| Z1-PU7 | WYDANIE N1 | Strona 1 z 3 |
|---|---|---|

(*faculty stamp*)

**COURSE DESCRIPTION**

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|---|---|
| **1.Course title:** Mathematical modeling in theory and implementations | **2. Course code:** WM1 |
| **3. Validity of course description:** 2020/21 | |
| **4. Level of studies:** 1st cycle of higher education | |
| **5. Mode of studies:** intramural studies | |
| **6. Field of study**: COMPUTER SCIENCE | (RMS) |
| **7. Profile of studies:** general academic | |
| **8. Programme:** all programmes | |
| **9. Semester:** 5 | |
| **10. Faculty teaching the course:** Institute of Mathematics | |
| **11. Course instructor**: Professor Władimir Mitiuszew | |
| **12. Course classification:** course of limited choice | |
| **13. Course status:** monographic | |
| **14. Language of instruction:** English | |

**15. Pre-requisite qualifications:**

Basic knowledge of data structures and algorithms. Basic knowledge of calculus and algebra. Basic knowledge of English. Skills to use computer on the basic level. Skills to operate by mathematical objects: calculation of derivatives and integrals, vector-matrix operations. Communication and project management skills to work in a team. Foundations of programming, theoretical foundations of computer science, mathematics, algorithms and data structures, programming procedures.

**16. Course objectives:**

The main course objectives is to teach students to develop mathematical models applied to various topics of engineering investigations used in different fields of economics and administration. The developed models concern topics of topics of physics, technology and real world problems of economy, biology and natural sciences. The special attention is paid to practical laboratory exercisers during which the students prepare individual and collective projects on the stated problems. Other goal of the course knowledge in computer simulations and science in order to be prepared to the second level education in applied mathematics and informatics. The course is given in English.

**17. Description of learning outcomes:**

**Student who has completed the subject:**

| Nr | Learning outcomes description | Method of assessment | Teaching methods | Learning outcomes reference code |
|---|---|---|---|---|
| 1. | W01: has general knowledge in the theory of mathematical modeling, basic algorithms and numerical methods | Test | Lecture/laboratory | K1P_U11<br>K1P_K01<br>K1P_K02 |
| 2. | W02: can use the tools of symbolic and numerical computations | Test | Lecture/laboratory | K1P_U11<br>K1P_K01 |
| 3. | U01: work out and develop mathematical models of the selected topics concerning informatics, mechanics, mathematics, physics, technology, economy | Project | Lecture/laboratory | K1P_U11<br>K1P_K01 |
| 4. | U02: can prepare a project (document) concerning mathematical models and can propose a corresponding simulation method | Project | Lecture/laboratory | K1P_U11<br>K1P_K01 |
| 5. | U03: can present the result of computer simulations in visual form including graphs, animations, can make conclusions on the basis of her/his results and can give practical recommendations | Project | Laboratory | K1P_U11<br>K1P_K01 |
| 6. | K01: can cooperate in a team to prepare a project, can cooperate with a customer (client) who has not the corresponding mathematical and computer knowledge and skills | Project | Laboratory | K1P_U11<br>K1P_K01 |

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|---|---|---|---|---|
| 7. | K02: can use various courses of information (including networks) to extend her/his knowledge and to get new skills | Project | Laboratory | K1P_U11<br>K1P_K01<br>K1P_K02 |

**18. Teaching modes and hours**

| Lecture | Class | Laboratory | Projekt | Seminar |
|---|---|---|---|---|
| 30 | | 30 | | |

**19. Syllabus description:**

1. Introduction and principles to develop a mathematical model.
2. Classification of models: deterministic and stochastic, continuous and discrete, linear and non-linear.
3. Computer implementation of mathematical models.
4. Mathematical models in the form of ordinary differential equations.
5. Visualization and animation of graph procedures.
6. Least Square Method.
7. Method of Monte Carlo.
8. Approximation of data and its visualization.
9. Application of the graph theory to problems of bioinformatics.

