



## Subject card

Subject name and code	Mechanics of materials, PG_00057369						
Field of study	Mechanical Engineering						
Date of commencement of studies	February 2023		Academic year of realisation of subject		2022/2023		
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. Bogdan Rozmarynowski				
	Teachers		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	Course outcome	Subject outcome	Method of verification
	[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	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.	[SW1] Assessment of factual knowledge
	[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	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).	[SU4] Assessment of ability to use methods and tools [SU2] Assessment of ability to analyse information
	[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	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.	[SW1] Assessment of factual knowledge
Subject contents	<p>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.</p> <p>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.</p> <p>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.</p> <p>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).</p> <p>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.</p> <p>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.</p> <p>7. Tensile - axial compression. State of stress and deformation.</p> <p>8. Bending. Moment applied about principal axis and moment arbitrarily applied.</p> <p>9. Shear in bending. Center of shear (twisting).</p> <p>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.</p> <p>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.</p> <p>12. Stability problems (bars, rectangular plates). Determination of critical loads.</p> <p>13. Material strength hypotheses. Criteria for assessing the safety of a construction element. Equivalent stresses.</p> <p>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.</p>		
Prerequisites and co-requisites	<p>The student knows and is able to apply the laws of technical mechanics.</p> <p>He knows and is able to solve simple cases of material strength.</p> <p>He knows the basics of higher mathematics</p>		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Lecture test	60.0%	40.0%
	Solving problems	60.0%	60.0%
Recommended reading	Basic literature	1. Hibbeler R.C.: Mechanics of Materials. Prentice Hall, 8th Edition, 2011	
	Supplementary literature	1. Hibbeler R. C.: Engineering Mechanics, Statics. 12ve Edition, 2013.	

	eResources addresses	Adresy na platformie eNauczenie: Mechanika Materiałów, Mgr, 2022/2023, sem. Lato, [W,C] (PG_00057369) - Moodle ID: 28989 <a href="https://enauczenie.pg.edu.pl/moodle/course/view.php?id=28989">https://enauczenie.pg.edu.pl/moodle/course/view.php?id=28989</a>
Example issues/ example questions/ tasks being completed	<ol style="list-style-type: none"> <li>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?</li> <li>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.</li> <li>3. Draw graphs of the maximum tangential and normal stresses in a cantilever loaded with a concentrated force P at its end.</li> <li>4. Determine the stiffness matrices of a truss, beam, frame and plate FEM elements?</li> </ol>	
Work placement	Not applicable	