9.10 CE0941 – Design of Energy Efficient Buildings

(1) GENERAL

SCHOOL	ENGINEERING SCHOOL		
ACADEMIC UNIT	CIVIL ENGINEERING DEPARTMENT		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**CE0941**	**SEMESTER**	**9**
COURSE TITLE	**Design of Energy Efficient Buildings**		

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**
	3	4
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, specialised general knowledge, skills development*	Special Background Course
PREREQUISITE COURSES:	
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	https://eclass.uniwa.gr/courses/CIV353/

(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 Outcomes*

The aim of the course is to give the students fundamental concepts and provide a comprehensive view of energy use in buildings, of the bioclimatic design for sustainability, and measures to improve the energy efficiency of buildings. It is extremely important to know and understand the basic parameters and principles that govern the energy design, the thermal protection of the building, the behavior and properties of the thermal insulation materials.

Upon completion of the course, students will have:

1. Basic knowledge of the energy and thermal balance in buildings.
2. In-depth knowledge and critical understanding of the thermal protection of the buildings and the thermal insulation materials.
3. In-depth knowledge of the passive heating solar systems as well as the natural ventilation and cooling

techniques.

Specifically, students will be able:

1. To understand the basic issues of energy behavior of buildings.
2. Understand the basic principles and systems of energy consumption in buildings.
3. To understand the concepts of energy and thermal balance of buildings, as well as the individual parameters that shape it.
4. To understand the basic principles of calculating the thermal insulation capacity of the building in relation to the basic parameters that determine it.
5. To understand the basic methods of thermal, energy measurements in buildings.
6. To determine the energy behavior of the building and to perform the design of the building shell.
7. To understand the basic principles of dimensioning energy systems in buildings.
8. To find optimal solutions for energy design of the shell in relation to solar radiation.
9. To understand the basic principles and specifications of the modern regulatory frame and to apply them in energy design.

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

The course aims at the following general competences:

- Practical application.
- Search for, analysis and synthesis of data and information, with the use of the necessary technology.
- Adapting to new situations.
- Decision-making on topics related to the energy efficiency of buildings.
- Team work, showing social, professional and ethical responsibilities.
- Working independently.
- Working in an interdisciplinary environment.
- Production of free, creative and inductive thinking.
- Respect for the natural environment.

(3) SYLLABUS

1. Historical evolution of energy demands in buildings. The modern energy problem. European directions on the energy efficiency of buildings. Greek regulations and legal framework.
2. Climate characteristics. Energy in buildings. The effect of climatic parameters on the design of energy efficient buildings. Microclimatic conditions.
3. Energy and thermal balance in buildings. Balance parameters. Heat transfer mechanisms. Heat gains and losses in buildings.
4. Energy efficient buildings, design principles. Thermal protection of buildings. Thermal insulation materials.
5. Evaluation of the thermal insulation capacity of the building's shell. Evaluation of thermal bridges. Calculations according to the regulatory frame.
6. Sun path, solar gains and solar protection of buildings.
7. Heating and cooling. Conventional and bioclimatic methods.
8. Passive solar systems for heating. Ventilation and natural cooling techniques.
9. Thermal confort. Visual confort. Accoustic confort. Internal air quality. Calculation standards.

10. Modern methods for the evaluation of the energy behavior and efficiency of buildings.

(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*	PowerPoint presentations. Online educational material, digitized bibliography, interactive stuff. Communication with students via announcements, email, Skype or MSTeams.
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.*	
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.*	Language of Evaluation: Greek Final written examination (60%) with multiple choice questions (conclusive), with short answer questions (conclusive), with problem solving (formative, concluding). Preparation of mid term assignments (40%) which will be delivered at the end of each thematic session. Explanations are given for the evaluation criteria at the beginning and during the courses and the relative weight of the topics and the criteria of the final written examination are pointed out. The implementation of these criteria is easily accessible and can be checked by each student, as there is a short commentary on the written intermediate assignments/problems and on the exam, which can be seen and discussed by the student with the teacher.

