COURSE OUTLINE

(1) GENERAL

SCHOOL	**Engineering**		
ACADEMIC UNIT	Mechanical Engineering		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	EN0600	**SEMESTER**	7th
COURSE TITLE	Turbomachines		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures and practice exercises	5	6
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialized general knowledge, skills development*	Special background, specialized general knowledge, skills development
PREREQUISITE COURSES:	There are no prerequisite courses. It is recommended that students who are interested in attending the course have completed successfully the following courses: Thermodynamics I & II, Fluid Mechanics I & II, Aerodynamics.
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek - English
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes (tutoring)
COURSE WEBSITE (URL)	https://www.mie.uth.gr/?page_id=18369&lang=en

(2) LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcome703s*

This course introduce the students in theoretical as well as practical subjects in the area of Energy Engineering, mainly for the production of thrust in aeroplanes, movement of fluids and production of energy with the use of turbomachinery, including wind turbines.

With the successful completion of this course the student will be able to calculate and design simple turbomachinery parts (hydroturbine and pump blades, fan rotors, turbine stages, wind turbine blades etc.) and understand their operation conditions

- explain how and why a turbomachine works. Recognize the basic types of turbomachinery.
- know the basic differences between a turbine and a pump, understand the dynamics and velocity
- triangles for each type of machine.
- recognize the importance of minimizing the various types of losses in a turbomachine.
- select an appropriate class of turbomachine for a particular application.
- understand why turbomachine blades are shaped like they are.
- appreciate the basic fundamentals of sensibly scaling turbomachines that are larger or smaller than a prototype.
- move on to more advanced engineering work involving the fluid mechanics of turbomachinery

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology
Adapting to new situations
Decision-making
Working independently
Team work
Working in an international environment
thinking Working in an interdisciplinary environment
Production of new research ideas
Project planning and management
Respect for difference and multiculturalism
Respect for the natural environment
Showing social, professional and ethical responsibility and sensitivity to gender issues
Criticism and self-criticism
Production of free, creative and inductive
……
Others…
…….

- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Decision-making
- Working independently
- Understanding 3D layout of machines
- Respect for the natural environment
- Production of free, creative and inductive thought
- Performing calculations of machine performance

(3) SYLLABUS

1. Introduction: Basic Principles. Definition of a turbomachine. Coordinate system. Relative velocities. Velocity diagrams for an axial flow compressor stage. The fundamental laws. Dimensional analysis and performance laws. Incompressible fluid analysis. Performance characteristics for low-speed machines. Compressible flow analysis. Flow coefficient and stage loading. Performance characteristics for high-speed machines. Specific speed and specific diameter.
2. Hydroturbines. History, Applications, Pelton turbine, Francis Turbine, Kaplan turbine, The effect of size of efficiency, Cavitation in hydroturbines
3. Wind turbines. Types of wind turbines, Efficiency calculations, Annual energy production, Wind Data Statistical Analysis, Actuator Disc Approach, Control methods, BEM method
4. Two-Dimensional Cascades. Cascade geometry. Compressor blade profiles. Turbine blade profiles. Cascade flow characteristics. Streamtube thickness variation. Cascade performance parameters. Analysis of cascade forces (lift and drag).
5. Axial-Flow Turbines: Mean-Line Analysis and Design. Velocity diagrams of the axial turbine stage. Turbine stage design parameters. Design flow coefficient. Stage loading coefficient. Stage reaction. Thermodynamics of the axial turbine stage. Repeating stage turbines. Stage losses and efficiency. Preliminary axial turbine design.
6. Axial-Flow Compressors and Ducted Fans. Mean-line analysis of the compressor stage. Velocity diagrams of the compressor stage. Thermodynamics of the compressor stage. Stage loss relationships and efficiency. Compressor loss sources. Mean-line calculation through a compressor rotor.
7. Centrifugal Pumps, Fans and Compressors. Definitions. Thermodynamic analysis of a centrifugal compressor. The impeller. The diffuser. Inlet velocity limitations at the compressor eye. Design of a pump inlet. Design of a centrifugal compressor inlet. The slip factor. The relative eddy concept. Slip factor correlations. Head increase of a centrifugal pump. Performance of centrifugal compressors. Determining the pressure ratio. Effect of backswept vanes.

8. 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 of the learning process through the web platform e-class Use of powerpoint slides Upload of course material on the course's website Exercise
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* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	I. Final examination – Written (80%). 4 problems with shorter questions, Problem solving, written work II. Interim quiz – Written (20%). 1 problem and 2 shorter theory questions

Activity	*Semester workload*
Lectures	56
Practical exercises targeting on the understanding of the delivered theory	29
Educational visits	9
Independent study	56
Course total	*150*

9. ATTACHED BIBLIOGRAPHY

-Suggested bibliography:

- S.L. Dixon and Cesare Hall -Fluid Mechanics and Thermodynamics of Turbomachinery-Butterworth-Heinemann (2014)
- Erik Dick-Fundamentals of Turbomachines-Springer Netherlands (2015)
- David Gordon Wilson, Theodosios Korakianitis-The Design of High-Efficiency Turbomachinery and Gas Turbines-MIT Press (2014)
- Aungier, Ronald H - Axial-flow compressors _ a strategy for aerodynamic design and analysis-ASME Press (2003)
- Aungier, Ronald H - Turbine aerodynamics _ axial-flow and radial-inflow turbine design and analysis-ASME Press (2006)

- ***- Related academic journals:***
- Transactions of the American Society of Mechanical Engineers ASME
- Journal of Turbomachinery
- Journal of Engineering for Gas Turbines and Power
- AIAA
- AIAA Journal
- Journal of Propulsion and Power
- IMechE

- Journal of power and energy - part a
- Journal of aerospace engineering - part g
- International Journal of Turbo and Jet-Engines /Freund Publishing House