GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Numerical modelling in biomedical engineering, PG_00065016		
Field of study	Modelowanie numeryczne w inżynierii medycznej		
Date of commencement of studies	February 2025	Academic year of realisation of subject	2025/2026
Education level	second-cycle studies	Subject group	Obligatory subject group in the field of study 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_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] Ocena umiejętności korzystania z metod i narzędzi
[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] Ocena wiedzy faktograficznej
[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] Ocena realizacji zadania
[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] Ocena umiejętności rozwiązywania problemów występujących w praktyce

<table>
<tr><td>Subject contents</td><td>Course content – lecture
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

Course content – project
Familiarization with the FEBio Studio Software Interface:
Acquisition of fundamental information about the program, the ability to create a simple model, and to perform numerical computations for it.

Finite Element Mesh Generation:
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.

Modeling of Soft Tissues:
Selection of a suitable constitutive material model; definition of local coordinate directions to account for fiber orientation within the material.

Definition of Boundary Conditions:
Specification of displacement-based support conditions and external loads acting on the model.

Execution of Nonlinear Analyses:
Definition of computational steps and selection of appropriate parameters for nonlinear analysis.

Definition of Interactions Between Model Components:
Creation of rigid constraints between parts; definition of surface-to-surface contact interactions; selection of appropriate contact parameters.

Verification of Simulation Results:
Assessment of the correctness of obtained results, critical evaluation of simulation outputs, and the ability to perform finite element mesh convergence analysis.

Analysis and Interpretation of Simulation Results:
Extraction and evaluation of selected simulation results; interpretation of stress and strain distributions in the context of biomechanics.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td></td></tr>
<tr><td>Assessment methods and criteria</td><td>
<table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Project</td><td>0.0%</td><td>50.0%</td></tr>
<tr><td>Lecture</td><td>0.0%</td><td>50.0%</td></tr>
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<tr><td>Recommended reading</td><td>
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<tr><td>Basic literature</td><td>FEBio Theory Manual
FEBio User Manual</td></tr>
<tr><td>Supplementary literature</td><td>RAKOWSKI G., KACPRZYK Z.: Metody elementów skończonych w mechanice konstrukcji. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 1993</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
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<tr><td>Example issues/ example questions/ tasks being completed</td><td></td></tr>
<tr><td>Practical activites within the subject</td><td>Not applicable</td></tr>
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