

## COURSE OUTLINE

### (1) GENERAL

<b>SCHOOL</b>	ENGINEERING		
<b>ACADEMIC UNIT</b>	ELECTRICAL AND COMPUTER ENGINEERING DEPT.		
<b>LEVEL OF STUDIES</b>	Postgraduate		
<b>COURSE CODE</b>	<b>ENE_APP-204</b>	<b>SEMESTER</b>	<b>1</b>
<b>COURSE TITLE</b>	ENERGY EFFICIENCY IN BUILDINGS		
<b>INDEPENDENT TEACHING ACTIVITIES</b> <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>	<b>WEEKLY TEACHING HOURS</b>	<b>CREDITS</b>	
Lectures	2		
Tutorial/Practical Exercises	1		
<i>Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (4).</i>	3	5	
<b>COURSE TYPE</b> <i>general background, special background, specialised, general knowledge, skills development</i>	Skills development		
<b>PREREQUISITE COURSES:</b>			
<b>LANGUAGE OF INSTRUCTION and EXAMINATIONS:</b>	Greek		
<b>IS THE COURSE OFFERED TO ERASMUS STUDENTS</b>	No		
<b>COURSE WEBSITE (URL)</b>			

### (2) LEARNING OUTCOMES

<p><b>Learning outcomes</b></p> <p><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"> <li>• <i>Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area</i></li> <li>• <i>Descriptors for Levels 6, 7 &amp; 8 of the European Qualifications Framework for Lifelong Learning and Appendix B</i></li> <li>• <i>Guidelines for writing Learning Outcomes</i></li> </ul> <p>The determination of the energy performance of buildings incorporates complex principles and applications of design and installation since it aims to satisfy thermal comfort in combination with energy saving and improvement of their environmental footprint. A key parameter for sustainable energy management of buildings is the integration of passive and active design systems through the implementation of efficient and "smart" energy management systems that will adapt their operation according to the use of buildings. According to the above, the energy design and air conditioning of buildings requires the consolidation of issues related to heat transfer, psychrometry and air conditioning as well as the integration of RES in their energy balance. The outline of the course incorporates the international teaching practice related to the study, design and installation specifications of elements and systems of energy design and air conditioning of buildings as well as net metering with the use of RES, through the integration of basic theory and the presentation of the relevant regulatory framework. In addition, students will be given the opportunity to acquire practical knowledge at an</p>
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applied level of design and implementation as well as to come into contact with companies active in the field of energy design of buildings.

#### **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?*

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

- Autonomous Work
- Teamwork
- Understanding of Technical Legislation, Regulations and Specifications
- Applying Basic Knowledge to Applied Engineering Problems

### **(3) SYLLABUS**

#### **Lectures:**

##### **Introduction to building physics**

- a. Building operating conditions
- b. Building Energy Balance (Sankey Charts)
- c. Environmental footprint of building operation
- d. Presentation of experimental measurements in residential buildings under real conditions

##### **Heat Transmission: Conduction, Convection and Radiation**

- a. One-dimensional heat conduction in a permanent state
- b. Applications of heat conduction in building materials and elements
- c. Physical mechanism of free and forced heat convection
- d. Development of thermal boundary layer
- e. Radiant heat transfer

##### **Introduction to Energy Design of Buildings**

- a. Presentation of the Energy Performance of Buildings Regulation
- b. Presentation of specifications for Air Conditioning and Ventilation of Buildings
- c. Calculation of thermal-cooling loads of buildings
- d. Presentation of heating and air-conditioning installations in buildings

##### **Introduction to Building Air Conditioning**

- a. Introduction to Psychrometry - Humid air Mollier diagram - Psychrometric map
- b. Liquid air treatment processes
- c. Thermodynamic properties of refrigerants

##### **Air Conditioning and Energy Management Systems for Buildings**

- a. Categories of air-conditioning systems
- b. Heat pumps and their duty cycles
- c. Presentation of BMS and BEMS architecture

