Curricular Unit Form (FUC)

Course:	**MSC IN MECHANICAL ENGINEERING**					
Curricular Unit (UC)	**Reverse Engineering**			Mandatory		
				Optional		**X**
Scientific Area:	**Mechanical Design, Manufacturing and Industrial Maintenance**					
Year: **1**	Semester: **2**	ECTS: **5**		Total Hours: **3**		
Contact Hours:	T:	TP:**45**	PL:	S:	OT:	TT:
Professor in charge		Academic Degree /Title		Position		
Maria Amélia Ramos Loja		**Doutor**		**Professor Adjunto**		

T- Theoretical ; TP – Theory and practice ; PL – Laboratory ; S – Seminar ; OT –Tutorial ; TT – Total of contact hours

Entry into Force	Semester: **Summer**	Academic Year: **2016/2017**

Objectives of the curricular unit and competences (max. 1000 characters)

This curricular unit intends to transmit fundamental notions on Reverse Engineering using laser scanning, and on the modelling and analysis of structures using finite element method.

Being this curricular unit, part of the second cycle in Mechanical Engineering, it also constitutes a goal, to provide the future Masters with skills in the domains of modelling and analysis of structures, in re-engineering and/or components design context.

With this main objective and also aiming for illustrating the knowledge acquired, one uses commercial applications / platforms for the surface reconstruction acquired via laser scanning, as well as to develop and implement finite element models.

The conclusion of this curricular unit provides the skills to carry out the different stages of a re-engineering process, in connection to finite element concepts. It also provides the student with the necessary knowledge to critically understand the characteristics and limitations of the whole process.

Syllabus (max. 1000 characters)

Introduction to laser scanning as a non-invasive technique, in the context of the geometrical characterization of objects. Points clouds characterization. Software for visualization of points clouds and to reconstruction of surfaces. Surfaces and meshes.

Interface with applications for the simulation and analysis of structures.

Finite element method. Virtual work and Hamilton principle.

First order shear deformation theory: displacement field. Formulation of the finite element model.

Plate bending elements.

Computational implementation: Shape functions. Geometry and primary variables approximation. Convergence. Isoparametric formulation. Coordinate systems. Element matrices and vectors. Numerical integration: exact and selective. Assembly of matrices and vectors. Boundary conditions. Equations' system solution and post-processing.

Points clouds, geometrical modeling, finite element analyses and 3D printing. Computer applications using components of mechanical systems and structures.

Demonstration of the syllabus coherence with curricular unit's objectives (max. 1000 characters)

The fundamental concepts of the curricular unit syllabus are introduced in classes, and whenever possible, they are based on real structural/mechanical systems. This allows a better perception of the qualitative and quantitative aspects involved.

The contents sequence, enable a progressive comprehension, forming a coherent whole with the knowledge in the context of the deformable bodies mechanics, already acquired by students in previous curricular units. This understanding of the subjects to taught, is facilitated though the use of teaching methodologies oriented for the formulation and implementation of solutions.

During the curricular unit lectures, one uses computer applications that allow a better perception of the fundamental aspects related to the re-engineering process including associated finite element analyses.

Teaching methodologies (including evaluation) (max. 1000 characters)

The methodology used in teaching this curricular unit, involves two perfectly defined and articulated phases.

In a first phase, the student is progressively introduced to the subjects, through the exposition of the related topics and in its illustration carrying out "by hand", typical situations, either for acquiring laser scanning points' clouds and the subsequent surface reconstruction, or on the development and implementation of finite element models.

In a second phase, and particularly concerning to model development and implementation, symbolic computation is used systematically, and the solutions are compared to the ones obtained via commercial applications.

The evaluation in this curricular unit will involve carrying out two projects (NTC) and a global written evaluation, test or exam (NE). The two projects may be substituted by a single one integrative

character project.

Demonstration of the teaching methodologies coherence with the curricular unit's objectives (max. 3000 characters)

To enable the achievement of the objectives of the Reverse Engineering curricular unit, the students carry out two computational projects.

The first project considers the laser scanning of a mechanical device/component, and the subsequent surface reconstruction. The reconstructed component will be after reproduced using additive manufacturing (3D printing). The solid to obtain, will be imported to a finite element application and carried out a mechanical behavior analysis to be defined in each case.

The second project considers the implementation of a finite element application for the analysis of a plate type structure. The student will analyze the structure proposed, and will carry out comparative studies between the results obtained through its own-developed application and the results obtained via an analytical way. Convergence studies should also be performed as well as eventual others about the influence of varying parameters (to define in each case) associated to the structure.

One considers that the application and development of the concepts learned in the context of this unit, will provide to the future Masters in Mechanical Engineering, the competences and critical thinking inherent to the domain of re-engineering, modeling, development and implementation of the finite element method, which are of growing relevance in innumerous areas of the mechanical and structural engineering.

Main Bibliography (max. 1000 characters)

Manuals/Tutorials of "laser scanner" and computer applications used in the curricular unit.
J. N. Reddy, "An Introduction to the Finite Element Method". 3.ª Edição, McGraw-Hill (2006)
A. Portela, A. Charafi, "Finite Elements Using Maple. A Symbolic Programming Approach", Springer-Verlag (2002)
Bhatti, M. A., "Fundamental Finite Element Analysis and Applications, with MATHEMATICA and MATLAB Computations" – Wiley (2005).
Moaveni, S., "Finite Element Analysis: Theory and Application with ANSYS" – 3ª Edição, Prentice Hall (2008);
Stolarski, T., Nakasone, Y., Yoshimoto, S., "Engineering Analysis with ANSYS Software" – Butterworth-Heinemann (2007).
Lawrence, K. L., "ANSYS Tutorial, Release 10.0" – Schroff Development Corporation Publications (2005).