UCL Université catholique de Louvain

LMECA2771

2012-2013

Thermodynamics of irreversible phenomena.

4.0 credits	30.0 h + 15.0 h	2q

Teacher(s) :	Papalexandris Miltiadis ; Dupret François ;
Language :	Français
Place of the course	Louvain-la-Neuve
Main themes :	- Elaboration of a general theoretical framework of irreversible phenomena having as starting points the kinetic theory of gases and classical thermodynamics - Presentation of the classical theory of Onsager-Prigogine. Presentation of more recent theories such as Rational Thermodynamics (theory of Truesdell & Noll), Extended Thermodynamics (theories of Jou & Lebon and of Müller), and the theory of Grmella & Ottinger.
Aims :	- A modern approach to non-equilibrium thermodynamics. - Unified description of thermal, mechanical, viscous, and electromechanical processes in order to enchance the students' synthetic skills. - Application of theoretical results in the modelling of irreversible phenomena in fluid and solid mechanics, geophysics, etc. *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".*
Content :	Kinetic approach : Presentation of the Maxwell-Boltzmann kinetic theory of gases. Relations between mascroscopic variables and kinetic theory. Derivation of principal transport coefficients (viscosity coefficient, conductivity, diffusivity), state equations, thermodynamic functions and their derivatives (internal energy, specific heats, entropy). Limits of continuum theory (rarefied gases, plasma). Study of specific problems in liquids (macromolecules) and solids (plasticity). Continuum approach : Summary of classical thermodynamics: first thermodynamic axiom (principle of energy conservation), absolute temperature and entropy, second thermodynamic axiom, thermodynamic potentials, thermochemistry and electrochemistry, Gibbs relations, equation of Gibbs & Duhem, phase transitions, interfaces. Classical theory of irreversible thermodynamics (linear theory of Onsager-Prigogine) : Local equilibrium, entropy production, thermodynamic fluxes and forces, reciprocal relations, evolution laws and constitutive relations. Stationary states: criteria for minimum of entropy production and minimum of dissipated energy. Couplings between thermal, mechanical, and electromagnetic phenomena: thermoelectric and thermomagnetic effects. Introduction in modern theories : Rational thermodynamics: material memory, objectivity, Clasius-Duhem inequality, constitutive relations. Applications in Non-Newtonian fluids and viscoelastic materials. Extended irreversible thermodynamics: basic hypotheses, causality, application in thermal conduction, second sound, comparison with the linear theory of Onsager-Prigogine. Hamiltonian formulations, Poisson brackets and dissipative brackets.
Other infos :	Prerequisites : Continuum Mechanics (MECA2901), Thermodynamics (MECA2855), Fluid Mechanics I and II (MECA2321 and MECA2322).
Cycle and year of study :	> Master [120] in Physics > Master [120] in Electro-mechanical Engineering > Master [120] in Physical Engineering > Master [120] in Mechanical Engineering
Faculty or entity in charge:	MECA