Theory of Elastic and Plastic Deformations

Wasyl Kowalczuk, Ph.D., Dr. Habil.
Department of Theory of Continuous Media and Nanostructures

The aim of this cycle of lectures and laboratory exercises is to acquaint the students with the most important theoretical concepts characterizing the deformations in continuum mechanics and their practical applications for the description of elastic and plastic behaviours of different real-world materials under some applied stress. The full understanding of the presented material demands from the students at least the basic knowledge of linear algebra, vector and tensor calculus, and the standard methods for solving ordinary and partial differential equations.

Main topics:

1. Mathematical preliminaries and introduction into the description of deformations: displacements and strains, geometric construction of small deformation theory, principal strains, spherical and deviatoric strains, curvilinear cylindrical and spherical coordinates.
2. Stress and equilibrium, body and surface forces, principal stresses, spherical and deviatoric stresses, equilibrium equations, relations in curvilinear cylindrical and spherical coordinates.
3. Material characterization, linear elastic materials, generalized Hooke's law, homogeneous deformations, physical meaning of elastic moduli, thermoelastic constitutive relations.
4. Deformations of plates and shells, torsion and bending of rods, the energy of deformed materials, two-dimensional formulations, plane strain, plane stress, Airy stress functions.
5. Plastic behaviour of materials, basic stress-strain relations, strain hardening rules, perfectly plastic material, deformation theory of plasticity, examples of elastoplastic problems.

The total number of lecture hours: 30, laboratory exercises: 30 hours, self-teaching: 45 hours, direct tutoring and consultations: 15 hours.

ECTS Points: 4.