

**DESCRIPTION/Syllabi of Curricula/Module**

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| <b>Short Name of the University/Country code</b><br><b>Date (Month / Year)</b> | <b>DSEA/P11</b><br><b>Sept 2020</b> |
| <b>TITLE OF THE MODULE</b>                                                     | <b>Code</b>                         |
| Mathematical modeling in biotechnical systems                                  | 2.2.5                               |

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| <b>Teacher(s)</b>                                              | <b>Department</b>                                          |
| <b>Coordinating:</b> Liudmyla Vasylieva, PhD<br><b>Others:</b> | Department of Computer and Information<br>Technology (CIT) |

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|--------------------------------------|--------------------------------------------------------|-----------------------------------------------------------|
| <b>Study cycle</b><br><b>(BA/MA)</b> | <b>Level of the module</b><br><b>(Semester number)</b> | <b>Type of the module</b><br><b>(compulsary/elective)</b> |
| MA                                   | 2st semester (first year) for<br>Masters               | Elective                                                  |

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| <b>Form of delivery</b><br><b>(theory/lab/exercises)</b> | <b>Duration</b><br><b>(weeks/months)</b> | <b>Language(s)</b>  |
| Lectures, exercises                                      | 18 weeks                                 | Ukrainian / English |

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| <b>Prerequisites</b>                                                                                                        |                                      |
| <b>Prerequisites:</b><br><br>study of the cycle of bachelor's degree disciplines<br>in the specialty 122 "Computer Science" | <b>Co-requisites (if necessary):</b> |

| ECTS<br>(Credits of the module)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Total student workload<br>hours                                    | Contact hours                                               | Individual work hours |
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| 5,5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 165                                                                | 72                                                          | 93                    |
| Aim of the module (course unit): competences foreseen by the study programme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                    |                                                             |                       |
| <p>The goal of the discipline is the formation of cognitive, affective, and psychomotor competencies in the field of application of mathematical modeling methods in biotechnical systems in professional activities, the development of object models, and the implementation of algorithms using modern programming languages and existing software.</p> <p>Students should be able:</p> <ul style="list-style-type: none"><li>- to use system analysis to obtain information about activities in various subject areas (technical, organizational, technical, and medical purpose) and use knowledge of the patterns of random phenomena, their properties and operations on them, models of random processes, and modern software environments for solving problems of statistical data processing and building predictive models.</li><li>- reasonably choose and improve numerical methods and the possibility of their adaptation when performing modeling tasks and studying systems of various nature.</li><li>- to perform modeling and research of technical, organizational, and technical systems, products, and systems for medical purposes; use operations research methods.</li></ul> |                                                                    |                                                             |                       |
| Learning outcomes of module (course unit)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Teaching/learning<br>methods<br>(theory, lab, exercises)           | Assessment methods<br>(written exam, oral exam,<br>reports) |                       |
| <p><b>Knowledge:</b></p> <ul style="list-style-type: none"><li>- knowledge of the basics of methodology for modeling biological, technical and biotechnical systems; possession of a systematic approach to their modeling;</li><li>- the ability to create and research mathematical models of technical and biological components of biotechnical systems, to take into account their mutual influence;</li><li>- ability for mathematical and logical thinking, formulation and research of mathematical models, substantiation of the choice of methods and approaches for solving theoretical and applied problems in the field of computer science, interpretation of the results obtained in various subject areas (technical, medical, etc.);</li><li>- the ability to process the results obtained, analyze, comprehend and present them, substantiate the proposed solutions at the modern scientific and technical level;</li><li>- the ability to use, develop</li></ul>                                                                                                                                                                                                                   | Working with lecture notes and basic literature on relevant topics | Knowledge test                                              |                       |

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| and research mathematical methods and algorithms for data processing.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                             |                                                                    |
| <b>Skills:</b> <ul style="list-style-type: none"> <li>- be able to plan and implement computer experiments with models using modern information technologies;</li> <li>- to apply the acquired modeling skills in the process of analysis and synthesis of biotechnical systems and their components;</li> <li>- control the results of one's own efforts in the educational process and correct (with the help of a teacher) these efforts to eliminate gaps in the assimilation of educational material or the formation of skills;</li> <li>- independently carry out the search, systematization, generalization of educational material, develop options for solving problems, and choose the most rational of them.</li> </ul>      | Lectures, practical training, consultations | Active attendance of lectures, individual project and presentation |
| <b>Competences:</b> <ul style="list-style-type: none"> <li>- critically comprehend lecture and non-selective educational material, argue based on theoretical material, apply the studied methods of finding optimal solutions in relevant practical problems; solve problems using software packages when using computers, implement high-performance computing based on modern services and technologies;</li> <li>- be able to present the results of modeling and in the process of discussion with other students to justify their conclusions.</li> <li>- the ability to communicate with representatives of other professional groups of different levels (with experts from other fields of knowledge and activities).</li> </ul> | Lectures, practical training, consultations | Individual project and presentation                                |