**20. Examination:** no

**21. Primary sources:**

1. V. Mityushev, N.Rylko, W. Nawalaniec, Introduction to Mathematical Modeling and Computer Simulations, CRC – Taylor & Francis, Boca Raton, 2018
2. V. Mityushev, W. Nawalaniec N. Ryłko, A. Malevich, *Podstawy matematyki przemysłowej, tom 1 – „Matematyczne modelowanie i symulacje komputerowe", tom 2 – „Zagadnienia wielowymiarowe", tom 3 – „Podstawy obliczeń, przykłady"*, Wydawnictwo Pracowni Komputerowej Jacka Skalmierskiego, Gliwice, 2010.
3. W. Krauth: Statistical mechanics: algorithms and computations, Oxford, 2006.
4. Z. Artstein, Mathematics and the Real World: The Remarkable Role *of Evolution in the Making of Mathematics*. Prometheus Books, Amherst, New York, 2014.
5. H. Gliński, R. Grzymkowski, A. Kapusta, D. Słota, *Mathematica 8*, Wydawnictwo Pracowni Komputerowej Jacka Skalmierskiego, Gliwice, 2012. (selected parts)

**22. Secondary sources:**

1. S. Mangano, *Mathematica Cookbook*, O'Reilly Media, 2010.
2. K. F. Riley, M. P. Hobson and S. J. Bence, Mathematical Methods for Physics and Engineering, 2006
3. S. Gluzman, V. Mityushev, W. Nawalaniec, Computational Analysis of Structured Media, Elsevier, Amsterdam, 2017
4. H.-J. Bungartz, S. Zimmer, M. Buchholz, D. Pfluger, *Modeling and Simulation. An Application-Oriented Introduction*, Springer-Verlag, New York etc, 2014
5. *Mathematica 8. Handbook*, Wolfram Research, 2006.
6. A. Grinko, A. Karpuk, V. Mityushev (Junior), V. Mityushev, N. Ryłko, *Ekonometria od podstaw z przykładami na EXCELU*, Wydawnictwo Pracowni Komputerowej Jacka Skalmierskiego, Gliwice, 2010.
7. D. Basmadjian, R. Farnood, *The Art of Modeling in Science and Engineering with Mathematica, Second Edition*, Chapman & Hall/CRC, 2006.
8. V. Andrianov, L. I. Manevitch, *Asymptotology: Ideas, Methods, and Applications*, Kluwer Academic Publishers, 2002.
9. A.I. Borisenko, I.E. Tarapov, *Vector and tensor analysis with applications*, Dover, 1979.
10. R. Grzymkowski, D. Słota, *Computational Methods for Integral Equations*. Silesian Technological University Publ., Gliwice, 2015.
11. J. Jost, *Mathematical Methods in Biology and Neurobiology*. Springer-Verlag, London, 2014.
12. V. V. Mityushev; S. V. Rogosin, *Constructive Methods for Linear and Nonlinear Boundary Value Problems for Analytic Functions: Theory and Applications*, Chapman & Hall/CRC Press, Boca Raton, 2000.

**23. Total workload required to achieve learning outcomes**

| Lp. | Teaching mode : | Contact hours / Student workload hours |
|---|---|---|
| 1 | Lecture | 30/30 |
| 2 | Classes | / |
| 3 | Laboratory | 30/40 |
| 4 | Project | /20 |
| 5 | BA/ MA Seminar | / |
| 6 | Other | / |
| | Total number of hours | 60/90 |

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| **24. Total hours:** 150 |
| **25. Number of ECTS credits:** 5 |
| **26. Number of ECTS credits allocated for contact hours:** 4 |
| **27. Number of ECTS credits allocated for in-practice hours (laboratory classes, projects):** 3 |
| **26. Comments:**<br>In the course student can collect 100 points: 30 points for the project, 30 points for the final test and 40 points for the laboratories. For passing the course it is required to collect 41 points altogether, including at least 12 points for the project, 12 points for the final test and 17 points for the laboratories. The grade will be given according to the number of collected points, in the following way:<br>41-55 p.: sufficient (3.0)<br>56-70 p.: plus sufficient (3.5)<br>71-80 p.: good (4.0)<br>81-90 p.: plus good (4.5)<br>91-100 p.: very good (5.0) |

Approved:

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*(date, Instructor's signature)* (*date , the Director of the Faculty Unit signature)*