

COURSE OUTLINE

(1) GENERAL

SCHOOL	Engineering		
ACADEMIC UNIT	Mechanical Engineering		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	EN3500	SEMESTER	8 th
COURSE TITLE	Advanced Energy Conversion Systems		
INDEPENDENT TEACHING ACTIVITIES <i>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</i>	WEEKLY TEACHING HOURS	CREDITS	
Lectures	3	6	
Laboratory exercises	2		
<i>Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).</i>			
COURSE TYPE <i>general background, special background, specialized general knowledge, skills development</i>	Special background, skills development		
PREREQUISITE COURSES:	None		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes (tutoring)		
COURSE WEBSITE (URL)	https://www.mie.uth.gr/?page_id=18456&lang=en		

(2) LEARNING OUTCOMES

<p>Learning outcomes <i>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.</i></p> <p><i>Consult Appendix A</i></p> <ul style="list-style-type: none"> • <i>Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area</i> • <i>Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B</i> • <i>Guidelines for writing Learning Outcomes</i>
<p>The objective is to introduce –for the first time- undergraduate Mechanical Engineering student to modern and future (renewable) energy conversion systems. For the effective understanding of these systems emphasis is given in i) constituents of these systems (anatomy) ii) the basic principles of (physiology) and iii) ways to maximize efficiency and reduce construction cost and pollutants.</p> <p>Initially is introduced the concept of fuels, conventional, renewable and alternative, focusing on the production and storage of hydrogen and biofuels. Emphasis is placed on ways to convert the chemical energy of fuels to other more usable forms mainly by catalytic methods. Next up future energy conversion and storage devices and their performance are presented. The performance of these devices is compared to the performance of conventional devices (internal and external combustion engines). Subsequent to the lesson material is the presentation of controlled thermonuclear fusion, a technology believed that will face humankind for centuries. Finally, hybrid energy conversion systems are introduced in order to increase efficiency. These systems can reach 80% of the efficiency which is impossible with today's systems. During the courses students choose a topic that they have been preparing and presenting in the last two weeks.</p> <p>With the successful completion of the course the student will be able to:</p> <ul style="list-style-type: none"> • Get in touch with hydrogen economy, know the characteristics of hydrogen as an energy carrier and biofuels, as well as the advantages and disadvantages of their production, storage and use (hydrogen, biofuels) in the environment and in the global economy • Know the basic methods of converting chemical fuel into electricity • Be able to identify and quantify the performance of modern energy conversion and storage devices (such as fuel cells, lithium-ion batteries, capacitors, etc.), and the impact of their use on the economy and the environment. • Be able to know the operating characteristics of photovoltaic systems and be able to design its performance measurement circuit.

- Know basic elements of chemical reaction analysis performed on energy conversion systems
- Be able to measure the electrochemical performance of elements such as fuel cells.
- Know the basic features of the construction and operation of future energy conversion systems such as controlled thermonuclear fusion, ion-propulsion engines, thermionic systems and hybrid fuel-gas turbine systems.
- Get in touch with any of the systems under consideration through specially designed laboratory exercises

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

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 thinking

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Others...

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- Team work
- Work in an interdisciplinary environment
- Adapting to new situations
- Search for, analysis and synthesis of data and information, with the use of the necessary technology
- Respect for the natural environment

(3) SYLLABUS

Theory

Conventional fuels, Alternative fuels. Hydrogen Fuels, Production and Storage, Hydrogen Economy. Biomass. Biogas. Introduction to Catalytic Combustion. Catalytic Methods for Energy Conversion, Catalytic Turbines, Catalytic Burners. Environment and Economy (3 weeks).

Electrochemical Energy Conversion and Storage Devices: Fuel Cells, Electrolysis Systems, Superconductors, Lithium Batteries, Sodium Batteries, Electrochemical Sensors, Electrochemical Reactors, Membranes (3 weeks).

Photovoltaic cells, Thermoelectric Systems. Ion Propulsion Systems, Controlled Thermonuclear Fusion, Combined Fuel-Gas Turbine Systems to Increase Performance. (3 weeks)

Laboratory exercises (4 weeks)

Performance measurement of a photovoltaic system

Assembling - disassembling - Fuel Cell operation, and measuring its performance.

Combined fuel cell-photovoltaic system for generating electricity & Introduction to laboratory analysis systems (gas analyzers, gas chromatography, mass spectrometry, catalytic reactors).

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY		
<i>Face-to-face, Distance learning, etc.</i>	Face to face, Student-centered teaching.	
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY		
<i>Use of ICT in teaching, laboratory education, communication with students</i>	Using slides Post educational material on the course in the website Laboratory exercises	
TEACHING METHODS	Activity	Semester workload
<i>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</i>	Lectures	36
	Laboratory practice	16
	Design a project, in collaboration with the teacher, and present it to all students (collecting bibliographical information, writing a 30-50 page report and 20-25 slides and presenting them).	28
	Independent study and exams	70
	Course total	150

<p>STUDENT PERFORMANCE EVALUATION Description of the evaluation procedure <i>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</i></p> <p><i>Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</i></p>	<p>The grades are derived from the written final examination of the semester (70%) and from the weekly laboratory exercises, the final presentation of the subject (Project) prepared by the students in groups of two (30%).</p>
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(5) ATTACHED BIBLIOGRAPHY

<ul style="list-style-type: none"> • Φραγκιαδάκης Ι.Ε., "Φωτοβολταικά Συστήματα", 2η Έκδοση, Εκδόσεις Ζήτη, Θεσσαλονίκη, 2007. • Joshua and Kaia Tickell, «From the Fryer to the fuel tank. The complete guide to using Vegetable Oil as an alternative Fuel», Second Edition, Green Teach Publishing, 1999. • A.W. Culp, «Principles of Energy Conversion», McGraw Hill Series in Mechanical Engineering, Second Edition, 1991. • E.S. Cassedy, P.Z. Grossman, "Introduction to Energy Resources, Technology and Society", Second Edition, Cambridge University Press, 1998.
