



ЦЕНТЪР ЗА ОБУЧЕНИЕ – БАН

1000 София
ул. „Сердика“ № 4
<http://edu.bas.bg>

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Basic Information:

Course Title: HYDROGEN ENERGY SYSTEMS

Lecturer: Assoc. Prof. Galin Rusev Borisov

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Total Teaching Hours: 30 hours of lectures

Annotation (up to 150 words)

The course is focused on the study of modern hydrogen technologies and their role in the transition toward sustainable and low-carbon energy systems. It presents the fundamental principles of hydrogen production, storage, and utilization as an energy carrier, including the concept of the green hydrogen cycle “from water to water.” The electrochemical processes occurring in electrolyzers, fuel cells, and other hydrogen systems are examined, together with their design features and operational characteristics. Special attention is given to the application of hydrogen technologies for the integration of renewable energy sources, reduction of carbon emissions, and development of sustainable solutions for industry, transportation, and residential applications. Current trends and future perspectives of the hydrogen economy are also discussed. The course combines theoretical knowledge with practical exercises and laboratory demonstrations. It is intended for graduate students, PhD candidates, researchers, and professionals in the fields of natural and engineering sciences.

Course content:

- Topic / Module 1: Introduction to Hydrogen Technologies and the Hydrogen Economy - The role of hydrogen in modern energy systems. Types of hydrogen and production methods. Green hydrogen and the “water-to-water” energy cycle. Environmental and economic aspects of the hydrogen economy.
- Topic / Module 2: Electrochemical Systems for Energy Production and Conversion - Fundamentals of electrochemistry. Operating principles of electrolyzers and fuel cells. Types of electrolyzers (AEL, PEM, AEM, and Zero-Gap) and fuel cells. Key performance characteristics, efficiency, and application areas.
- Topic / Module 3: Hydrogen Storage, Compression, and Applications - Methods for hydrogen storage and transportation. Hydrogen compressors and safety systems. Integration with renewable energy sources. Applications in energy, transportation, industry, and residential sectors. Practical exercises and laboratory demonstrations.

Teaching and assessment methods

The course includes lectures, practical exercises, laboratory demonstrations, and independent assignments. Assessment is based on continuous evaluation, participation in practical activities, completion of an individual assignment or project, and a final test or oral examination. Participants who successfully complete the course receive a certificate of completion in hydrogen technologies.

Competencies acquired as a result of training (3–5 points)

- Understanding of the fundamental principles of hydrogen technologies, hydrogen production, storage, and utilization.



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- Ability to analyze the operation and performance of electrolyzers, fuel cells, and related hydrogen systems.
 - Knowledge of integrating hydrogen technologies with renewable energy sources and sustainable energy systems.
 - Practical skills in working with laboratory equipment and experimental hydrogen systems.
 - Competence in applying hydrogen technologies in research, industry, and energy sectors while following safety and sustainability requirements.

Literature:

During the course, participants are provided with all necessary teaching materials, presentations, and supplementary information resources to ensure adequate theoretical and practical preparation. Additional specialized literature may be recommended when required.

Additional information:

No specific prior knowledge or preparation is required. All necessary educational materials and laboratory equipment are provided by the course organizers.