Tadeusz Kosciuszko Cracow University of Technology

Course Card

Faculty of Civil Engineering

Field of study: Civil Engineering

Study profile: general academic

Study form: full-time

Field of study code: BUD

Study cycle: 1st

Specialty: no specialty

1 COURSE INFORMATION

Course name	Wytrzymałość materiałów
Course name in English	Strength of Materials
Course code	WIL BUD oIS C25 24/25
Course category	Basic
No. of ECTS points	10.00
Semester	3 and 4

2 CLASS TYPE, NUMBER OF HOURS ACCORDING TO THE STUDY PLAN

Semester	Lecture	Class exercise	Laboratory	Computer lab	Design exercise	Seminar
3	30	0	0	0	30	0
4	30	15	15	0	0	0

3 COURSE OBJECTIVES

Objective 1 To familiarize the students with basic notions, definitions and theorems of the statics of plane bar statically determinate structures.

Objective 2 To familiarize the students with fundamentals of mechanics of continua and boundary problems as theoretical basis to analyze simple and complex cases of strength of materials in order to learn design rules for cross- sections in limit states of bearing capacity and usability.

Objective 3 To familiarize the students with working of beam elements in nonlinear range to establish material reserves in the case of the work in the elastic-plastic range.

Objective 4 To familiarize the students with the stability problem of straight bars (without imperfections) along with the simple analyses of effective design of such bars.

Objective 5 To draw students' attention to the importance of understanding of theoretical and experimental results and the ability to interpret them in order to avoid the error of uncritical confidence in standards and numerical results preparing them for performing scientific work

4 PREREQUISITES IN TERMS OF KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1 Credit for 1st year of mathematics and 1st semester of theoretical mechanics

5 LEARNING OUTCOMES

LO1 Knowledge Student has ordered and theoretically founded knowledge in the scope of statics of bar structures statically determined.

LO2 Skills Student can draw the cross-section forces diagrams for beams, arches, trusses and combined structures.

LO3 Knowledge Student has knowledge of simple and composed cases of building elements and uses it to design structural elements in the limit states of strength and usability.

LO4 Skills Student can identify the working case and design cross-section in simple stress state as well as in complex stress state.

LO5 Skills Student has the basic knowledge of non-elastic behavior of simple beam elements and analyses limit bearing capacity in elastic and plastic range.

LO6 Knowledge Student has sufficient knowledge of the stability problem of straight bars, its importance in design and can analyze simple engineering cases.

LO7 Skills Student has basic knowledge of recent trends in the subject matter of the strength of materials.

LO8 Knowledge Student can formulate tasks and independtly or in group work on them.

6 COURSE CONTENT

Laboratory		
No.	Subject matter of the course Detailed description of thematic blocks	No. of class hours
L1	Importance of experiments in Strength of Materials.	2
L2	Introduction to the strain gauges: mechanical and electric.	2
L3	Quasi-static tensile strength test of metal samples. Elastic and non-elastic behaviour of material during tension. Mechanisms of failure.	4

Laboratory		
No.	Subject matter of the course Detailed description of thematic blocks	No. of class hours
L4	Verification of the equations of linear theory of elasticity through determination of elastic modulus from elongation and deflection measurement.	2
L5	Photoelastic analysis of structures. Photoelastic and strain gauges analysis of the stress in beams and shields.	3
L6	Stress state analysis in curved bars and its verification by strain gauges experiments.	2

Class exercise		
No.	Subject matter of the course Detailed description of thematic blocks	No. of class hours
C1	Geometric characteristics of cross-section.	2
C2	Torsion of bars with circular, rectangular and thin-walled cross-section.	2
C3	Simple and biaxial bending.	3
C4	Eccentric tension, cross-section core.	2
C5	Transversal bending.	2
C6	Limit analysis of beams in elastic-plastic range.	2
C7	Analysis of structure in complex stress states.	2