| Themes | Contact work hours | Time and tasks for individual work |
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|                                                                                                                                                                                                                                             | Lectures  | Consultations | Seminars | Practical work | Laboratory work | Placements | Total contact work | Individual work | Tasks                                               |
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| 1. The concept and characteristics of systems. Biotechnical systems and their features. Essence and general principles of systems modeling. Mathematical modeling. Basic requirements for mathematical models and their characteristics.    | 8         |               |          | 6              |                 |            | 14                 | 18              | Study exam/<br>complete design<br>of practical work |
| 2. Fundamentals of construction and identification of objects and parameters of mathematical models based on experimental dependencies, fundamentals of correlation, and regression analysis. Statistical modeling of biotechnical systems. | 6         |               |          | 6              |                 |            | 14                 | 19              | Study exam/<br>complete design<br>of practical work |
| 3. Linear models. Statistical criteria. Checking the model for adequacy. Statistical significance of the parameters.                                                                                                                        | 6         |               |          | 8              |                 |            | 14                 | 18              | Study exam/<br>complete design<br>of practical work |
| 4. Non-linear models. Collinearity and multicollinearity. Types of the forecast.                                                                                                                                                            | 8         |               |          | 8              |                 |            | 16                 | 18              | Study exam/<br>complete design<br>of practical work |
| 5. Dynamic data. Time series analysis. Row smoothing methods.                                                                                                                                                                               | 8         |               |          | 8              |                 |            | 16                 | 20              | Study exam/<br>complete design<br>of practical work |
| <b>Total</b>                                                                                                                                                                                                                                | <b>36</b> |               |          | <b>36</b>      |                 |            | <b>72</b>          | <b>93</b>       |                                                     |

| Assessment strategy          | Weight in % | Deadlines                  | Assessment criteria                                          |
|------------------------------|-------------|----------------------------|--------------------------------------------------------------|
| Written theory exam          | 40%         | during the semester / exam | good response to questions                                   |
| Practical exam on a computer | 60%         | during the semester / exam | the work is done completely without mistakes or minor errors |

| Author                                                                                            | Year of issue | Title                                                              | No of periodical or volume | Place of printing. Printing house or internet link  |
|---------------------------------------------------------------------------------------------------|---------------|--------------------------------------------------------------------|----------------------------|-----------------------------------------------------|
| <b>Compulsory literature</b>                                                                      |               |                                                                    |                            |                                                     |
| В.А. Устюжанин, И.В. Яковлева                                                                     | 2014          | Моделирование биотехнических систем                                |                            | Старый Оскол: ТНТ – 215 с.                          |
| Montgomery, Douglas C.                                                                            | 2017          | Design and analysis of experiments.                                |                            | John wiley & sons                                   |
| Wu, Cf Jeff; Hamada, Michael S.                                                                   | 2011          | Experiments: planning, analysis, and optimization                  |                            | John Wiley & Sons                                   |
| Fedorov, V. V.                                                                                    | 2013          | Theory of optimal experiments.                                     |                            | Elsevier                                            |
| Гліненко Л.К., Сухонос О.Г.                                                                       | 1999          | Основи моделювання технічних систем                                |                            | Львів: “Ніка-ПЛЮС”. – 204 с.                        |
| Филатова Н.Н.                                                                                     | 2008          | Моделирование биотехнических систем                                |                            | Тверь: ТГТУ – 144 с.                                |
| О. Э. Соловьева, В. С. Мархасин, Л. Б. Кацнельсон, Т. Б. Сульман, А. Д. Васильева, А. Г. Курсанов | 2013          | Математическое моделирование живых систем                          |                            | Екатеринбург : Изд-во Урал, ун-та. — 328 с.         |
| <b>Additional literature</b>                                                                      |               |                                                                    |                            |                                                     |
| В.А.Павлиш, Л.К. Гліненко                                                                         | 2013          | Основи інформаційних технологій і систем                           |                            | Львів: Видавництво львівської політехніки. - 500 с. |
| J.Enderle, J.Bronzino.                                                                            | 2012          | Introduction to Biomedical Engineering                             |                            | Elsevier Inc.                                       |
| Khoo M.C.K.                                                                                       | 2015          | Physiological Control Systems. AnaLysis, Simulation and Estimation |                            | John Wiley & Son, Inc.                              |