COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Engineering		
ACADEMIC UNIT	Department of Naval Architecture		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	NAOME1223	**SEMESTER**	4th
COURSE TITLE	**INTERNAL COMBUSTION ENGINES**		
INDEPENDENT TEACHING ACTIVITIES		**WEEKLY TEACHING HOURS**	**CREDITS (ECTS)**
Lectures		3	6
Laboratory		2	
Total		5	
COURSE TYPE *general background, specialbackground, specialised general knowledge, skills development*	Special background		
PREREQUISITE COURSES:			
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes		
COURSE WEBSITE (URL)	https://eclass.uniwa.gr/courses/NA214/		

(2) COURSE GOALS / LEARNING OUTCOMES

This course covers basic aspects of internal combustion engines, both reciprocating and rotary. The course aims at introducing the students to the thermodynamic analysis of ICEs and to all their structural and functional characteristics.

The aim of the course is to familiarize students with the construction principles of piston and rotary internal combustion engines and analyze their function. The advantages and disadvantages of all ICEs are analyzed in relation to specific applications in transport and others, such as electricity generation, with special emphasis on those applications related to the propulsion and auxiliary functions of ships: Diesel, natural gas, double fuel, gas turbines. The ultimate goal is for the student to make preliminary calculations and system design based on a justified choice of ICE technology for each naval application.

Upon successful completion of the course the student will be able to:

- Understand the structure and basic principles of operation of all internal combustion engines with emphasis on those used on ships (piston and rotary).
- Calculate key functional parameters of ICEs.
- Establish an ICE energy balance.
- Understand the combustion process and pollution mechanisms in ICEs.
- Calculate fuel consumption and environmental footprint of marine energy systems.
- Understand the structure and operating principles of marine engine charging systems.
- Understand the application of the basic principles of thermodynamics in the

calculation and design of internal combustion engines.

(3) COURSE CONTENT / SYLLABUS

- Introduction to Internal Combustion Engines, general principles of operation, fields of application, basic principles of operation of piston and rotary engines.
- Reciprocating enginess: description and analysis of the kinetic mechanism, basic geometric characteristics, volume capacity, compression ratio
- 4- & 2-stroke engines
- Otto's ideal air cycle: thermodynamic analysis and basic calculations of the main characteristics: efficiency, mean pressure, theoretical power, parametric study. Modeling of the combustion process in gasoline engines.
- Diesel ideal air cycle: thermodynamic analysis and basic calculations of the main characteristics: efficiency, mean pressure, theoretical power, parametric study and comparison with the Otto cycle. Modeling of the combustion process in diesel engines
- Dual ideal air cycle and its correlation with Otto and Diesel engines.
- Theory of combustion in ICE, stoichiometry analysis and definition of the ratio of air-fuel equivalence. Preparation of the combustible mixture.
- Real ICE cycles and their differences from the theoretical air cycles. Fuel Injection systems (direct and indirect) and ignition in gasoline engines. Fuel injection systems in diesel engines. Design of combustion chambers and pistons. Octane and cetane numbers.
- Pressure – Volume chart in gasoline and diesel engines and related quantities: indicative work and indicative performance
- Air induction – preparation of air-fuel mixture. Turbo- and Super-charging systems.
- Key operating parameters of a real ICE: torque, efficiency, specific fuel consumption, mean pressure, mechanical efficiency. Energy balance in actual ICEs
- ICE subsystems: cooling, lubrication, valve movement, starter.
- Multi-cylinder ICEs – Different cylinder arrangements
- Air pollution and related anti-pollution technologies
- Characteristics of Marine Diesel Engines. 2 and 4 stroke engines, range of marine engines revolution speeds. Analysis of the special characteristics of slow-moving two-stroke marine engines and their wide applications
- Rotary internal combustion engines: gas turbine, Joule-Brayton cycle, performance improvements, simple / complex devices, thermodynamic analysis, Gas turbine combustion chambers, turbine blade cooling techniques, Functional characteristics, Compressor -Turbine matching, gas turbine load adjustment.
- Laboratory exercises using two laboratory engine rigs employing an experimental single-cylinder variable-compression ratio gasoline engine and a twin cylinder diesel engine, a test rig for fuel injectors, a test rig for diesel fuel pumps, a compression tester, a pollutants measurement instrument and tools for assembling and disassembling ICEs.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY Face-to-face, Distance learning, etc.	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY Use of ICT in teaching, laboratory education, communication with students	• Support learning through the electronic e-class platform.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	(see table below)
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other*	Written examination (70%) and reports on Laboratory exercises (30%)

Activity	*Workload (hours)*
Lectures	39
Laboratory exercises	26
Homework assignments for laboratory exercises	26
Study of Lectures and preparation for exam	65
Course total	***156***

(5) ATTACHED BIBLIOGRAPHY

- J. L. Lumley “Engines An Introduction” Cambridge University Press , 1999
- J.B. Heywood, “Internal Combustion Engine Fundamentals”, McGraw-Hill, New York, 1988
- C. F. Taylor, “The Internal Combustion Engine in Theory and Practice, Vol. 1”, The M.I.T. Press, 1984.
- “Bosch Automotive Handbook”, 9th edition, R. Bosch GmbH, 2014.
- D. Woodyard, “Pounder's Marine Diesel Engines and Gas Turbines”, Butterworth-Heinemann, 2009.
- H. Cohen, G.F.C. Rogers, H.I.H. Saravanamuttoo, “Gas Turbine Theory”, Longman, 1972.
- D.G. Wilson, T. Korakianitis, “The design of high-efficiency turbomachinery and gas turbines”, Prentice Hall, 1998.
- Walsh P., Fletcher P., Gas Turbine Performance, Blackwell Science, ASME Press, 1998.
- M. P. Boyce, “Gas Turbine Engineering Handbook”, 4th edition, Elsevier, 2011.