GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Mechanics of materials, PG_00057369		
Field of study	Mechanical Engineering		
Date of commencement of studies	February 2024	Academic year of realisation of subject	2023/2024
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	1	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Institute of Ocean Engineering and Ship Technology -> Faculty of Mechanical Engineering and Ship Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Beata Zima	
	Teachers	mgr inż. Paweł Bielski dr hab. inż. Bogdan Rozmarynowski	

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	30.0	0.0	0.0	0.0	60
	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	60	10.0	30.0	100

Subject objectives	1. Providing knowledge in the field of analysis and solving problems of mechanics and strength of one-dimensional systems (bars, beams, frames) and selected two-dimensional systems (shield, plates). 2. Preparing the student to solve problems involving complex cases of material strength. 3.Developing the ability to assess the stability of structural elements (forms of stability loss, critical forces). 4. Consolidation of skills of numerical solutions using FEM (finite element method).

Learning outcomes	<table><tr><th>Course outcome</th><th>Subject outcome</th><th>Method of verification</th></tr><tr><td>[K7_W02] possesses a wide and profound knowledge on continuum mechanics and materials strength within the range of modelling and simulating multi-function mechanical systems</td><td>The student is able to define the types of planar and spatial bar and surface systems and determine the functions of internal forces (freely supported beams, continuous beams, statically determinate and indeterminate frames, trusses, grids, shields, plates). The student knows how to recognize deformation states (axial and eccentric tension / compression, bending, torsion) and can perform calculations in terms of the state of deformation and stress.</td><td>[SW1] Assessment of factual knowledge</td></tr><tr><td>[K7_U06] when solving engineering problems on design, technology and operation of machines is able to assess and classify typical methods and tools, define systemic and ex-technical aspects using modern calculating methods and design tools or modifying the current ones</td><td>The student supported by knowledge of mathematical methods of analysis and numerical experiments can apply it to solving engineering tasks of the above-mentioned scope using the Finite Element Method apparatus as a modern and effective computational method implemented in commercial computer systems (eg Femap, Ansys).</td><td>[SU2] Assessment of ability to analyse information [SU4] Assessment of ability to use methods and tools</td></tr><tr><td>[K7_W01] possesses a profound mathematical knowledge useful in the analysis and description of the operation of complex mechanical systems, technological processes and operating properties of machines and devices; is familiar with the main development trends</td><td>The student has the ability to use computational methods as well as strength and material analysis techniques to analyze and describe the operation of the mentioned systems, processes and device properties.</td><td>[SW1] Assessment of factual knowledge</td></tr></table>
Subject contents	1. Introduction, classification of structure elements. Specification and definitions of elements of bar and planar structures. The problem of the degree of static indeterminacy. Presentation: Internal forces in 3D systems. 2. Stress analysis. Definition of the stress vector with its components in the normal and tangential directions in the case of a three-dimensional Cartesian space; The concept of a stress tensor with its special cases. Thermal stresses. 3. State of deformation, constitutive relation. Description of the deformation state of three-, two- and one-dimensional deformations in terms of small displacements and deformations. Hooke's law and a general description of constitutive relations. 4. The principle of virtual work and its applications. The principle applies to the statics of bar systems in the variant of real displacements and virtual loads, and is the theoretical basis of the Force Method (FM). 5. The Force Method and the Displacement Method. Definition of unknowns, coefficients for unknowns, canonical equation. Basics of the classical approach to the Displacement Method (DM) applied to beam and frame systems. 6. The Matrix Displacement Method (MDM). Fundamentals of FEM. Application of matrix calculus to solve statics of trusses, beams and flat frames. The importance of the stiffness matrices of the element and the system. FEM: 8 main steps of the Finite Element Method algorithm (linear and planar elements). Stiffness matrices of basic elements (truss and beam). Transformations of coordinate systems. 7. Tensile - axial compression. State of stress and deformation. 8. Bending. Moment applied about principal axis and moment arbitrarily applied. 9. Shear in bending. Center of shear (twisting). 10. Torsion of thin-walled bars. Free torsion of thin-walled multi-chamber closed sections (with partitions), the concept of restrained torsion of thin-walled open sections. 11. Elements of the theory of shields and plates. The case of isotropic, rectangular and circular discs and thin plates. Definitions of internal forces, description of the state of stress and deformation. 12. Stability problems (bars, rectangular plates). Determination of critical loads. 13. Material strength hypotheses. Criteria for assessing the safety of a construction element. Equivalent stresses. 14.Fundamentals of nonlinear mechanics. Lagrange's material description and Euler's spatial description, initial, incremental and final configurations. Calculation schemes using the incremental and iterative methods. Equilibrium path boundary points.
Prerequisites and co-requisites	The student knows and is able to apply the laws of technical mechanics. He knows and is able to solve simple cases of material strength. He knows the basics of higher mathematics
Assessment methods and criteria	<table><tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr><tr><td>Solving problems</td><td>60.0%</td><td>60.0%</td></tr><tr><td>Lecture test</td><td>60.0%</td><td>40.0%</td></tr></table>
Recommended reading	<table><tr><td>Basic literature</td><td>1. Hibbeler R.C.: Mechanics of Materials. Prentice Hall, 8th Edition, 2011</td></tr><tr><td>Supplementary literature</td><td>1. Hibbeler R. C.: Engineering Mechanics, Statics. 12ve Edition, 2013.</td></tr></table>

	eResources addresses	Adresy na platformie eNauczanie: Mechanika materiałów (PG_00057369), W/Ć, BM, II stop., sem1, lato, 2023/24 - Moodle ID: 37570 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=37570
Example issues/ example questions/ tasks being completed	1. Draw the stress vector and its components in the general case of the vector location, name the components of the stress vector. What planes (sections) do we call the principal? 2. Give the rules for dimensioning the cross-section (determining the dimensions of the cross-section) taking into account the strength condition and the stiffness condition in the case of tension / compression. 3. Draw graphs of the maximum tangential and normal stresses in a cantilever loaded with a concentrated force P at its end. 4. Determine the stiffness matrices of a truss, beam, frame and plate FEM elements?	
Work placement	Not applicable	