semester I

II. Subject requirements

Assessment and evaluation of the learning outcomes

3.1 General rules

- Evaluation of learning outcomes described in Section 2.2. is based on three mid-term written checks.
- The duration of each mid-term test is 90 minutes.
- Mid-term tests below 50% are regarded unsuccessful.
- The dates of the checks can be found in the "Detailed semester schedule" on the website of the subject.

3.2 Assessment methods

Evaluation form	Abbrev.	Assessed learning outcomes
1st mid-term test (summarizing check)	ZH1	A.1-A.7; B.1-B.3; C.1-C.2; D.1
2nd mid-term test (summarizing check)	ZH2	A.1-A.7; B.4-B.5; C.1-C.2; D.1
3rd mid-term test (summarizing check)	ZH3	A.1-A.11; B.1-B.8; C.1-C.2; D.1

The dates of deadlines of assignments/homework can be found in the detailed course schedule on the subject's website.

3.3 Evaluation system

Abbreviation	Score
ZH1	33.3%
ZH2	33.3%
ZH3	33.4%
Sum	**100%**

3.4 Requirements and validity of signature

There is no signature from the subject.

3.5 Grading system

- In the case of complying with the requirements on attendance the results are determined as follows.
- The semester is accomplished successfully if all mid-term tests are accomplished successfully. the final result is computed by the weighted average A of the mid-term tests as in section 3.3.:

Grade	Points (P)
excellent (5)	80%≤A
good (4)	70%≤A<80%

satisfactory (3)	60%≤A<70%
passed (2)	50%≤A<60%
failed (1)	A<50%

3.6 Retake and repeat

- Each of the mid-semester tests can be retaken only once at dates announced at the beginning of the semester.
- In the case of each test, the better one of the results of the ordinary test and its retake is considered.
- At the end of the semester, a second retake is available to the students if only one of the tests has no successful result at that time (i.e. two tests are successful after the first retakes).
- The second retake covers the whole semester, the result of the second retake replaces that of the remaining unsuccessful test.

3.7 Estimated workload

Activity	**Hours/semester**
contact lessons	35×2=70
preparation for lessons during the semester + home works	35×1=35
preparation for the checks	3×15=45
study of the assigned written sources	30
Sum	**180**

3.8 Effective date

2 February 2022

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2023/2024 semester I