Faculty of Applied Sciences

MECA1901   Continuum mechanics.

[30h+30h exercises] 5 credits

This course is not taught in 2005-2006
This course is taught in the 1st semester
Language: French
Level: First cycle

Aims

The objective is to provide a general introduction to the Mechanics of continuous media, together with its elementary applications to Solid and Fluid Mechanics.
At the end of his learning, the student should have assimilated the principal concepts and laws governing the kinematics and dynamics of deformable media. In addition, he should understand the application of this theory to the cases (i) of infinitesimal Thermo-Elasticity, and (ii) of Newtonian and perfect Fluid Mechanics. Moreover, he should be able to apply these concepts to the solution of simple analytical problems.

Main themes

a. General theory of continuous media.
- Basic principles and physical justification of the continuity assumption. Tensor field representation. Invariance. Cylindrical and spherical coordinates.
- Principal concepts and tools to analyze the kinematics of deformable media (velocity, acceleration, strain, rotation, strain and rotation rates, Eulerian and Lagrangian representations).
- Principal concepts and laws governing the dynamics of continuous media. Stresses, Mohr circles. Conservation laws.
- Elementary Thermodynamics of continuous media. Constitutive equations.
b. Applications.
- Solid Mechanics: Basic infinitesimal Thermo-Elasticity (elastic moduli, thermal effects). Classical analytical examples.
- Fluid Mechanics: Pressure, viscosity, and compressibility concepts. Newtonian viscous fluid model. Classical examples (e.g. flow in a pipe). Perfect fluid approximation and elementary applications.

Content and teaching methods

Introduction: Continuity assumption, tensorial field representation, invariance.
Elements of kinematics: Velocity, acceleration, pathlines, strain and rotation rates, Eulerian and Lagrangian motion representations, material derivative, small displacements, strain, rotation, compatibility equations, transport theorem (Reynolds).
Dynamics: Stresses, Mohr circles, conservation laws (mass, momentum, moment of momentum, energy).
Thermodynamics: Clausius-Duhem inequality. Constitutive equations.
Application to Solid Mechanics: Infinitesimal Thermo-Elasticity, isotropic media, elastic moduli. Isothermal or adiabatic problems: solution existence and uniqueness, examples, beam theory (St-Venant), elastic waves. Non-isothermal problems.
Application to Fluid Mechanics: Viscous Newtonian fluid, Navier-Stokes equations, Poiseuille and Couette flows, flow in a pipe, Reynolds number, non-isothermal problems. Perfect isentropic or incompressible fluid flow approximation, irrotational flows, lift of an airfoil. Acoustic waves.
Appendices: Introduction to tensor calculus. Cartesian and curvilinear coordinates.

Other information (prerequisite, evaluation (assessment methods), course materials recommended readings, ...)

Prerequisite: Basic knowledge in Mathematics and Physics as obtained from previous basic formation.
Evaluation procedure: Normal written exam, half on the theory and half on original exercises.
Support: Lecture notes available on web page (www.mema.ucl.ac.be/teaching/meca2901).
Some document photocopies are supplied if necessary.
Teaching framework: exercises (in classes), and one or two interrogations (taken into account in the final evaluation in case of success).
Associated stream: Basic module in Mechanics 50.10.
Reduced part: Part A of the course (which does not include the application of the theory to Fluid Mechanics), includes 22,5h of theory and 22,5h of exercises, for 3,5 credits.