INSTITUTO SUPERIOR DE ENGENHARIA DE LISBOA

Área Departamental de Engenharia Mecânica

Curricular Unit Form (FUC)

Course:	**MSc IN MECHANICAL ENGINEERING**					
Curricular Unit (UC)	**Thermodynamics Computational Calculus**				Mandatory	
					Optional	**X**
Scientific Area:	**Thermofluids and Energy**					
Year: 1st	Semester: 1st	ECTS: 5,0		Total Hours: 135		
Contact Hours:	T:	TP: 45	PL:	S:	OT:	TT: 45
Professor in charge		Academic Degree /Title		Position		
Nelson Pereira Caetano Marques		Doctor of Philosophy		Invited Assistant Professor		

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

Entry into Force	Semester: **Winter**	Academic Year: **2019/2020**

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

Cover theoretical and practical topics in the resolution of heat transfer problems. Numerical methods derive from the Finite Difference, Finite Element and Finite Volume methods, the three most popular in engineering applications. Students will acquire competences in the approach to problems stemming from Applied Thermodynamics and Fluid Mechanics when applied to Heat Transfer. Fundamentals of the three families of methods will also be conveyed

Syllabus (max. 1000 characters)

REVIEW

Heat transfer modes. Examples from production, transmission/transport and distribution of thermal energy with significance in the Curricular Unit. Physical modelling: Heat Conduction Equation. Initial and boundary conditions. Numerical resolution of systems of equations and numerical integration.

CONDUCTION

Steady-state and transient regimes. Boundary conditions. Typical examples. Conduction through walls. Conduction with heat sources. Conduction in fins. Exact solutions.

FINITE DIFFERENCE METHOD

Physical models common in Fluid Mechanics and Heat Transfer. Steady-state and transient regimes. Discretization of partial derivatives in space and time. Order of approximation and numerical stability. Lax's Theorem.

RADIATION

Black and grey bodies. Shape factors. Numerical solution of radiation problems in participating media.

FINITE ELEMENT METHOD

Comparison between Finite Difference and Finite Element methods. Variational formulation. Rayleigh-Ritz and Galerkin methods. Discretization examples.

CONVECTION

Boundary layer and thermal boundary layer. Energy conservation equation. Laminar and turbulent flowfields. Numerical applications.

FINITE VOLUME METHOD

Variational Form of the Finite Volume Method. Generic transport equation. Term-by-term discretization and need for Upwind character. Pressure-velocity coupling methods. Mesh generation and quality parameters.

INDUSTRIAL APPLICATIONS

Heat exchangers. Cooling towers. Ovens and dryers. Solar collectors and Thermal powerplants.

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

The content scope is in line with the objectives of the Curricular Unit. The depth given to the several topics and the hours available to the students are made to be in balance.

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

The teaching methodology combines classroom teaching in both theoretical and practical components, using the main bibliography, PowerPoint presentations and additional material to be made available via the Moodle platform.

Evaluation:

Four (4) class assignments to aid in knowledge acquisition, without minimum classification;

One (1) final project with execution during normal class period and presentation (with Q&A).

Final grade is obtained according to the following weights:

20% – Average of Class assignments

80% – Project

The passing mark is obtained with a final grade bigger than or equal to 9,5 (in 20).

Demonstration of the teaching methodologies coherence with the curricular unit's objectives (max. 3000 characters)
A dual approach is followed to provide the students with a solid knowledge and competence acquisition in the curricular unit's contents: theoretical-practical component during classes, "hands-on" approach to be developed by the students with the help of the teaching staff. The latter is based on the execution of a project using commercial-grade software, therefore allowing an integration of the subject material delivered in class with the real-life stages of addressing an engineering problem.

Main Bibliography (max. 1000 characters)

Holman, J.P.: HEAT TRANSFER - McGraw-Hill;

Cengel, Y.A.: HEAT TRANSFER, A PRACTICAL APPROACH 2nd Ed. – McGraw-Hill;

Moaveni, S.: FINITE ELEMENT ANALYSIS – Theory and Application with ANSYS – Pearson Prentice Hall;

Reddy, J.N., Gartling, D.K.: THE FINITE ELEMENT METHOD IN HEAT TRANSFER AND FLUID DYNAMICS, 3rd Ed. – CRC Press;

Versteeg, Malasekera: INTRODUCTION TO CFD, FINITE VOLUME METHOD – Taylor & Francis Group;