COURSE OUTLINE

(1) GENERAL

SCHOOL	ENGINEERING		
ACADEMIC UNIT	ELECTRICAL AND COMPUTER ENGINEERING DEPT.		
LEVEL OF STUDIES	Postgraduate		
COURSE CODE	**ENE_APP-201**	**SEMESTER**	**2**
COURSE TITLE	SYSTEMS FOR ENERGY STORAGE		

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	2	
Tutorial/Practical Exercises	1	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (4).	3	6

COURSE TYPE *general background, special background, specialised, general knowledge, skills development*	Special Background, Specialized
PREREQUISITE COURSES:	No
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	No
COURSE WEBSITE (URL)	

(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 "SYSTEMSFOR ENERGY STORAGE " course is the postgraduate students to deepen their knowledge of energy storage systems in order to be able to assess the relevant processes from a technical, economic and social point of view, in the context of their training. In particular, the students are expected to develop personal skills, such as critical thinking, the ability to design research studies, oral presentation fluency, as well as the ability to write scientific articles on overview, investigation and evaluation of modern energy storage technologies (electrical & thermal) , as the specific scientific field is a critical parameter for optimizing the respective power flows and an essential factor in enhancing the further penetration of RES in the energy balance. These abilities, combined with the know-how and specialization of the students, will make them a highly attractive and competitive scientific staff, able to cope with the modern demands of the global labor market.

Learning results

Upon successful completion of the course, postgraduate students will be able to:

In terms of Knowledge:

1. To understand and recognize the need to use energy storage systems but also their role in the

energy requirements of Greece and the rest of the World.
2. To know the structure and operation of the basic energy storage systems from conventional and new technologies.
3. To know the structure and principle of operation of specialized electrochemical or electrocatalytic decomposition systems
4. To know the methods of Hydrogen production and its storage as a future fuel for energy production.
5. To know characteristics of supercapacitors.
6. To know the characteristics and operating principles of new technology accumulators.

In abilities level:
1. How to use tools to calculate the expected electrical energy density and to know methodologies for its optimization.
2. To study the difference in treatment of supercapacitors from high capacity capacitors and their possible applications.
3. To know the structure and functional characteristics of systems for the production and storage of hydrogen.
4. To know the structure and functional characteristics of new technology accumulators.

In terms of Skills:
1. To understand and solve complex problems related to energy storage systems as well as the taught material.
2. To generalize the knowledge they acquired and use it to solve problems they are not familiar with.
3. The ability to compare the advantages and disadvantages of different energy storage technologies. Finally, to propose the optimal technological solution for the efficiency of management of the stored energy.

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…*
	…….

- Decision making
- Work in an international environment
- Work in an Interdisciplinary environment
- Development of new research ideas
- Respect to the natural environment
- Criticism and self-criticism
- Promotion of free, creative and inductive thinking

(3) SYLLABUS

Lectures:
LESSON 1: General information from energy storage devices and technologies - their basic operating principles.

LESSON 2: Overview of existing storage technologies.

LESSON 3: Advanced knowledge in mechanical energy storage, indicative: Flywheels, compressed air, etc.

LESSON 4: Electrocatalytic decomposition.

LESSON 5: Electrochemical breakdown.

LESSON 6: Hydrogen production and storage.

LESSON 7: Fuel Cells (High and Low Temperature).

LESSON 8: Capacitors-Supercapacitors.

LESSON 9: Accumulators, batteries of various types.

LESSON 10: Industrial and other applications of storage systems.

LESSON 11: Design and modeling of storage systems.

LESSON 12: Hybrid storage systems.

LESSON 13: Comparative study of storage technologies, advantages, disadvantages.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face to Face in class
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Support of learning process through the platform "e-class" (slides ppt and communication). Helpful simulation programs
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*	Language for students' evaluation: Greek. Evaluation Method: Written exam (Short answer questions, solving problems using software): 50% Elaboration of Works concerning the solution of combined applications in the proposed technologies: 50%.

Activity	***Semester workload***
Lectures	26 hours
Exercises (in classroom)	13 hours
Writingassignments	39 hours
Project	20 hours
Literature survey and analysis	52 hours
Course Total (25 workload hours per credit)	***125 hours (5 ECTS)***

students.	

(5) ATTACHED BIBLIOGRAPHY

1. Burheim Odne Stokke, ΜΗΧΑΝΙΚΗ ΔΙΕΡΓΑΣΙΩΝ ΑΠΟΘΗΚΕΥΣΗΣ ΕΝΕΡΓΕΙΑΣ, έκδοση πρώτη, ISBN: 978-960-418-942-7.
2. Γεώργιος Σταυρακάκης «Συστήματα αποθήκευσης ενέργειας»Έκδοση: *Τεχνολογικό Εκπαιδευτικό Ίδρυμα Κρήτης – Τμήμα Ηλεκτρολόγων Μηχανικών & Πανεπιστήμιο Κρήτης – Τμήμα Χημείας*Άδεια διανομής: Ελεύθερη διάθεση
3. Λουκάς Γ. Χριστοφόρου Κατερίνα Παναγιωτακοπούλου, Παραγωγή, μεταφορά και αποθήκευση ενέργειας στην Ελλάδα: Ηλεκτρισμός-Φυσικό Αέριο-ΥδρογόνοΕκδόσεις Ακαδημίας Αθηνών.
4. Robert HugginsEnergy Storage Fundamentals, Materials and Applications Springer ISBN 978-3-319-21238-8
5. Nihal Kularatna, Kosala Gunawardane, Energy Storage Devices for Renewable Energy-Based Systems Rechargeable Batteries and Supercapacitors2nd Edition - May 13, 2021 ISBN:9780128207789.
6. Robert A. Huggins. Advanced BatteriesMaterials Science Aspect, Springer ISBN: 978-0-387-76423-8
7. Dr. Agus Purwanto, Dr. Hendri Widiyandari and Dr. Anif Jamaluddin, Energy Storage Technology and Applications, Scientific Net ISBN 9783035717068.