STRENGTH OF MATERIALS II

Course code: **06.4-WILŚ- BUD- WM2- IB07**

Type of course: compulsory

Entry requirements: strength of materials I, fundamentals of mathematical analysis, concepts and principles of general mechanics

Language of instruction: Polish

Director of studies: prof. dr hab. inż. Mieczysław Kuczma
Department of Structural Mechanics

Name of lecturer: prof. dr hab. inż. Mieczysław Kuczma
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Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					5
Lecture	30	2	III	Exam	
Class					
Laboratory	15	1		Grade	
Seminar					
Workshop					
Project	30	2		Grade	
Part-time studies					
Lecture	20	2	III	Exam	
Class					
Laboratory	10	1		Grade	
Seminar					
Workshop					
Project	10	1		Grade	

COURSE CONTENTS:

Lecture

Torsion of a bar of circular section. Torsional moment, shear stress and strain, angle of twist. Torsion of thin-walled tubes. Thin-walled open or closed sections - comparison.

Shear centre. Complex state of stress – eccentric bending and tension. Neutral axis. Core of a section ("middle third" and "middle quarter"). Design of bars under eccentric tensile load. Stability of struts. Design rules for struts, design by codes. Basic theory of disks. Pane state of stress. Internal forces in disks. Boundary conditions. Basic theory of thin plates. Solution methods for plates. Design rules for plates. Description of selected experimental tests. Creep and relaxation. Long-term strength and material fatigue. Failure mechanisms. Isotropy and anisotropy. Fundamentals of rheology. Rheological models. Basic concepts of energy. Work of forces. Strain energy density function. Principle of minimum potential energy. Effort of material. Theories of elastic failure. Shear strain energy (distortion energy) per unit volume – Huber-Mises-Hencky's theory (criterion), Maximum shear stress – Tresca-Guest's theory (criterion), Modified shear stress (internal friction theory) – Mohr's theory (criterion). Safety factor. Basic theory of limit load capacity for bar structures. Associated flow rule. Limit load capacity of a cross-section and that of a bar system – plastic hinge, kinematical collapse mechanism, limit load analysis of beams by both the static and kinematic approaches. Basics of V.Z. Vlasov torsion theory. Kinematical relations. Sectorial characteristics of thin wall cross-sections. Normal stress and bitorque, shear stress, constricted-torsion moment. Summary – final remarks on structural design and laboratory tests on materials.

Laboratory

1. *Static tensile test.*
2. *Determination of critical Euler's force.*
3. *Static bending test.*
4. *Static torsion test.*
5. *Determination of shear centre.*
6. *Creep of plastics.*

Project

1. *Calculation of the core of a cross-section. Stress analysis under eccentric tensile load.*
2. *Design of a strut of compound cross-section made from cold rolled steel sections*.
3. *Calculation of internal forces, stresses and displacements in a plate (use of tables and computer programs within the subject "Computer Analysis of Materials and Structures).*

LEARNING OUTCOMES:

Competence and skill (i) to understand the difference of structural behaviour between the elastic and elasto-plastic ranges; (ii) to design of cross-sections by limit load state rules, (iii) to understand the necessity of stability analysis of struts and structures, (iv) to determine internal forces, stresses, displacements and strains in disks, plates, and bars under torsion.

ASSESSMENT CRITERIA:

Lecture – *to pass the exam.*

Laboratory – *to receive a credit for all projects and tests.*

Project – *to receive a credit for all projects and tests.*

RECOMMENDED READING:

1. Bąk R., Burczyński T.: Wytrzymałość materiałów z elementami ujęcia komputerowego. WNT, Warszawa 2001 http://www.mes.polsl.gliwice.pl
2. Gawęcki A.: Mechanika materiałów i konstrukcji. t. I-II, Wyd. PP, Poznań 1998 http://www.uz.zgora.pl/~mkuczma/spis_tresci.pdf
3. Banasiak M., Grossman K., Trombski M.: Zbiór zadań z wytrzymałości materiałów. PWN, Warszawa 1998.
4. Cieślak B.: Metodyczny zbiór zadań z wytrzymałość materiałów. Wyd. PŚl, Gliwice 1984.

5. Jastrzębski P., Mutermilch J., Orłowski W.: Wytrzymałość materiałów. t. I - II, Arkady, Warszawa 1985 (wyd. 2).
6. Jakubowicz A., Orłoś Z.: Wytrzymałość materiałów. WNT, Warszawa 1984.
7. Piechnik S.: Wytrzymałość materiałów dla wydziałów budowlanych. PWN, Warszawa-Kraków 1980.

OPTIONAL READING:

1. Magnucki K., Szyc W.: Wytrzymałość materiałów w zadaniach. Pręty, płyty i powłoki obrotowe. PWN, Warszawa 1999.
2. Walczak J.: Wytrzymałość materiałów oraz podstawy teorii sprężystości i plastyczności. t. I - II. PWN, Warszawa -Kraków 1977.
3. Gross D., Hauger W., Schröder J., Wall W.A.: Technische Mechanik, Band 1: Statik, Band 2: Elastostatik. Springer, Berlin Heidelberg New York 2006, 2007.
4. Gross D., Hauger W., Schröder J., Wall W.A., Rajapakse N., Bonet J.: Engineering Mechanics, Vol. 1: Statics, Vol. 2: Mechanics of Materials. Springer, Berlin Heidelberg New York 2009.
5. Ragab A.R., Bayoumi S.E.: Engineering Solid Mechanics: Fundamentals and Applications. CRC Press, Boca Raton, FL, 1998.