COURSE DESCRIPTION CARD - SYLLABUS

Course name

Elasticity and Plasticity

Course

Field of study	Year/Semester
Civil Engineering	1/1
Area of study (specialization)	Profile of study
Structural Engineering	general academic
Level of study	Course offered in
Second-cycle studies	English
Form of study	Requirements
full-time	compulsory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
30	0	
Tutorials	Projects/seminars	
15	15	

Number of credit points

4

Lecturers

Responsible for the course/lecturer:

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Faculty of Civil Engineering and Transport

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Responsible for the course/lecturer:

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 of the necessity of constant education.

Course objective

The goal of the course is focused on formulating elastic, visco-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

1. Student knows the 3D-space concepts of stress and stain tensors and displacement vector at a material point of deformable elastic body along with the relations between them - [KB_W03, P7S_WG (O/I)].

2. Student has knowledge about the constitutive material laws of elasticity, viscoelasticity and plasticity

3. Student understands the principle of minimum of potential energy and its corresponding equilibrium equations and boundary conditions

4. Student knows the solution methods for two dimensional problems in the field of theory of elasticity

5. Student understands the specificity of elasto-plastic material response, conditions of plasticity and models describing plastic behaviour of bar structures (beams, frames)

Skills

1. Student is able to solve problems involving tensor calculus in absolute, index and matrix notations, in particular to check the differential equilibrium equations

2. Student is able to calculate components of stress and strain tensors and to determine their principal directions and principal vaules

3. Student is able to calculate components of stress and strain tensors according to the generalized Hooke`s law

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

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

Social competences

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

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

3. Student is capable of working individually as well as in a team

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) Lectures:
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 summ 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 and projects:
- written test at the end of semester,

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

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

- 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 amnd frames. Limit load theory and its theorems.

Teaching methods

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

Tutorials – 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. Itskov M.: Tensor Algebra and Tensor Analysis for Engineers with Applications to Continuum Mechanics, Springer-Verlag, Berlin 2007.

3. Mase G.T., Smelser R.E., Mase G.E.: Continuum mechanics for engineers, CRC Press , Boca Raton 2010.

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

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

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

4. Kleiber M., Kowalczyk P.: Wprowadzenie do nieliniowej termomechaniki ciał odkształcalnych, IPPT PAN, Warszawa 2011.

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

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

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,0
Classes requiring direct contact with the teacher	60	2,5
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	40	1,5

[1] delete or add other activities as appropriate