



Subject card

|   |  |  |                                     |            |  |         |     |
|---|--|--|-------------------------------------|------------|--|---------|-----|
| Subject name and code                       | Numerical modelling in biomedical engineering, PG_00065016   |  |                                     |            |  |         |     |
| Field of study                              | Mechanical and Medical Engineering   |  |                                     |            |  |         |     |
| Date of commencement of studies             | February 2026  | Academic year of realisation of subject  |                                     |            | 2026/2027  |         |     |
| Education level                             | second-cycle studies   | Subject group  |                                     |            | Obligatory subject group in the field of study<br>Subject group related to scientific research in the field of study |         |     |
| Mode of study                               | Full-time studies  | Mode of delivery   |                                     |            | at the university  |         |     |
| Year of study                               | 1  | Language of instruction  |                                     |            | Polish   |         |     |
| Semester of study                           | 2  | ECTS credits   |                                     |            | 4.0  |         |     |
| Learning profile                            | general academic profile   | Assessment form  |                                     |            | assessment   |         |     |
| Conducting unit                             | Department of Mechanics of Materials and Structures -> Faculty of Civil and Environmental Engineering -> Faculties of Gdańsk University of Technology  |  |                                     |            |  |         |     |
| Name and surname of lecturer (lecturers)    | Subject supervisor   | prof. dr hab. inż. Wojciech Witkowski  |                                     |            |  |         |     |
|   | Teachers   |  |                                     |            |  |         |     |
| Lesson types                                | Lesson type  | Lecture  | Tutorial                            | Laboratory | Project  | Seminar | SUM |
|   | Number of study hours  | 15.0   | 0.0                                 | 0.0        | 30.0   | 0.0     | 45  |
|   | E-learning hours included: 0.0   |  |                                     |            |  |         |     |
| Learning activity and number of study hours | Learning activity  | Participation in didactic classes included in study plan   | Participation in consultation hours | Self-study | SUM  |         |     |
|   | Number of study hours  | 45   | 11.0                                | 44.0       | 100  |         |     |
| Subject objectives                          | Introduction to finite element method modelling of selected anatomical structures  |  |                                     |            |  |         |     |
| Learning outcomes                           | Course outcome   | Subject outcome  |                                     |            | Method of verification   |         |     |
|   | [K7_K11] is aware of importance of professional acting, the need for critical verification of acquired knowledge and consulting experts opinion in case of facing difficulties with individual problem solving | student is able to critically evaluate the numerical results obtained by himself.  |                                     |            | [SK5] Assessment of ability to solve problems that arise in practice   |         |     |
|   | [K7_W04] has structured and well-founded knowledge covering issues in the field of mechanical engineering allowing to design medical devices, rehabilitation systems and to formulate research procedures      | student possesses advanced knowledge necessary to understand the social, economic, legal, ecological, and other non-technical determinants of engineering activities in the field of mechanical and medical engineering. |                                     |            | [SW1] Assessment of factual knowledge  |         |     |
|   | [K7_U13] evaluates the feasibility and potential for utilizing new technical and technological achievements in accomplishing tasks characteristic for the field of study                                       | student is able to select appropriate tools (measurement, analytical, or numerical) for solving problems related to numerical modeling, as well as for acquiring, evaluating, processing, and analyzing data             |                                     |            | [SU1] Assessment of task fulfilment  |         |     |
|   | [K7_U01] uses acquired analytical, simulation and experimental methods as well as mathematical models to solve engineering problems in the field of medical engineering  | student is able to select appropriate tools (measurement, analytical, or numerical) for solving problems related to numerical modeling, as well as for the acquisition, evaluation, processing, and analysis of data.    |                                     |            | [SU4] Assessment of ability to use methods and tools   |         |     |

| Subject contents   | <p>Course content – lecture<br/>Introduction to nonlinear continuum mechanics. Selected problems in nonlinear finite element method (FEM) modeling. Selected problems of constitutive relations in biomechanics. Presentation of finite element method biomechanical models in commercial FEM systems. Case studies in FEM modelling and in imaging of anatomical structures of human body</p> <hr/> <p>Course content – project<br/>Familiarization with the FEBio Studio Software Interface:<br/>Acquisition of fundamental information about the program, the ability to create a simple model, and to perform numerical computations for it.</p> <p>Finite Element Mesh Generation:<br/>Creation of finite element (FE) meshes for geometries imported from external software; definition of FE meshes for geometries created directly within the program; selection of appropriate finite element types.</p> <p>Modeling of Soft Tissues:<br/>Selection of a suitable constitutive material model; definition of local coordinate directions to account for fiber orientation within the material.</p> <p>Definition of Boundary Conditions:<br/>Specification of displacement-based support conditions and external loads acting on the model.</p> <p>Execution of Nonlinear Analyses:<br/>Definition of computational steps and selection of appropriate parameters for nonlinear analysis.</p> <p>Definition of Interactions Between Model Components:<br/>Creation of rigid constraints between parts; definition of surface-to-surface contact interactions; selection of appropriate contact parameters.</p> <p>Verification of Simulation Results:<br/>Assessment of the correctness of obtained results, critical evaluation of simulation outputs, and the ability to perform finite element mesh convergence analysis.</p> <p>Analysis and Interpretation of Simulation Results:<br/>Extraction and evaluation of selected simulation results; interpretation of stress and strain distributions in the context of biomechanics.</p> |   |  |                          |                   |                               |         |      |       |         |      |       |
|--|---|---|--|--------------------------|-------------------|-------------------------------|---------|------|-------|---------|------|-------|
| Prerequisites and co-requisites                                |   |   |  |                          |                   |                               |         |      |       |         |      |       |
| Assessment methods and criteria                                | <table border="1"> <thead> <tr> <th data-bbox="451 983 794 1016">Subject passing criteria</th> <th data-bbox="794 983 1137 1016">Passing threshold</th> <th data-bbox="1137 983 1487 1016">Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td data-bbox="451 1016 794 1050">Project</td> <td data-bbox="794 1016 1137 1050">0.0%</td> <td data-bbox="1137 1016 1487 1050">50.0%</td> </tr> <tr> <td data-bbox="451 1050 794 1084">Lecture</td> <td data-bbox="794 1050 1137 1084">0.0%</td> <td data-bbox="1137 1050 1487 1084">50.0%</td> </tr> </tbody> </table>  |   |  | Subject passing criteria | Passing threshold | Percentage of the final grade | Project | 0.0% | 50.0% | Lecture | 0.0% | 50.0% |
| Subject passing criteria                                       | Passing threshold   | Percentage of the final grade   |  |                          |                   |                               |         |      |       |         |      |       |
| Project  | 0.0%  | 50.0%   |  |                          |                   |                               |         |      |       |         |      |       |
| Lecture  | 0.0%  | 50.0%   |  |                          |                   |                               |         |      |       |         |      |       |
| Recommended reading  | <p>Basic literature</p> <p>Supplementary literature</p> <p>eResources addresses</p>   | <p>FEBio Theory Manual<br/>FEBio User Manual</p> <p>RAKOWSKI G., KACPRZYK Z.: Metody elementów skończonych w mechanice konstrukcji. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 1993</p> |  |                          |                   |                               |         |      |       |         |      |       |
| Example issues/<br>example questions/<br>tasks being completed |   |   |  |                          |                   |                               |         |      |       |         |      |       |
| Practical activities within the subject                        | Not applicable  |   |  |                          |                   |                               |         |      |       |         |      |       |

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