COURSE DESCRIPTION CARD - SYLLABUS

Course name

Theory of Elasticity and Plasticity. Rheology

Course

Field of study

Civil Engineering

Area of study (specialization)

Construction Engineering and Management

Level of study

Second-cycle studies

Form of study

full-time

Year/Semester

1/1

Profile of study

general academic

Course offered in

Polish

Requirements

compulsory

Number of hours

Lecture

30

Tutorials

30

Laboratory classes

0

Projects/seminars

0

Other (e.g. online)

0

Number of credit points

3

Lecturers

Responsible for the course/lecturer:

Michał Guminiak, Dr Habil. Eng.

email: michal.guminiak@put.poznan.pl

tel.: +48 61 665 2475

Faculty of Civil and Transport Engineering

Piotrowo 3 Street 60-965 Poznań

Responsible for the course/lecturer:

Maciej Przychodzki, Dr. Eng.

email: maciej.przychodzki@put.poznan.pl

tel.: +48 61 665 2697

Faculty of Civil and Transport Engineering

Piotrowo 3 Sgtreet 60-965 Poznań

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:

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.

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	3,0
Classes requiring direct contact with the teacher	60	2,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	30	1,0

[1] delete or add other activities as appropriate