Course description

1 General information

Course name	Strength of materials
Course code	M1-SM
Level of study (B.Sc, M.Sc., Ph.D.)	B.Sc
ECTS	5
Course manager	dr hab. inż. Halina Egner, prof. CUT, Institute of Applied Mechanics (M-01)
Course length	One (1) semester
Coordinator for international programs	erasmus@mech.pk.edu.pl

2 Prerequisites

- Completed courses in "Mathematics" and "General mechanics"

2 Program

Type	Lectures	Classes	Labs	Computer labs	Project	Seminar
Hours	15	15	-	-	30	-

3 Contents

Lectures		
No.		Hours
1	Introduction to engineering design: basic assumptions and design procedure; problem formulation and solution; significant digits; computational tools; system of units. Review of static equilibrium. Internal force resultants.	2
2	Internal force diagrams: internal axial forces; internal torque; shear and moment in beams; load, shear and moment relationships; internal forces in frames and arches.	2
3	Concept of stress: normal stress in axially loaded members; bearing and shearing stresses in connections; allowable stress and factor of safety.	1
4	Strain and material properties: deformation; components of strain; stress-strain diagram; elastic versus plastic behaviour; Hooke's law; Poisson's ratio; strain energy.	1
5	Design of statically determinate axially loaded members.	1
6	Torsion: deformation of a circular shaft; torsion formula; angle of twist; design of circular shafts.	1
7	Stresses in beams: beam deformation in pure bending; assumptions of beam theory; normal strains in beams; normal stresses in beams; shear stresses in beams; design of prismatic beams; deflection of beams (method of integration).	2
8	Transformation of stress and strain: plane stress; principal stresses; maximum shear stresses; Mohr's circle for plane stress; Mohr's circle for plane strain.	1
9	Energy methods: strain energy under axial loading; strain energy in circular shafts; strain energy in beams; conservation of energy; displacements by Castigliano's theorem.	1
10	Statically indeterminate structures.	1
11	Buckling of columns: stability of structure; pin-ended columns; columns with other end conditions; critical stress; classification of columns; design of columns for centric loading.	1
12	Combined loading and failure criteria: material failure; yield criteria for ductile materials; fracture criteria for brittle materials; combined stresses (axial and torsional loads, torsional loads and bending moment loads, transverse shear and bending moment loads); eccentric axial loads.	1

Classes		
No.		Hours
1	Internal forces in bar elements.	4
2	Stresses and deformation of axially loaded members, circular shafts subjected to torsion, beams, frames.	3
3	Energy methods.	2
4	Analysis of internal forces in statically indeterminate structures.	2
5	Buckling of columns: Euler's problem; critical force; iterative methods.	2
6	Stresses in combined loading.	2

Project		
No.		Hours
1	Properties of areas: centroid; first moments; moments of inertia; parallel-axis theorem; principal moments of inertia.	2
2	Design of axially loaded members (bars, trusses).	2
3	Design of bars subjected to torsion. Transmission shafts.	2
4	Design of beams.	2
5	Design of axisymmetric members in elastic range: thin-walled pressure vessels; thick-wall pressure vessels.	2
6	Calculating displacements by the use of energy methods. Method of forces.	4
7	Design of statically indeterminate structural elements.	6
8	Design of columns against buckling.	4
9	Design of structural elements subjected to combined loading.	6

3 Learning Outcomes (skills and knowledge):

Upon successful completion of this course students should be able to:

- calculate and represent the internal force diagrams in bars and simple structures
- understand the fundamental concepts of stress and strain and the relationship between both in order to solve simple problems of applied elasticity
- solve problems related to axial loading, torsion and bending of simple structural elements
- understand the concept of buckling and be able to solve the problems related to isolated bars
- analyse and design structural members subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behaviour of materials.

4 Assessment policy (examination):

- Attendance and assignment (5%)
- Midterm exam (written) (35%)
- Test (written) (10%)
- Final Exam (written) (50%)

5 Literature

1. Ansel C. Ugural — Mechanics of Materials, USA, 2007, John Wiley & Sons
2. R. C. Hibbeler — Mechanics of Materials, Singapore, 2005, Pearson
3. A. Pytel, J. Kiusalaas — Mechanics of Materials, Cengage Learning, 2012
4. V. D. da Silva, — Mechanics and Strength of Materials, Springer 2010