Semester: 1
Teaching unit: UEF 1.1.1
Subject : Continuum Mechanics
VHS: 67h30 (class: 3h00, tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives:

The objective of continuum mechanics is to analyze the motion of a body or material object. The continuity of the domain is defined mathematically by continuous functions characterizing that domain. We focus on material domains undergoing continuous transformations, paying particular attention to domains exhibiting solid-body behavior. Continuous transformations of the domain give rise to strain and stress tensors, which are linked by constitutive laws. The aim of this course is to teach students the theoretical foundations and methodological principles required to solve certain linear elasticity problems analytically. To simplify the course, the use of index notation is recommended.

Recommended prior knowledge:

Rational Mechanics, Materials Science, Strength of Materials Lab, Linear Algebra, Matrix Calculus, Differential Equations, Elasticity and Strength of Materials,

Contents :

Chapter I: Introduction to continuum mechanics (1 weeks)

Chapter II: Tensor calculus, Indicial notation (2 weeks)

- II-1 Tensors
- II-2 Indicial Notation: Summation convention, free index, dummy index, Kronecker symbol, permutation symbol.
- II-3 Tensor Field and Differentiation of a Tensor Field: Differentiation of a vector, gradient of a scalar, divergence and rotational of a vector, Laplacian of a scalar, gradient of a vector and divergence of a matrix.
- II-4 Gauss's and Stokes's integral theorems

Chapter III: Strain tensor (2 weeks)

- III-1 Motion and its representations
- III-2 Strain of a continuous medium: concept of Strain, definition of the Strain operator, Strain tensor.
- III-3 Invariants of the Strain tensor
- III-4 Compatibility equations

Chapter IV: Stress tensor (3 weeks)

- IV-1 Stress tensor and invariants
- IV-2 Equilibrium equation and symmetry of the stress tensor
- IV-3 Normal stress and shear stress
- IV-4 Principal directions and principal stresses
- IV-5 Mohr's circles
- IV-6 Special cases of the stress tensor

Chapter V: Linear elastic constitutive laws (2 weeks)

V-1 General form of the constitutive law for a homogeneous, isotropic elastic material

V-2 Mechanical properties of some isotropic materials

Chapter VI: Strain energy and strength criterions (1 week)

VI-1 Strain energy

VI-2 Strength criterion: Problem definition, Von Mises criterion, Tresca criterion

Chapter VII: Solving linear elasticity problems (4 week)

VII- 1- Solutions using the displacement method (Navier equations).

VII- 2- Examples of problem solutions using the displacement method: torsion of a cylinder, thick-walled cylinder under pressure.

VII- 3- Solution using the stress method (Beltrami method).

VII- 4- Plane elasticity and Airy functions.

VII- 5- Plane elasticity in polar coordinates.

VII- 6- Examples of elasticity problems solved using the Airy function.

Evaluation method: Continuous monitoring: 40%; Examination: 60%.