COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Engineering		
ACADEMIC UNIT	Department of Naval Architecture		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	NAOME1368	**SEMESTER**	9th
COURSE TITLE	**SPECIAL TOPICS IN THERMAL TURBOMACHINES**		

INDEPENDENT TEACHING ACTIVITIES	**WEEKLY TEACHING HOURS**	**CREDITS (ECTS)**
Lectures	3	4
Laboratory	demonstration	

COURSE TYPE *general background, specialbackground, specialized general knowledge, skills development*	Specialized
PREREQUISITE COURSES:	NAOME1222 - Viscous Flows – Fluid Machinery
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	https://eclass.uniwa.gr/courses/ET173/

(2) COURSE GOALS / LEARNING OUTCOMES

The aim of the course is to understand the work exchange between rotating shaft and working medium, the aero-thermodynamic analysis of compressor and turbine stages, the kinds of compressors and turbines, their characteristic parameters and operational diagrams, compressor-turbine matching and manufacturing topics. After the completion of the course, the student should:

- Know the operational principles of thermal turbomachines and energy transformations taking place in them.
- Perform one-dimensional aero-thermodynamic analysis calculations in compressor and turbine stages, basic kinds of compressor and turbines, their operational diagrams and the parameters that affect them.
- Be aware of special topics during operation in compressors (e.g. rotating stall, surge), turbines (blade cooling techniques) and steam-turbines.
- Understand compressor-turbine matching at design and off-design conditions in gas turbines and turbochargers.
- Be aware of part-load control in gas turbines.

(3) COURSE CONTENT / SYLLABUS

Lectures:

- Definition, classification and main applications of thermal turbomachines, thermodynamic analysis of compressors and turbines, stagnation state, isentropic and polytropic efficiency.
- Gas turbines, classification, ideal Joule-Brayton cycle, complex cycles (regeneration, compression in two stages with intercooling, expansion in two stages with reheat), solution of real cycles, calculation of performance measures, combustion chambers, turbine blade cooling, reference to cogeneration and trigeneration plants.
- Turbomachinery fluid mechanics, elements of blade theory, absolute and relative velocity, velocity triangles, Euler equation, one-dimensional aero-thermodynamic analysis of compressor and turbine stage (of either gas or steam turbine).
- Elements of one-dimensional compressible flow in ducts, sound velocity, Mach number, compressibility phenomena, isentropic flow, shock waves, flow in a duct with non-constant area, diffuser, nozzle, adiabatic and non-isothermal gas flow in a duct, mass flow rate calculation through an opening, mass chocking and application in turbines.
- Axial compressors, design parameters (mass flow rate coefficient, loading coefficient, degree of reaction), operational diagram of a compressor, centrifugal compressor, rotating stall, surge, axial turbines, radial turbines, operational diagram of a turbine.
- Compressor-turbine matching in gas-turbines and turbochargers, design and off-design operation, special viscous flow topics in turbomachines, total pressure loss models, simulation approaches, design and manufacturing topics, rotating shaft structural and vibration issues, reference to diagnostics.

(4) TEACHING and LEARNING METHODS - EVALUATION

<table>
<tr><td>DELIVERY
Face-to-face, Distance learning, etc.</td><td>Face-to-face</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY
Use of ICT in teaching, laboratory education, communication with students</td><td>• Support learning through the electronic e-class platform.</td></tr>
<tr><td>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</td><td>
<table>
<tr><th>Activity</th><th>Workload (hours)</th></tr>
<tr><td>Lectures</td><td>44</td></tr>
<tr><td>Laboratory demonstration</td><td>8</td></tr>
<tr><td>Homework assignments</td><td>25</td></tr>
<tr><td>Individual study</td><td>40</td></tr>
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<tr><td>Course total</td><td>117</td></tr>
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<tr><td>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</td><td>Evaluation:
Written examination (100%).
Alternatively, percentage of the final mark could be obtained by means of an assignment or project</td></tr>
</table>

presentation, laboratory work, clinical examination of patient, art interpretation, other	presentation.

(5) ATTACHED BIBLIOGRAPHY

1. W.W. Bathie, 2nd Edition, John Wiley and Sons, 1996.
2. H. Cohen, G.F.C. Rogers, H.I.H. Saravanamuttoo, “Gas Turbine Theory”, Longman, 1972.
3. R.I. Lewis, “Turbomachinery Performance Analysis”, Arnold, A member of the Hodder Headline Group, 1996.
4. S.L. Dixon, “Fluid Mechanics, Thermodynamics of Turbomachinery”, 5th Edition in SI/Metric Units, Pergamon Press, 1998.
5. D.G. Wilson, T. Korakianitis, “The design of high-efficiency turbomachinery and gas turbines”, Prentice Hall, 1998.
6. Walsh P., Fletcher P., Gas Turbine Performance, Blackwell Science, ASME Press, 1998.
7. M. P. Boyce, “Gas Turbine Engineering Handbook”, 4th edition, Elsevier, 2011.
8. Watson N, Janota M.S., Turbocharging the Internal Combustion Engine, MacMillan Publishers LTD, 1982.