Curricular Unit Form (FUC)

Course:	**FIRST CYCLE IN MECHANICAL ENGINEERING**					
Curricular Unit (UC)	**Reciprocating Engines**			Mandatory	**X**	
				Optional		
Scientific Area:	**Thermofluids and Energy**					
Year: **3rd**	Semester: **1st**	ECTS:**5,0**		Total Hours: **4,5**		
Contact Hours:	T: **45,0**	TP:**22,5**	PL:	S:	OT:	TT:
Professor in charge		Academic Degree /Title		Position		
Jorge Mendonça e Costa		**Doctor**		**Professor Coordinator**		

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)

Introduce the basic fundamentals and competences in the following topics:
Internal combustion engine classification and operation principle.
Classical engine evolution.
Study of four- and two-stroke engines. “Otto” and “Diesel” engines. Main components.
Engine performance and influencing factors. Analysis and interpretation of characteristic curves.
Ancillary systems and their evolution.
Supercharging.
Combustion and pollutant formation.
Conventional and alternative fuels.
Anti-pollution systems.

Syllabus (max. 1000 characters)

I. THEORY

Engine classification and operation principle.

Theoretical and real cycles. Indicated diagrams. Pressure diagrams.

Classical engine evolution. Geometry and engine components.

Operation parameters: Power. Efficiencies. Torque. Specific consumption. Thermal balance. Air/fuel ratio. Excess air and mixture richness. Mean effective pressure and piston mean velocity. Engine performance and influencing factors.

“Otto” engine: Fuel supply systems. Matching the ignition and injection systems. Transducers.

“Diesel” engine: Combustion chambers. Fuel supply system. Injection and control systems. Electronic management “Diesel” injection. Electronic injection system auxiliary devices.

Scavenging in two-stroke engines. Scavenging types. Scavenging efficiency.

Supercharging of "Otto" and "Diesel" engines: Objective. Compressor types. Turbocharger. Achievable results with supercharging. "Comprex" compressor. Benefits of the turbocharger in Otto and Diesel engines. Power used in supercharging.
Thermodynamics of the combustion process: Air - fuel reaction. Combustion with and without dissociation.
Engine energy balance. Engine cooling. Cooling systems.
Fuels: Generalities. Fuel structure and components of crude oil derived fuels used in reciprocating internal combustion engines. Knocking in Otto engines. Octane number. HFO – Heavy Fuel Oils. Cetane number. Other fuel types: Liquefied Petroleum Gas (LPG), natural gas, hydrogen, alcohols. Calculation of air fuel mixtures with gaseous fuels.
Engine combustion.
Pollutants production and abatement: European legislation. Origin and pollutant formation mechanism. Active and passive pollutant reduction systems.

II. PRACTICE
Operation cycles and characteristic values.
Calculations and problem solving on kinematics, power and efficiencies of reciprocating engines.

III. LABORATORY
Identification of tools and engine components, comprising auxiliary systems.
Engine assembly and disassembly ("Otto" and "Diesel").
Measurement of engine displacement, residual volume and components.
Engine diagnostics - OBD

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

The syllabus aims at providing students with specific knowledge on reciprocating engines building on thermodynamics, fluid mechanics, heat transfer and machine components. One of the main objectives encompasses the students' awareness on energy conversion equipment (chemical – mechanical) that still today has one of the highest single cycle efficiency with a widespread application in industry and transport sectors.

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

Assessment:

1) Attendance to 75% of the laboratory classes and elaboration of a project report with final discussion. Minimum classification should be 10/20, having a 30% weight in the final classification.

2) Written exam (2h) covering all the programme contents. A classification of 10/20 must be achieved for approval, having a weight of 70% in the final classification.

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

The objective of providing students with a solid theoretical and practical knowledge on reciprocating engines builds on a dual approach encompassing a theoretical component delivered in class and a laboratory hands-on approach. This is complemented by the organization of field trips to companies (e.g. EMEF) where students can study other types of engines. The elaboration of project reports allow students a better integration of acquired concepts through bibliographic survey and problem solving on reciprocating engines.

Main Bibliography (max. 1000 characters)

Reference book:

Author(s): MARTINS, J.
Internal Combustion Engines.

Other recommended text books:

HEYWOOD, J. B. – Internal Combustion Engine Fundamentals.
SHAPIRO, H. N. – Fundamentals of Engineering Thermodynamics.
INCROPERA /De WITT/BERGMAN/LAVINE – Fundamentals of Heat and Mass Transfer.
Several magazine articles and up-to-date scientific papers.