



## ЦЕНТЪР ЗА ОБУЧЕНИЕ – БАН

1000 София  
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### **Basic Information:**

Course Title: FUNDAMENTALS OF THE BRAIN-COMPUTER INTERFACE

Lecturer: prof. Anna Lekova

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Total Teaching Hours: 30

### **Annotation** (up to 150 words)

The course provides an opportunity to understand what an electro-encephalography (EEG)-based Brain-Computer Interface (BCI) is, and its mission to connect directly the person's brain activity with the digital world around us to control by cognitive intentions and emotional reactions. The course covers the basic concepts in the field, as well as the main methods and algorithms for registering, processing, classifying and translating EEG signals into machine commands. The course will cover the BCI design and development, BCI programming platforms and key application areas. The most used wireless and non-invasive mobile EEG-based devices will be addressed, as well as the ethical challenges and legal aspects of implementing BCI and processing EEG data. Brain-robot interfaces as well as BCI s operating in the "Internet of Things" to control "things" in "smart" homes will be discussed in detail.

### **Course content** (brief description by topics or modules)

Topic / Module 1: Fundamentals of EEG-based brain-computer interfaces; stages in the design and development of BCI systems.

Topic / Module 2: Types of wireless and non-invasive mobile EEG-based devices; application domains and ethical challenges.

Topic / Module 3: Brain-robot interfaces and BCIs in the Internet of Things (IoT). Cloud architectures for BCIs. Security and ethical considerations in BCI-IoT systems.

### **Teaching and assessment methods**

- 15 hours of in-person lectures
- 15 hours of practical/laboratory work
- Oral examination (final assessment)

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

1. Definition of BCIs. Types of BCIs, principles and practices. Advantages and limitations of platforms for building BCIs. Application domains of BCIs. Contemporary trends in the development of brain-robot, brain-brain, and brain-IoT interfaces. Cloud architectures for BCIs.
2. Non-invasive, portable, and wireless devices based on the principles of electroencephalography. Spatial and temporal resolution of the brain's electrical activity. Design platforms.
3. Analysis, design, and development of an EEG-based BCI. Main stages, levels, and models. Ethics in the use of BCIs and the processing of personal data.



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4. Analysis and processing of EEG signals in MATLAB. Filtering and artifact removal, visualization of EEG signals.

### Literature:

- [1]. Wolpaw, J. R., & Wolpaw, E. W. (Eds.). (2012). Brain–computer interfaces: Principles and practice. Oxford University Press.
- [2]. Kumar, S., & Sharma, A. (2025). Advances in non-invasive EEG-based brain–computer interfaces: Signal acquisition, processing, emerging approaches, and applications. *Advances in Neural Engineering*. <https://doi.org/10.1016/b978-0-323-95437-2.00014-8>
- [3]. Dhole, P. V., Chaudhary, D. G., Dhangar, V. D., Shejul, S. D., Datwase, S. S., & Gawali, B. W. (2025). *A review of EEG artifact removal techniques for brain–computer interface*. *SN Computer Science*, 6, Article 1026. <https://doi.org/10.1007/s42979-025-04592-z>
- [4]. Nam, C. S., Traylor, Z., Chen, M., Jiang, X., Feng, W., & Chhatbar, P. Y. (2021). Direct communication between brains: A systematic PRISMA review of brain-to-brain interface. *Frontiers in Neurorobotics*, 15, 656943. <https://doi.org/10.3389/fnbot.2021.656943>
- [5]. Rahaman, M. M. (2022). A Review on Internet of Things-IoT-Architecture, Technologies, Future Applications & Challenges. *International Journal of Science and Business*, 14(1), 80-92.
- [6]. Maki, Z., & Abdulhameed, A. (2025). Integrating a consumer brain-computer interface with IoT: A systematic review. *AIP Conference Proceedings*, 3169(1), 030031. <https://doi.org/10.1063/5.0256152>

**Additional information** (optional) (e.g., special requirements, laboratory equipment, prior knowledge)

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