Course Outline

Title: Continuum Mechanics

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Prerequisite: The first essential course of graduate studies so no prerequisite.

Overview

Continuum Mechanics is a three-credit course, which emphasizes on the mathematics and analysis methods used in the study of the behavior of a continuous medium. The course is designed to be taken by first-year graduate students of the mechanical engineering department at Iran University of Science and Technology (IUST).
This course aimed to provide comprehensive understanding of the fundamental, unifying concepts of the mechanics of continuum media to facilitate further study in specialized fields such as elasticity, plasticity, viscoelasticity, continuum damage mechanics and interdisciplinary areas such as geomechanics, biomechanics, mechanobiology and nanoscience.

Goal(introduction)

The subject of Continuum Mechanics deals with the study of motion and forces in solids, liquids, and gases and the deformation or flow of these materials which are assumed as continues media. In this course it is assumed that the matter is distributed continuously, without gaps or empty spaces (i.e., the molecular structure of matter is disregarded) and completely fills the space that it occupies. In addition, it is assumed that an infinitesimal volume of the matter has the property of the all matter.

Objectives

The primary objectives of this course are:
1. To study the conservation principles in the mechanics of continua and formulate the equations that describe the motion and mechanical behaviors of continuum materials
2. To present the applications of these equations to simple problems associated with

solid and fluid mechanics

Skills Objectives

1. Demonstrate knowledge of the physical meanings, principles, and mathematics of continuous media represented as solids, liquids, and gases.
2. Formulate and solve simplified problems using the methods of continuum mechanics.
3. Articulate basic principles and equations applicable to all constitutive models. State capabilities and limitations of the specific constitutive models covered in this course.
4. Be familiar with applicability limitations of continuum mechanics.

Materials

Week	Subject	Table of Contents
1	Introduction	Course organization, What is continuum mechanics?
2	Vectors and tensors	Fundamentals of tensors, Transformation of tensors, tensor and vector products (dot, cross and dyadic)
3	Vectors and tensors algebra	summation convention, Kronecker delta, permutation symbol, identity relation
4	Vectors and tensors calculus	Tensor fields and tensor calculus; partial differential operator, Integrals
5	Kinematics of Continua	Description of motion in Eulerian and Lagrangian coordinate systems, material time derivative, deformation tensor
6	Lagrangian strain tensor	Right Cauchy-Green deformation tensor
7	Infinitesimal strain tensor and rotation tensor	Geometrical meaning of strain components, principal strains, dilatation, infinitesimal rotation tensor
8	Rate of deformation and vorticity tensors	Definitions, relationship between D and E
9	Compatibility Equations	Derivation of compatibility equations
10	Eulerian strains	left Cauchy-Green deformation tensor
11	Force, balance and stress	Cauchy, 1st and 2nd Piola–Kirchhoff stress tensors
12	Conservation laws	Conservation of mass, momentum and energy
13	Constitutive equations	Constitutive modeling principles, principle of material frame indifference and objectivity principle of work conjugacy

14	Elastic materials	Constitutive equation of elastic isotropic materials
15	Hyper elastic materials	Nonlinear elasticity, Cauchy and Green material models
16	Viscoelastic materials	Viscoelastic materials

References

1. W. Michael Lai, Erhard Krempl and David Rubin. Introduction to Continuum Mechanics, 4th Edition, 2010, Elsevier, ISBN: 978-0-7506-8560-3.
2. A.J.M. Spencer. Continuum Mechanics, Longman, 1980. (Also Courier Dover Pubs, 2004
3. Lawrence E. Malvern. Introduction to the Mechanics of a Continuous Medium, Prentice-Hall, Inc. 1969.

Classroom Methods(policies)

- Attendance is required for all lecture sessions.
- 4-5 sets of homework problems will be assigned during the course. No late homework will be accepted.
- Homework must be written and organized in a professional manner or points will be deducted.
- Students are required to complete a course project and present in the class.

Evaluation

- Homework 10% , Project 20%
- Final exam 50% , Mid exam 20%

Project

Students will be required to complete a course project. The course project is a critical literature review of a specific topic that has significant relevance to continuum theory. It is very important in a critical literature review not only to present an overview of the latest work in the literature but to identify opportunities for advancement or improvement. It is the responsibility of each group (two-student max) to generate a topic for the critical literature review. Topics that relate to the student's area of research are acceptable and encouraged. In order to approve the project title each group has to prepare title and an abstract not less than 200 words and electronically submit to Professor Taheri email by twelve-week of the course.

Project results will be evaluated through a written report (10-15 pages, with sufficient references) and an oral presentation (10 minutes to be given in class at the end of semester)