Curricular Unit Form (FUC)

Course:	**MSC IN MECHANICAL ENGINEERING**					
Curricular Unit (UC)	**Optimization Applied to Engineering**			Mandatory	**X**	
				Optional		
Scientific Area:	**Mechanical Design, Manufacturing and Industrial Maintenance**					
Year: **1**	Semester: **1**	ECTS: **6.5**		Total Hours: **4.5**		
Contact Hours:	T:	TP:**67.5**	PL:	S:	OT:	TT:
Professor in charge		Academic Degree /Title		Position		
José M. P. do Valle C. Igreja		**PhD**		**Associate Professor**		

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)

At the end of the curricular unit the student should be able to:

1. Formulate optimization engineering problems mathematically.

2. Analyze the optimization outputs and criticize the results.

3. Calculate optimum solutions in engineering problems.

4. Understand linear and nonlinear algorithms applied in optimization techniques.

5. Understand the use of artificial intelligence techniques in complex engineering problems.

6. Model and simulate engineering systems.

7. Use intelligent systems in the modeling and optimization of engineering

Syllabus (max. 1000 characters)

1. Introduction to Optimization

History. Introduction to formalization. Examples.

2. Linear Programming

Definitions and basic concepts. Linear programming hypotheses. Basic definitions. Graphic resolution. Simplex Algorithm. Auxiliary variables, the Big M method. Sensitivity analysis. The Simplex Dual algorithm.

3. Artificial Neural Networks. Introduction. The neuron. Activation Function. Multilayer Perceptrons. Approximation property. Supervised training. Generalization and validation.

5. Genetic Algorithms.

Mathematical foundations. Computational applications. Learning with genetic algorithms.

6. Introduction to Simulation.

Basic concepts. Discrete simulation example. Generation methods for probability distribution. Activity cycle diagrams.

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

The curricular unit is focused essentially in optimization algorithms. The use of optimization techniques in engineering problems (production, transports, resources) can lead to decision taking that improves the efficiency of the problem. The correct use of these tools, is very important in engineering. In the first part of the curricular unit the development of mathematical models is taught. The development of mathematical systems and their linear optimization is the focus during chapter 2. Artificial intelligent systems are used to optimize different and complex engineering problems. The capability of learning towards an optimum solution makes artificial neural networks and genetic algorithms good solutions to complex problems. Chapter 3, 4 and 5 presents the use of artificial intelligent methods in nonlinear complex optimization problems. In the last topic a brief approach to model and simulation is taught.

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

The curricular unit exposes the different theoretical concepts, and uses practical engineering cases to demonstrate the defectiveness of the techniques. When useful dedicated software is introduced to the students, in order to optimise complex engineering problems.

The evaluation is 1 final exam classified from 0 to 20. To get positive evaluation the student must have a grade equal or greater than 10.

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

Being a curricular unit with a strong application in engineering systems, the use of laboratory classes where computer software is used to solve practical cases, develops in the student the ability to solve different types of problems that can be applied directly on an working environment. The mandatory project increases the sense of analysis and criticism of a given solution. The student has to decide what outputs of the problem should be implemented and what type of solution should be used. The student is able to reach the objectives, working with different types of application problems. The theoretical learning of each one of the proposed methods is reenforced with real practical applications, motivating the student towards the importance of the curricular unit in the future of the mechanical engineer.

Main Bibliography (max. 1000 characters)

L. Valadares Tavares et al., Investigação Operacional, Mc Graw-Hill, 1997.

Frederick S. Hillier, Gerald J. Lieberman, Introd. to Operation Research, Mc Gr.-Hill, 2010.

Wayne L. Winston, Operations Research Appl. and Algorithms, Duxbury Press, 2003.

Alexander M. Meystel, James S. Albus, Intelligent Systems - Architecture, Design, and Control, John Wiley & Sons, Inc., 2002.

Laurene Fausett, Fundamentals of Neural Networks Architectures, Algorithms and Applications, Prentice-Hall, 1994.

Lance D. Chambers , The Practical Handbook of Genetic Algorithms: Applications (2nd Ed.) Chapman and Hall/CRC, 2000.