



ЦЕНТЪР ЗА ОБУЧЕНИЕ – БАН

1000 София
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Basic Information:

Course Title: Innovative Approaches to Monitoring and Control of Biotechnological Processes

Lecturer: Prof. DSc Velislava Lyubenova

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Total Teaching Hours: 20 hours of lectures, 10 hours of practical exercises.

Annotation (up to 150 words)

The course is designed for the training of specialists and PhD students in the field of higher education 5. Technical Sciences, Professional Field 5.2 “Electrical Engineering, Electronics and Automation”. The aim of the course is to introduce contemporary innovative approaches, including hybrid metaheuristic algorithms, for modelling, monitoring, and control of biotechnological processes (BTPs).

During the laboratory exercises, PhD students will supplement, systematize, and deepen the knowledge acquired in the lectures. The main stages in the design of a modern monitoring and control system will be examined: database development; creation of biotechnological models and control models; structural and parametric identification of models; development of software sensors for unmeasurable variables and parameters based on related real-time measurements; construction of linearizing systems for nonlinear objects and their application in the synthesis of adaptive control. Each stage will be demonstrated using data from real bioprocesses. During the classroom exercises, PhD students will further supplement, systematize, and deepen the lecture material.

Course content (brief description by topics or modules)

Topic / Module 1: Contemporary approaches to process modelling and monitoring

Topic / Module 2: Hybrid metaheuristic algorithms and their applications

Topic / Module 3: Synthesis of adaptive control of biotechnological processes

Teaching and assessment methods

Forms of instruction: lectures, classroom exercises

Forms of assessment: course project, project defence

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

Course participants know and apply metaheuristic algorithms for modelling and monitoring of biotechnological processes (BTPs).

Course participants develop software implementations for structural and parametric identification of models.

Course participants synthesize and test algorithms for monitoring and control of biotechnological processes (BTPs).

Literature:

1. Dochain, D. (Ed.). (2013). Automatic Control of Bioprocesses. John Wiley & Sons.
<https://www.perlego.com/book/1009724/automatic-control-of-bioprocesses>



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2. Lyubenova, V., Kostov, G., & Denkova-Kostova, R. (2021). Model-based monitoring of biotechnological processes—a review. *Processes*, 9(6), 908.
Линк: <https://www.mdpi.com/2227-9717/9/6/908>
3. Roeva, O., Zoteva, D., Roeva, G., & Lyubenova, V. (2023). An Efficient Hybrid of an Ant Lion Optimizer and Genetic Algorithm for a Model Parameter Identification Problem. *Mathematics*, MDPI, 11(6), 1292.
<https://www.webofscience.com/wos/woscc/full-record/WOS:000959725600001>
<https://jcr.clarivate.com/jcr-jp/journal-profile?journal=MATHEMATICS-BASEL&year=2023>
4. Lyubenova, V., Ignatova, M., Zoteva, D., & Roeva, O. (2024). Model-Based Adaptive Control of Bioreactors—A Brief Review. *Mathematics*, MDPI, 12(14), 2205
<https://www.webofscience.com/wos/woscc/full-record/WOS:001277053400001>
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5. Lyubenova, V., Zoteva, D., Ignatova, M., Kristeva, D., & Roeva, O. (2025). A System Designed for Modelling, Monitoring, and Control of Fermentation Processes, Powered by Metaheuristic Algorithms. *Processes*, 13(6), 1632.
<https://www.mdpi.com/2227-9717/13/6/1632>
6. Roeva, O., Roeva, G., & Chorukova, E. (2024). Crow Search Algorithm for modelling an anaerobic digestion process: Algorithm parameter influence. *Mathematics*, 12(15), 2317.
<https://www.mdpi.com/2227-7390/12/15/2317>
7. Jin, X.-B., & Jeremiah. (2021). The new trend of state estimation: From model-driven to hybrid-driven methods. *Sensors*, 21, 2085.
<https://www.mdpi.com/1424-8220/21/6/2085>
8. Li, G., Zhang, T., Tsai, C. Y., Yao, L., Lu, Y., & Tang, J. (2024). Review of the metaheuristic algorithms in applications: Visual analysis based on bibliometrics. *Expert Systems with Applications*, 255, 124857.
https://www.researchgate.net/publication/382512812_Review_of_the_metaheuristic_algorithms_in_applications_Visual_analysis_based_on_bibliometrics_1994-2023.....

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