Unit information

Program	Mechanical Science (53001010053P0)
Course unit	PLASTICITY
Unit code	PCMEC
Unit number	2153
Credit points	4
Period	01/01/2023 -
Professor	Lucival Malcher
Prerequisites	No

Unit outline

Objective:

The course's main objective is to introduce the student to concepts related to the non-linear behavior of metallic materials, as well as to implement algorithms and carry out simulations in academic and commercial finite element tools.

Purpose:

A range of mechanical components and structures are subject to loads that lead the material to have its mechanical response within the so-called plastic regime. Fatigue problems in low number of cycles, manufacturing processes such as mechanical forming, machining, wire drawing, are examples of engineering applications where the macroscopic behavior of the material is in the plastic regime. Thus, for a better understanding of the student, the course addresses concepts related to tensor algebra, mechanics of continuous media, finite element method, plastic flow criteria, determination of plastic flow law, concepts related to isotropic and kinematic hardening of the material , models with damage, implicit integration of elasto-plastic models and non-linear simulation.

Contents:

Module 1: Introductory concepts and evolution of the area; Introduction to tensor algebra; Introduction to continuum mechanics; Introduction to the concepts of the finite element method. Module 2: Plastic flow criteria; Plastic and viscoplastic flow laws; Isotropic hardening; Kinematic and mixed hardening; Models with isotropic damage; Fracture indicators. Module 3: Numerical implementation; 1D implicit integration method; 3D implicit integration method; Implementation with ABAQUS; Numerical simulations in elastoplastic problems.

Assessment

The student will have a grade for each module of the course, where the grade for each module will be given by:

$$\boldsymbol{M_i = 0.2LE + 0.8AV}$$

The final average will be given by the weighted average of the modules, represented by the equation:

$$\boldsymbol{M_{final} = \frac{0.7M_1 + 1.0M_2 + 1.3M_3}{3}}.$$

Obs:

Reference:

1) Computational Methods for Plasticity: Theory and Applications; De Souza Neto, et al, 2008; 2) Computational Inelasticity; Simo, J.C., & Hughes, T.J.R., 1997; 3) Nonlinear Solid Mechanics. A Continuum Approach for Engineering; Holzapfel, G.A, 2000; 4) Mechanics of Solid Materials; Lemaitre, J., Chaboche, J.L., 2002; 5) Continuum Theory of Plasticity; Khan, Akhtar S, 1995; 6) Non-Linear Mechanics of Materials: Besson et al; Springer, 2012; 7) The Mathematical Theory of Plasticity; Hill; Oxford, 2009. Steigmann, D. J. (2023). A course on plasticity theory (Vol. 7). Oxford University Press.