UCL Université catholique de Louvain

LMAPR2481

2014-2015

Deformation and fracture of materials

5.0 credits	30.0 h + 30.0 h	1q

Teacher(s) :	Pardoen Thomas ;
Language :	Anglais
Place of the course	Louvain-la-Neuve
Inline resources:	> http://icampus.uclouvain.be/claroline/course/index.php?cid=MAPR2481
Main themes :	The main themes involve -- The physical and mathematical description at the atomic, microscopic and macroscopic scales of the (thermo-visco-) elastic deformation mechanisms within all material classes; -- The physical and mathematical description at the atomic, microscopic and macroscopic scales of the (visco-) plastic deformation mechanisms within all material classes, involving creep; -- The physical and mathematical description at the atomic, microscopic and macroscopic scales of the damage and fracture mechanisms within all material classes, involving fracture mechanics theory.
Aims :	Contribution of the course to the program objectives Having regard to the LO of the programme KIMA, this activity contributes to the development and acquisition of the following LO: -- LO1 Foundations of scientific and technical knowledge (LO1.1, LO1.2, LO1.3) -- LO2 Engineering skills (LO2.1, LO2.2, LO2.5) -- LO3 R & mp; D skills (LO3.2) -- LO5 Efficient communication (LO5.3) -- LO6 Ethics and professionalism (LO6.1, LO6.3) Specific learning outcomes of the course At the end of this course, the student will be able to -- LO1.1. Distinguish and classify the different classes of mechanical behaviour: reversible deformation, permanent deformation (rate dependent or not), damage and fracture; -- LO1.1. Define the macroscopic properties characterizing the mechanical performances of materials : stiffness, strength, ductility, creep resistance, fracture toughness and explain how these quantities are measured experimentally and indexed (units); -- LO1.1 and 1.2. Identify and schematically represent the various mechanisms in terms of length and time scales, interactions and couplings, for the various classes of materials, responsible for the macroscopic properties; -- LO1.2 and 1.3. Solve simple mechanical problems using the physical/mechanical models derived during the lectures as well as the new concepts discovered in this course (e.g. internal stress, stress intensity factor, energy release rate, '); -- LO2.1, 2.2, 2.5, 3.2, 6.1, 6.3. Establish, justify and present a strategy of resolution of a complex engineering problem involving plasticity and fracture, implying in particular the simplification of the geometry, of the loading conditions and of the material response in order to reveal to key parameters playing a role; -- LO5. Speak and understandthe English language better. *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”.*

Evaluation methods :	The students will be individually graded based on the objectives indicated above. More precisely, the evaluation involves the grading of -- short lab reports; -- an original exercise invented by the student based on a real engineering problem (see further); the criteria are : (1) creativity/ originality in the selection of the problem; (2) diversity of concepts involved in the problem; (3) complexity of the problem; (4) quality/ exactness of the approximations/assumptions and solution. The exercise will be presented on paper; an oral discussion is optional. This exercise can be prepared by group of two but each student must provide a specific report involving different values for the parameters appearing in the problem; -- the solution to an imposed exercise; the textbook being available for that part of the exam; -- the answers to a few questions of synthesis regarding the main concepts, models and phenomena presented in the course; the list of possible questions is given to the students during the year.
Teaching methods :	Students attend laboratory sessions (typically 5 or 6) by groups of about 10 during which they perform experiments with the help of researchers. The lab sessions take place before the theoretical courses to follow the deductive scientific methodology. The theoretical courses are supplemented by application exercises to help the student mastering the new concepts. A fairly comprehensive textbook is provided to the students. The slides used for some of the lectures are available on icampus. Students are also expected to invent and solve a specific engineering problem involving a fracture assessment and relevant sub-problems allowing the introduction of several features covered in the different parts of the course.
Content :	Basic concepts I. Reversible deformation : Chap II Elasticity and thermoelasticity ; Chap III Viscoelasticity, anelasticity II. Irreversible deformation : Chap IV Macroscopic plasticity ; Chap V Dislocation theory ; Chap VI Hardening mechanisms, link microstructure - plasticity ; Chap VII Viscoplasticity and creep of polymers and metals III. Damage and fracture : Chap VIII Damage ; Chap IX Fracture mechanics ; Chap X Mechanisms of cracking ; Chap XI Sub-critical crack growth and fatigue (not covered every year)
Bibliography :	Additional books are available at the BSE.
Other infos :	The students must be familiar with the basic concepts -- of materials science, and especially of the basics of crystallography and microstructures; -- of continuum mechanics (stress and strain tensors) and of mechanics of deformable solids (linear elasticity theory) that have been taught in the program of bachelor of engineering. Nevertheless, the course primarily aims at illustrating these concepts in practical engineering situations rather than at making extensive use of the mathematics behind.
Cycle and year of study :	> Master [120] in Biomedical Engineering > Master [120] in Mechanical Engineering > Master [120] in Electro-mechanical Engineering > Master [120] in Physical Engineering > Master [120] in Chemical and Materials Engineering
Faculty or entity in charge:	FYKI