COURSE DESCRIPTION CARD - SYLLABUS

Course name
Elasticity and Plasticity

Course

Field of study
Building Engineering

Year/Semester
1/1

Area of study (specialization)
Structural Engineering

Profile of study
general academic

Level of study
Second-cycle studies

Course offered in
English

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
0

Other (e.g. online)
0

Tutorials
15

Projects/seminars
15

Number of credit points

4

Lecturers

Responsible for the course/lecturer:
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Faculty of Civil Engineering and Transport

Institute of Building Engineering

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Wydział Inżynierii Lądowej i Transportu

Instytut Budownictwa

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Prerequisites

KNOWLEDGE: Basic knowledge of the following subjects: mathematics, theoretical mechanics,strength of materials and structural mechanics covered during Civil Engineering or other similar type of studies up to the Bachelor of Science degree.

SKILLS: Capability to apply the acquired knowledge and obtain further information from the literature. One is capable to apply the theoretical knowledge to solve practical problems.

SOCIAL COMPETENCE: Awareness about necessity of expending the theoretical knowledge in order to justify its application during the professional career. Understanding the necessity of constant education.

Course objective

The goal of the course is focused on formulating elastic and elasto-plastic constitutive relations for continua. Techniques for solving related boundary value problems will be also covered, including the limit-load method of structural analysis.

Course-related learning outcomes

Knowledge

Student knows the concepts of stress and stain tensors, displacement vector in the point of deformable elastic body along with the relations between them.

Student knows the solving methods of two dimensional problems in the field of theory of elasticity.

Student knows the elasto-plastic material models, plasticity conditions and theories describing plastic behaviour.

Skills

Student is capable to solve problems involving tensor calculus in absolute, index and matrix notations.

Student is capable to solve 2-D boundary value problems for elastic disks (plane stress and plane strain states).

Student is capable to calculate the ultimate load capacity of bar systems (elasto-plastic beams and frames).

Social competences

Student is capable to work individually as well as in the team.

Student is aware of the responsibility arising from the accuracy of obtained results and is able to provide the interpretation.

Student is aware of the necessity of constant education and knowledge expansion.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Written tests and exercises. The lectures will be summerised by written exam.

1) Exam:(two terms: first one during the regular examination period, second during the last chance examination period) - each exam lasts 2 hours - each student receives test with individual and unique problems - the final mark is the summation of all the answers provided to the given problems, passing note in the scale 2= fail, 5= very good can be granted after obtaining at least 50% of the maximum amount of points

2) Tutorial sessions:

- two written tests during semester

- each student receives the set of two unique problems which must be solved and described individually (projects)

-during the tutoring sessions the individual help will be granted and knowledge of solving problems will be tested

- final grade for each project will be based on the quality of the project as well as the result of the quiz

- dates of each quiz will be set at the beginning of the semester.

Programme content

Elements of tensor calculus. Stress tensor. Analysis of stress state, principal stresses and directions. Equilibrium equations and boundary conditions. Description of movement, Lagrange and Euler coordinates. Analysis of strain state. Strain tensor and its interpretation. Geometrical equations. Constitutive relations, generalized Hooke's law. Principal strains and directions. Lame and Michell's-Beltrami's equations. Energy principles. 2-D stress and strain problems. Airy's stress function. Planar problems in polar coordinates. Boundary value problems and methods of solution. Boussinesq's and Flamant's problems and solutions. Elasto-plastic behaviour of materials. Plastic deformations and plastic flow. Idealized models of elasto-plastic materials. Yield conditions, Tresca and Huber-von Mises criteria. Elasto-plastic bending of beams. Limit load theory and its theorems. Examples of calculation for beams and frames.

Teaching methods

Lecture – traditional lectures ("chalk-and-talk"), with computer-assisted presentations at times.

Tutorial – discussing and solving problems on the blackboard with plenty of student participation.

Projects – two projects on topics presented at Lectures.

Bibliography

Basic

1. Fung Y. C.: Foundations of solid mechanics, Prentice-Hall, Englewood Cliffs, 1965

2. Mase G.E.,Theory and problems of continuum mechanics, Mc-Graw Hill , New York 1970

3. Ragab A.-R., Bayoumi S.E.: Engineering Solid Mechanics. Fundamentals and Applications, CRC, Boca Raton 1999.

4. Skrzypek J.,Hetnarski R.B.: Plasticity and creep, CRC Press 1993

5. Stein E., Barthold F.-J.: Elastizitätstheorie, Skript, Hannover 2004.

6. Mang H.A., Hofstetter G.: Festigkeitslehre, Springer Vieweg 2018

Additional

1. Brunarski L., Kwiecinski M.: Wstęp do teorii sprężystości i plastyczności, Wyd. PW, Warszawa 1976.

2. Brunarski L., Górecki B., Runkiewicz L.: Zbiór zadań z teorii sprężystości i plastyczności, Wyd. PW, Warszawa 1976

3. Gawęcki A., Mechanika materiałów i konstrukcji prętowych, (tom I+II), Wyd. PP, Poznań 1998

4. Krzyś W., Życzkowski M.: Sprężystość i plastyczność, PWN, Warszawa 1962.

5. Nowacki W.: Teoria sprężystości, PWN, Warszawa 1970.

6. Ostrowska-Maciejewska J., Podstawy mechaniki ośrodków ciągłych, PWN, Warszawa 1982

Breakdown of average student's workload

	Hours	ECTS
Total workload	110	4,0
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]	50	2,0

[1] delete or add other activities as appropriate