### Energy Saving in Buildings

- a. Regulatory framework for energy saving in buildings
- b. Economic, Technical and Environmental Evaluation of Energy Saving Interventions

### Energy Net Metering in Buildings

- a. Institutional framework for net metering
- b. Dimensionalization of net metering systems

## (4) TEACHING and LEARNING METHODS - EVALUATION

<b>DELIVERY</b> <i>Face-to-face, Distance learning, etc.</i>	In lecture										
<b>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY</b> <i>Use of ICT in teaching, laboratory education, communication with students</i>	Support of learning process through the platform "e-class" (slides ppt and communication). Helpful simulation programs										
<b>TEACHING METHODS</b>  <i>The manner and methods of teaching are described in detail.</i>  <i>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.</i>  <i>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>	<table border="1"><thead><tr><th><b>Activity</b></th><th><b>Semester Workload</b></th></tr></thead><tbody><tr><td>Lectures</td><td>35</td></tr><tr><td>Laboratory</td><td>40</td></tr><tr><td>Elaboration of a six-monthly topic</td><td>50</td></tr><tr><td><b>Total Course (25 hours of workload per credit)</b></td><td><b>125</b></td></tr></tbody></table>	<b>Activity</b>	<b>Semester Workload</b>	Lectures	35	Laboratory	40	Elaboration of a six-monthly topic	50	<b>Total Course (25 hours of workload per credit)</b>	<b>125</b>
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	Lectures	35									
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	Elaboration of a six-monthly topic	50									
<b>Total Course (25 hours of workload per credit)</b>	<b>125</b>										
<b>STUDENT PERFORMANCE EVALUATION</b>  <i>Description of the evaluation procedure</i>  <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>  <i>Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</i>	<p>I. Delivery of a written thesis of semester duration on the design of mechanical installations at the level of final design.</p> <p>II. Oral presentation of a six-month thesis</p> <p>The final grade is formed with a weight of 70% of the issue of the thesis and 30% of its presentation</p> <p>Work is organized in groups of 2-4 people to encourage the development of a spirit of collaboration and a culture of work in project teams.</p>										

## (5) ATTACHED BIBLIOGRAPHY

- Suggested bibliography:

1. Energy efficient buildings architecture, engineering, and environment, 2002, Dean Hawkes and Wayne Forster

2. Fundamentals of Heat and Mass Transfer, 2011, 7th Edition, Incropera DeWit, Willey
3. Heating, Ventilating and Air-Conditioning Applications, 2015, ASHRAE Handbook
4. Natural ventilation in buildings a design handbook, 1998, editor Francis Allard; Project coordinator: Mat Santamouris; contributors Servando Alvarez ... [et. al.]
5. Recommendations for Life Cycle Impact Assessment in the European context, 2011, Handbook, Institute for Environment and Sustainability, EU Commission
6. Energy Efficiency in buildings – Influence of Building Automation and Control and Building Management, EN 15232-1, 2017
7. Heat Transmission, 2005, Th. Panidis, University of Patras Press
8. Thermodynamics for Engineers, 2015, Yunus A. Cengel, Michael A.Boles, Tziola Publications
9. Mass and Heat Transfer, 2018, Yunus A. Cengel, Afshin J. Ghajar, Tziola Publications
10. Technical Instructions T.E.E., T.O.T.E.E. 20701/1-4/2017
11. Guide for Energy Audits in Buildings, Industry and Transport, Part A' and B', 2018, Ministry of Environment and Energy
12. Air Conditioning Studies, 2009, from theory to computer solving, Tekdotiki SELKA-4M
13. V. Sellountos, (2002). Heating – Air Conditioning, SELKA - 4M LTD, ISBN: 960 - 8257 - 04 – 2, Book Code in Evdoxus: 13169965.
14. D. A. Katsaprakakis, M. Moniakis, (2015). Heating – Cooling – Air Conditioning, HEAL-Link, ISBN: 978-960-603-339-1.
15. E, G. Pita, (2002). Air Conditioning Principles and Systems, Prentice Hall.