ΜΟΝΑΔΑ ΔΙΑΣΦΑΛΙΣΗΣ ΠΟΙΟΤΗΤΑΣ Α.Π.Θ.

Materials and Systems in Energy Technologies

1. GENERAL			
SCHOOL	Faculty of Sciences in collaboration with Faculty of Engineering, Aristotle University of Thessaloniki		
DEPARTMENT	Materials Science and Engineering		
LEVEL OF STUDIES	ISCED level 7 (5-year Integrated Master's programme) ISCED level 6 (4-year BSc programme)		
COURSE CODE	MSEN 822	SEMESTER	8th Semester
COURSE TITLE	**Materials and Systems in Energy Technologies**		
TEACHING ACTIVITIES Lectures, tutorials/problem sessions, laboratory/computer exercises (where applicable), case studies and guided self-study.		TEACHING HOURS PER WEEK	ECTS CREDITS
		4 (3L + 1T)	6
COURSE TYPE	Background / General Knowledge		
PREREQUISITES	none		
TEACHING AND EXAMINATION METHODS	Face – to – face lectures and guided problem-solving sessions; final written examination.		
COURSE OFFERED TO ERASMUS STUDENTS	Yes		
COURSE URL	https://elearning.auth.gr/course/view.php?id=xxxxx		

2. LEARNING OUTCOMES	
Learning Outcomes	**Knowledge** After successfully completing the course, students will be able to: • Explain how materials properties, microstructure and interfaces govern the performance of energy-related devices and systems. • Describe the roles of electrodes, electrolytes, separators and composite architectures in representative energy technologies such as batteries, electrochemical capacitors and fuel cells. • Understand transport phenomena (ionic, electronic, thermal and mass transport) in materials used within energy devices. • Interpret degradation mechanisms, aging processes and failure modes arising from materials selection and operating conditions. • Relate materials processing routes and interfacial design to efficiency, durability and reliability at the device and system level. **Skills**

	Upon completion, students will be able to: • Apply materials science principles to analyze structure-property-performance relationships in energy-related systems. • Evaluate materials selection criteria using performance metrics such as stability, conductivity, capacity and efficiency. • Perform basic characterization and performance assessment of materials and components within energy devices using laboratory measurements and diagnostic tools. • Analyze experimental data to identify materials-limited performance and degradation effects. **Abilities / Competences** Students will develop the ability to: • Integrate materials science concepts across length scales to assess the behavior of materials in functional energy devices. • Assess trade-offs between materials properties, processing complexity and system-level performance. • Identify materials-driven limitations and opportunities for improving device durability and reliability. • Communicate materials-focused analyses and experimental findings clearly in written and oral formats. • Connect this course with advanced subjects such as functional materials, interfaces, corrosion, electrochemistry and materials characterization.
General Skills	• Practical application of knowledge • Search, analysis and synthesis of data and information • Autonomous work • Teamwork • Working in a multidisciplinary environment

3. COURSE CONTENT

This course introduces materials-oriented principles underlying energy technologies, with emphasis on how material properties, interfaces and architectures govern the performance of functional devices and engineered systems. Building on concepts from electrochemical and materials science, students examine the role of electrodes, electrolytes, interfaces and composite structures in representative energy technologies such as batteries, electrochemical capacitors and fuel cells. The course highlights structure-property-performance relationships, materials selection criteria, transport phenomena and degradation mechanisms relevant to materials used in energy-related applications. Attention is given to how processing routes, microstructure and interfacial design influence efficiency, durability and reliability at the device and subsystem level. Laboratory demonstrations focus on materials characterization and performance assessment within energy-related systems, including electrochemical response, stability metrics and diagnostic analysis. By the end of the course, students will understand how materials science principles enable the design, optimization and integration of materials into complex energy technologies.

4. LEARNING & TEACHING METHODS - EVALUATION

Teaching method	Face-to-face.
Use of ICT	ICT will be used in teaching the course, and in communication with students: • teaching of the course with modern distance learning (ZOOM) and asynchronous education tools via elearning platform of AUTH, • communication with students via email, ZOOM, and elearning platform of AUTH.
Teaching organization	The supervised and unsupervised workload per activity is indicated below (total workload complies with ECTS standards).

Activity	Workload/semester (hours)
Lectures	32
Laboratory work	18
Bibliographic Research	16
Written assignements	32
Study	50
Final written exam	2
Total	**150**

Student evaluation

Assessment language
The assessment language is English.

Assessment methods
Written Assignment (Summative), Performance / Staging (Summative), Written Exam with Problem Solving (Summative)

Student information
Students are informed about the assessment process through:

- The course outline distributed in the first lecture.
- Detailed instructions for the written assignment and presentation posted on the course website.

A dedicated assessment briefing during tutoring time where expectations and criteria are explained.

5. SUGGESTED BIBLIOGRAPHY

EUDOXUS

1. "Electrochemical Power Sources: Batteries, Fuel Cells, and Supercapacitors ", V.S. Bagotsky, A.M. Skundin, Y.M. Volfkovich John Wiley & Sons (2015) 2. "Electrochemical Energy Storage", Reinhart Job, De Gruyter (2025) 3. "Electrochemical Energy Systems", Artur Braun, De Gruyter (2018) 4. "Hydrogen, Batteries and Fuel Cells", Bengt Sundén, Academic Press (2019) 5. "Fuel Cell Fundamentals", Ryan O'Hayre, Suk-Won Cha, Whitney Colella and Fritz B. Prinz, John Wiley & Sons (2016)
Additional bibliography for study
Teaching material slides