GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Calculation of coupled problems in medical engineering, PG_00057883		
Field of study	Mechanical and Medical Engineering		
Date of commencement of studies	February 2023	Academic year of realisation of subject	2023/2024
Education level	second-cycle studies	Subject group	
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish Polish
Semester of study	2	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Zakład Konstrukcji Maszyn i Inzynierii Medycznej -> Institute of Mechanics and Machine Design -> Faculty of Mechanical Engineering and Ship Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Leszek Dąbrowski	
	Teachers		

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	0.0	0.0	0.0	30.0	0.0	30

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	30	0.0	0.0	30

Subject objectives

The aim of the course is to develop skills achieved during the Engineer Course in the field of computer-aided engineering. Students gain practice in the field of computing additional phenomena (movement of mechanisms, heat transfer and thermal deformation, air circulation) and analytical methods (optimization, graphic method of parametric FEM modeling). Subject specific to medical engineering covers tomographic data analysis and their use for the construction of FEM models of bone tissue.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_K03] He/she can analyze and realize given tasks proposing entrepreneur and creative activities	solve complex computational problems	[SK4] Assessment of communication skills, including language correctness
[K7_U04] He/she can use programming-communicative techniques concerning to the scope of engineering tasks	solves problems in different areas of engineering	[SU5] Assessment of ability to present the results of task [SU1] Assessment of task fulfilment
[K7_U08] He/she can formulate and verify hypotheses for simple engineering problems and research	solves problems by finite element method	[SU1] Assessment of task fulfilment

Subject contents	1. The simulation of the movement: the construction of the beam FEM model of a mechanism, modal analysis and determining the integration step in the simulation by implicite method (ANSYS system), simulation of a drive with constant speed, movement visualization, plotting trajectories and Fourier analysis for selected points, conclusions for necessary changes in structure. 2. Simulation of heat transfer and thermal deformation: building solid FEM model, description of the characteristic boundary conditions, calculations of the stationary or time-varying (specifying the integration time step of providing convergent solution), possible structural conclusions. 3. Calculation of air flow: the construction of a room model (fluid domain) with hexahedron elements (ignoring the volume of items in the room), design of a surface to describe the boundary conditions of flow and heating of the air to describe the computational features of the model, the description of the boundary conditions, the simulation and evaluation of thermal comfort in selected locations of the room. 4. Construction of parametric FEM model in computer 3D modeling environment in DesignModeler program from ANSYS package. 5. Analysis of tomographic images: acknowledging the DICOM file format, verification of the anonymity of patient data, recognition the dimensions of a vortex in the 3D image, construction of a three-dimensional matrix of individual tomographic sections, based on the matrix, performing of any flat sections of the three-dimensional image, bone edge detection on the CT image, presentation of approximate 3D image of bones based on radiological density isosurfaces. 6. FEM calculation of narrow bone sample : application to tomographic image of the finite element mesh, assigning varied Young's modulus to individual elements based on the local density of radiation (expressed in Hounsfield units), the description of the simplified boundary conditions (support and pressure) and conclusions about the location, threats and rehabilitation of the regions of reduced bone mineral density.
Prerequisites and co-requisites	
Assessment methods and criteria	

Subject passing criteria	Passing threshold	Percentage of the final grade
Project	50.0%	100.0%

Recommended reading	Basic literature	Course Website: http://www.kkiem.mech.pg.gda.pl/oacm/imm/
	Supplementary literature	-
	eResources addresses	Adresy na platformie eNauczanie:
Example issues/ example questions/ tasks being completed	1. Simulation of a crankshaft drive of different construction.2. Thermal calculations in cryotherapy devices (including effects on tissue).3. Calculating the circulation of air flow through a hospital room with different configurations of airconditioning, ventilation, windows, doors, radiators, patient beds' position, determination of thermalcomfort of patients.4. Rating the strength of the support (of different designs) loaded engine based on the FEM modeldeveloped parametrically in a graphical 3D environment.5. Tomographic image analysis of selected bone of the foot.6. FEM calculations of a part of selected bones of the foot.	
Work placement	Not applicable	

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