COURSE DESCRIPTION CARD - SYLLABUS

Course name

Theory of elasticity, plasticity and rheology [N2Bud1>TSPiR]

Course

Field of study
Civil Engineering

Year/Semester
1/1

Area of study (specialization)
Construction Engineering and Management

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
part-time

Requirements
compulsory

Number of hours

Lecture
18

Laboratory classes
0

Other (e.g. online)
0

Tutorials
18

Projects/seminars
0

Number of credit points

3,00

Coordinators

dr inż. Maciej Przychodzki
maciej.przychodzki@put.poznan.pl

Lecturers

Prerequisites

Knowledge: The student has basic knowledge of mathematics, theoretical mechanics, strength of materials, and structural mechanics, such as covered in the Civil/Structural Engineering Studies or other similar types of studies that finished with a Bachelor of Science degree. Skills: The student is capable of formulating mechanical problems in mathematical terms and of solving algebraic and differential equations, which appear in typical problems of theoretical mechanics, strength of materials and structural mechanics. Social competencies: The student is aware of the necessity of lifelong learning in order to expand und update his/her knowledge and skills.

Course objective

Acquaintance with basic knowledge of the mechanics of materials and structures and of constitutive modelling of materials as well as acquisition of skills, all of which are essential for solving typical problems in the stress-strength analysis of structural elements.

Course-related learning outcomes

Knowledge:

1. The student knows the notion and physical interpretation of stress and strain tensors and their use in

stress-strength analysis of materials.
2. The student knowledge of constitutive laws in elasticity, viscoelasticity and plasticity of materials.
3. The student knows the specifics and static analysis methods of two-dimensional problems (plain state of stress or strain, disks).
4. The student knows the specifics and static analysis methods of thin plates.
5. The student understands the specifics of elasto-plastic material behaviour and knows methods of ultimate load-carrying capacity analysis of bar structures.

Skills:
1. The student is capable of examining the differential equilibrium equations of a material continuum.
2. The student is capable of calculating the components of strain and stress tensors, and the principle values and directions of the tensor.
3. The student is capable of calculating the components of strain and stress tensors by the generalized Hooke`a law.
4. The student is capable of solving the plane stress or plain strain problems.
5. The student is capable of calculating the internal forces and displacements in elastic plates.
6. The student is capable of predicting ultimate load-bearing capacity of beams.

Social competences:
1. The student is aware of the responsibility for the correctness of conducted analyses and of the need of verifying adopted assumptions and obtained results.
2. The student sees the necessity of systematic expanding und updating his/her knowledge and skills.
3. The student understands the need of teamwork in solving theoretical and practical problems.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Lectures:
The 90-minute final written test at the time specified at the beginning of the semeste Answers and solutions to the tasks are rated on a scale of 2.0-5.0 each. The final grade is the weighted average of partial grades. The weights correspond to the degree of difficulty of individual questions and tasks.
Tutorials:
The 90-minute written test at the end of the semester. The test consists in solving 3-4 accounting problems. Task solutions are rated on a scale of 2.0-5.0 each. The final grade is the weighted average of partial grades. The weights correspond to the difficulty of the individual tasks. The final grade for the tutorials may be increased in the event of significant student activity during classes.

Programme content

The module program covers the following topics:
1) description of the stress state at a point,
2) description of deformation and strain state,
3) constitutive relations of elasticity,
4) plane problems of the theory of elasticity,
5) constitutive relations of plasticity,
6) ultimate load capacity,
7) constitutive relations of rheology.

Course topics

The lecture program covers the following topics:
1) elements of vector and tensor calculus,
2) stress tensor, equilibrium equations and conditions at the boundary, values and directions of principal stresses,
3) description of motion - Lagrange's notation and Euler's notation,
4) strain tensor, strain compatibility equations,
5) constitutive equations of elasticity (Hooke's law), relationship between material constants,
6) Lame equations, Beltrami-Michell equations,
7) plane stress state, plane strain state,

9) Airy stress function,
10) basics of thin plate theory,
11) basics of rheology,
12) constitutive equations of plasticity,
13) basic assumptions, theorems and methods of the theory of the ultimate load capacity of structures.

The program of auditorium exercises includes solving tasks in the following areas:
1) stress tensor, equilibrium equations and conditions at the boundary, values and directions of principal stresses,
2) description of motion - Lagrange's notation and Euler's notation,
3) strain tensor, strain compatibility equations,
4) constitutive equations of elasticity (Hooke's law), relationship between material constants,
5) Airy stress function,
6) thin plates,
7) limit load capacity of structures.

Teaching methods

Lecture - informative, monographic.
Tutorials - exercise method.

Bibliography

Basic
1. Gawęcki A., Mechanika materiałów i konstrukcji prętowych, (tom I+II), Wyd. PP, Poznań 1998.
2. Stanisławski S., Podstawy teorii sprężystości, Wyd. PP, Poznań 1963.
3. Rakowski J., Guminiak M., Teoria sprężystości i plastyczności. Reologia. Wyd. PP, Poznań 2018.
Additional
1. Nowacki W., Teoria sprężystości, PWN, Warszawa 1970,
2. Rymarz Cz., Mechanika ośrodków ciągłych, PWN, Warszawa 1993,
2. Ostrowska-Maciejewska J., Podstawy mechaniki ośrodków ciągłych, PWN, Warszawa 1982,
3. Skrzypek J.: Plastyczność i pełzanie, PWN, Warszawa 1986.

Breakdown of average student's workload

	Hours	ECTS
Total workload	80	3,00
Classes requiring direct contact with the teacher	36	1,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	44	1,50