UCLouvain

lmapr2482

2017

Plasticity and metal forming

5 credits	30.0 h + 22.5 h	Q2

Teacher(s)	Delannay Laurent ;Pardoen Thomas ;
Language :	English
Place of the course	Louvain-la-Neuve
Main themes	• Macroscopic theory of plasticity • Crystal and polycrystal plasticity • Main plastic forming operations : rolling, extrusion, deep drawing, wire drawing, forging • Formability • Internal stress • Contact mechanics • Crystallographic textures
Aims	**Contribution of the course to the program objectives** According to the classification of LO in the EPL programme, this activity contributes to the development and acquisition of the following LO: • LO1.1, LO1.2, LO1.3 • LO2.1, LO2.2, LO2.4 • LO5.3, 5.4, 5.6 **Specific learning outcomes of the course** At the end of this course, the student will be able to 1 • LO1.1. Explain the fundamental assumptions underlying several continuum plasticity theories (J2 deformation theory, yield surface, normality rule, J2 flow theory, anisotropic extensions, etc) and single crystal theory (e.g. Schmidt rule); • LO1.1. Explain and identify the key technological and scientific issues in the most important forming operations: rolling, deep drawing, extrusion, wire drawing, forging. • LO1.1. Describe how metal forming operations are affected by a few important phenomena including: plastic localization, damage, internal stresses, texture development, plastic anisotropy, contact and wear, high temperature microstructure evolution; • LO1.2. and 1.3. Calculate, analytically, the evolution of stress and strain in plastically deforming samples/crystals under homogenous loading; • LO1.2, 2.1, 2.2, 2.4. Use a commercial finite element code to simulate forming operations based on existing input files that can be modified to test different conditions/parameters; • LO1.3, 2.2. Critically assess/compare numerical results to analytical model and make links with technological issues; • LO5.3, 5.4, 5.6. Report (writing and oral) on a study based on finite element simulations of a forming operation involving a discussion on technological issues that can be addressed with the simulations and on the assessment of the analytical models. - - - - *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 • a project, by groups of 3 or 4 students, based on the use of the finite element code Abaqus to simulate a forming process under different operating conditions. The forming operation will be orally presented to the rest of the class, illustrated by the results of the finite element simulations. The oral presentation will be supplemented by a written report. The grading will account also for daily work during the semester. • a set of imposed exercises the day of the written exam • the answers to one or two theoretical questions selected within a list of about 10 questions of synthesis provided by the teachers during the year.
Teaching methods	Ex-cathedra lectures are given to present the plasticity theories as well as the additional scientific aspects essential in metal forming operations (plastic localization, damage, internal stress, texture, contact and wear, high temperature microstructure evolution). 7 to 8 sessions are organized during which students can solve exercises with the support of an assistant. The rest of the time is devoted to the project which starts with a presentation of the use of the finite element code. Each group is helped by a dedicated assistant. The students can use Abaqus teaching licences to run simulations and analyze the results, with access to a computer room.

Content	Part I ' Plasticity theory A. Macroscopic theory in 1D B. Macroscopic theory in 3D (yield surface, J2 deformation theory, J2 flow theory, anistropic theory) C. Crystal plasticity theory Part II ' Other phenomena during plastic forming operations D. Internal stress E. Crystallographic textures F. Formability G. Contact mechanics H. Microstructural evolution and high temperature deformation I. Évolutions microstructurales et déformation à chaud Part III ' Main plastic forming operations
Inline resources	https://moodleucl.uclouvain.be/course/view.php?id=9273
Bibliography	Un syllabus rédigé en anglais par les enseignants.
Other infos	This course requires sufficient solid mechanics background (continuum mechanics and elasticity theory) and basic knowledge about mechanical properties of materials (notions of strength, ductility, hardening).
Faculty or entity in charge	FYKI

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Aims
Master [120] in Electro-mechanical Engineering	ELME2M	5		
Master [120] in Chemical and Materials Engineering	KIMA2M	5		
Master [120] in Civil Engineering	GCE2M	5		
Master [120] in Physical Engineering	FYAP2M	5		
Master [120] in Mechanical Engineering	MECA2M	5		