COURSE DESCRIPTION CARD - SYLLABUS

Course name
Theory of elasticity, plasticity and rheology [S2Bud1>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
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
0

Other
0

Tutorials
30

Projects/seminars
0

Number of credit points

3,00

Coordinators

dr hab. inż. Michał Guminiak prof. PP
michal.guminiak@put.poznan.pl

Lecturers

Prerequisites

Knowledge. Basic knowledge of the following subjects: mathematics, theoretical mechanics, strength of materials and construction mechanics in the field of construction or related at the level of engineering studies. Skills. The ability to formulate physical problems in the language of mathematics and to solve algebraic and differential equations that occur in the tasks of theoretical mechanics, strength of materials and building mechanics. Social competence. Awareness of the need to constantly update and supplement knowledge and skills.

Course objective

Acquisition by students of basic knowledge and skills in the field of mechanics of materials and structures as well as constitutive modeling of materials, which are necessary to solve typical tasks of static and strength analysis of basic structural elements.

Course-related learning outcomes

Knowledge:
The student knows the concept and physical interpretation of stress and strain tensors and their application in the structural analysis of materials.

The student has knowledge of the constitutive laws of elasticity, viscoelasticity and plasticity of materials.
The student knows the minimum potential energy theorem and the corresponding equations.
The student understands the specificity and knows the methods of static analysis of two-dimensional problems.
The student understands the specifics and knows the methods of static analysis of thin plates.
The student understands the specifics of the elastic-plastic behavior of materials and knows the methods of analysis of the ultimate load-bearing capacity of bar structures and plates.

Skills:
The student is able to check the fulfillment of differential equilibrium equations of a continuous medium.
The student is able to calculate the components of strain and stress tensors as well as the main values and main directions of these tensors.
The student is able to solve the problems of plane stress or strain.
Student is able to calculate internal forces and displacements in elastic plates.
The student is able to calculate the ultimate load capacity of beams and simple frames.

Social competences:
The student is aware of the responsibility for carrying out a reliable static and strength analysis of materials and structures and the need to verify the assumptions made in order to carry out appropriate analyzes and calculations.
The student sees the need to systematically deepen and expand their competences.
The student is able to work independently and in a team in solving theoretical and practical problems.
The student is able to formulate a thesis (scientific, design) and prove it using calculations.

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. A 90-minute final written test at the time specified at the beginning of the semester, including two parts. Part 1 is to test the knowledge and consists in answering 3 questions. Part 2. Aims at checking the skills and consists in solving 2 accounting problems. In doubtful cases, the test is extended by the oral part. Students" activity is assessed during each lecture.
Auditorium exercises. 90-minute written test in the last week of the semester. The test consists in solving 3 accounting problems. Continuous assessment in every class (bonus activity).
Assessment scale for test results:
> = 90% - 5.0 (very good)
> = 85% - 4.5 (good plus)
> = 75% - 4.0 (good)
> = 65% - 3.5 (sufficient plus)
> = 55% - 3.0 (satisfactory)
<54% - 2.0 (insufficient).

Programme content

Elements of vector and tensor calculus. Stress state - stress tensor. Equilibrium equations and shore conditions. Principal stresses and principal directions of the tensor. Motion description, Lagrange record and Euler record. State of deformation - deformation tensor. Deformation equations. Constitutive equations of elasticity (Hooke"s law), relationship between material constants. The laws of conservation of mass, momentum, angular momentum, energy. Theorem on minimum potential energy. Virtual work equation. Lame"s equations. Beltrami-Michella equations. Two-dimensional issues. Plane stress state. Plane deformation state. Airy"s stress function. Plane tasks in polar coordinates. Methods and examples of calculating boundary tasks. Boussinesq"s Quest and Flamant"s Quest. Fundamentals of the theory of thin plates. Assumptions and derivation of equations. Internal forces in plates. Rectangular plates. Wheel plates loaded axially symmetrically. Examples of calculation of internal forces and displacements in plates. Basics of rheology. Basic models and constitutive relationships of viscoelasticity. Constitutive relationships of plasticity. Plasticity conditions of Treska, Huber-Mises-Hencky. Basic assumptions, theorems and methods of the theory of ultimate load capacity. Examples of the calculation of the ultimate load capacity of beams, frames and slabs.

Course topics

Class topics:
- introduction to the description of deformations of the material continuum
- basic measures of deformation and strain at a point in the material continuum,
- state of stress at a point in the material continuum,
- plane states of stress and strain in the material continuum,
- principal stresses at a point in the material continuum,
- extreme shear stresses at a point in the material continuum,
- equations of the theory of elasticity,
- solving plane stress and strain problems,
- statics of beams and shields,
- introduction to the theory of thin plates (Kirchhoff-Love)
- methods for solving basic problems in the statics of thin plates,
- engineering theory of limit states,
- basics of rheology.

Teaching methods

Lecture - informative monographic, exercises - practice method. Direct recording of information on the board with the use of multimedia equipment.

Bibliography

Basic
1. Rakowski J., Guminiak M.: Teoria sprężystości i plastyczności. Reologia, Wyd. PP, Poznań 2018.
2. Brunarski L., Kwiecinski M.: Wstęp do teorii sprężystości i plastyczności, Wyd. PW, Warszawa 1976.
3. Brunarski L., Górecki B., Runkiewicz L.: Zbiór zadań z teorii sprężystości i plastyczności, Wyd. PW, Warszawa 1976.
4. Stanisławski S., Podstawy teorii sprężystości, Wyd. PP, Poznań 1963
5. Fung Y. C.: Podstawy mechaniki ciała stałego, PWN, Warszawa 1969.
6. Krzyś W., Życzkowski M.: Sprężystość i plastyczność, PWN, Warszawa 1962.
7. Nowacki W.: Teoria sprężystości, PWN, Warszawa 1970.
8. Ostrowska-Maciejewska J., Podstawy mechaniki ośrodków ciągłych, PWN, Warszawa 1982
9. Skrzypek J.: Plastyczność i pełzanie, PWN, Warszawa 1986.
10. Gawęcki A., Mechanika materiałów i konstrukcji prętowych, (tom I+II), Wyd. PP, Poznań 1998.
Additional
1. Mase G.E.,Theory and problems of continuum mechanics, Mc-Graw Hill , New York 1970
2. Mase G. E.: Continuum Mechanics, McGraw-Hill Book Comp., 1970.
3. Ragab A.-R., Bayoumi S.E.: Engineering Solid Mechanics. Fundamentals and Applications, CRC, Boca Raton 1999.
4. Stein E., Barthold F.-J.: Elastizitätstheorie, Skript, Hannover 2004.

Breakdown of average student's workload

	Hours	ECTS
Total workload	90	3,00
Classes requiring direct contact with the teacher	60	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00