Activity	***Semester Workload***
Lectures	39
Classwork Assignements	16
Preparation for Projects	20
Personal Study	50
Course Total	**125**

(5) ATTACHED BIBLIOGRAPHY

Greek Bibliography:

1. Energy design and passive solar systems in buildings, Papadopoulos Michael, Axarli Kleo (2015), ISBN: 978-960-599-019-0, Kyriakidis IKE Publications (in Greek).
2. Bioclimatic design, 2nd Edition, Climatic change, Environment and Sustainability, Andreadakis – Chronaki Eleni (2017), ISBN: 978-960-12-2337-7, University Studio Press Publications (in Greek).
3. Electrical and mechanical systems in buildings, S. Kouris, B. Sotiropoulos (1996), ISBN: 9789603570150, Modern Education Publications Christina and Vasiliki Kordali (in Greek).
4. Energy evaluation guide for buildings according to the new K.E.N.A.K 2017, Pantelides Georgios (2018), ISBN: 978-960-9482-67-7, Konstantinos Dedemadis Publications (in Greek).
5. Bioclimatic architecture and energy efficient design, Konstantinidou Ch. (2009), SELKA - 4M EPE Publications (in Greek).
6. Environmental design: zero energy consumption buildings, Kosmopoulos P., Perivolaris A. (2017), University Studio Press, Thessaloniki (in Greek).

7. Detailed national parameters for the calculation of the energy efficiency of buildings and the issuance of the energy efficiency certificate, TOTEE 20701-1/2017 (in Greek).
8. Thermophysical properties of building materials and control of the thermal insulation adequacy of buildings, TOTEE 20701-2/2017 (in Greek).

Foreign Bibliography:

1. Handbook of sustainable building, Anink David, Boonstra Chiel and Mak John (1996), James Publishing.
2. Solar building architecture, Anderson B., Bankston C. (ed) (1990), Mit Press.
3. Daylighting in architecture a European reference book, Baker N.V., Fanchiotti A., Steemers K. (1993), James Publishing.
4. The passive solar design and construction handbook, Crosbie M. (1997), John Wiley and Sons.
5. Solar energy houses, Hestnes Anne-Grete (1995), James Publishing.
6. Design with climate, Olgay Victor (1963), Princeton University Press.
7. Eco house design guide, Roaf Sue (2000), Butterworth.
8. Architecture comfort and energy, Sayigh A.M.M., Sala M., Gallo C. (1999), Elsevier Science.
9. Passive cooling of buildings, Santamouris M., Asimakopoulos D. (1996), James Publishing.
10. ASHRAE Green guide (3rd Edition), The design, construction and operation of sustainable buildings, American Society of Heating Refrigeration and Air-Conditioning Engineering (2010), Atlanta, Georgia.
11. European residential buildings and empirical assessment of the hellenic building stock, energy consumption, emissions and potential energy savings, Balaras C.A. et al. (2007), Building and Environment.
12. Shading and solar availability in the urban environment, Theodosiou Theodore, Chrisomallidou Niobe (2005), Int. Conference on Passive and Low Energy Architecture, Beirut, Lebanon.
13. The impact of thermal bridges on the energy demand of buildings with double brick wall constructions, Theodosiou T.G. and Papadopoulos A.M. (2008), Energy and Buildings.
14. A study on integrationg efficient shading devices in office buildings, Tsikaloudaki K. (2005), Lighting Engineering Journal.

Related academic journals:

1. Energy and Buildings: An international journal devoted to investigations of energy use and efficiency in buildings.
2. Advances in Building Energy Research: An international journal which provides expert reviews and analyses of the most important developments across the fields of energy efficiency and environmental performance of buildings.
3. Energy and Built Environment: An international journal that disseminates original research articles on energy harvesting and utilization in the built environment.