Design exercise		
No.	Subject matter of the course Detailed description of thematic blocks	No. of class hours
P1	Classification of structures, loadings and constraints. Geometric rigidity.	2
P2	Determination of constraints reactions.	2
P3	Determination of cross-sectioon forces in simple beams.	2
P4	Determination of cross-sectioon forces in not single span beams.	2
P5	Determination of cross-sectioon forces in continuous beams.	2
P6	Determination of cross-sectioon forces in slanted beams.	2
P7	Determination of cross-sectioon forces in frames.	2
P8	Determination of cross-sectioon forces in circular and parabolic arches.	2

Design exercise		
No.	Subject matter of the course Detailed description of thematic blocks	No. of class hours
P9	Determination of cross-sectioon forces in trusses.	2
P10	Determination of cross-sectioon forces in combined structures.	2
P11	Stress state analysis. Static boundary conditions. Shields.	2
P12	Strain state analysis. Kinematic boundary conditions.	2
P13	Constitutive equations of elastic continua.	2
P14	Torsion of bars with circular, rectangular and thin-walled cross-section.	2
P15	Completion and reserve.	2

Lecture		
No.	Subject matter of the course Detailed description of thematic blocks	No. of class hours
L1	Introduction to the subject of Strength of Materials (SM). Basic notions and assumptions. Internal and cross-sectional forces.	4
L2	Cross-section forces in plane bar structures. Static calculations for simple and continuous beams, frames, circular and parabolic arches. Forces in trusses.	10
L3	Theory of stress state - basic definitions and notions. Stress matrix and its transformation at coordinate set rotation. Principal stresses. Equations of equilibrium (Navier's) in material point. Static boundary conditions.	5
L4	Theory of strains state and displacements of material point. Strain matrix and displacements vector. Geometric equations (Cauchy's). Kinematic boundary conditions.	3
L5	Constitutive equations for linearly elastic material (Hooke's). Stiffness and compliance matrices. Boundary problem formulation in linear theory of elasticity.	3
L6	Geometric characteristics of cross-section - static and inertia moments. Matrix of inertia and its transformation due to coordinate set rotation and translation (Steiner's theorems). Principal, central axes and inertia moments.	2
L7	Boundary problem formulation for twisted straight bars. Torsion of bars with circular and rectangular cross-section. Approximate analysis of torsion of thin-walled profiles.	4
L8	Analysis of simple and composed cases (tensions, simple bending, biaxial bending, eccentric tension, transversal bending).	12
L9	Determination of beams' deflections using differential equation and Mohr's analogy.	4

Lecture		
No.	Subject matter of the course Detailed description of thematic blocks	No. of class hours
L10	Analysis of axially compressed struts strength - Euler's problem. Cross-section design. Design of steel members.	5
L11	Non-elastic behavior of elastic-plastic materials. Limit elastic and plastic bearing capacity of the cross-section and the bar structure (kinematic method).	4
L12	Elastic energy of continua and its determination for bar member (Maxwell-Mohr's formula). Effect hypotheses for structure elements (Galileo, Coulomb, Tresca-Guest, Huber-Mises-Hencky and Mohr hypotheses).	4

7 TEACHING TOOLS

N1 Lectures

N2 Exercises

N3 Laboratories

N4 Design classes

N5 Office hours

8 Student workload

Activity form	Number of hours of activity
Hours realized in contact with the teacher	
Hours resulting from the study plan	120
Consultation hours	15
Exams and tests during session	5
Hours of autonomous student work	
Preparing for classes, studying literature	60
Developing results	10
Preparing of reports, projects presentations, discussion	80
Total number of hours devoted to the subject	**290**
Total number of ECTS points	10.00

9 Methods of grading

Partial grades

F1 Test

F2 Individual project

F3 Laboratory exercise report

F4 Final test

Summary grade

P1 Weighted average of forming grades

Conditions for passing the course

L1 Active participation in lectures and classes - presence will be verified and taken into consideration

L2 Design projects approved on time

L3 Positive grade from the design tests

L4 Positive grade from the final test

Assessment of activity without teacher participation

B1 Individual project