GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	, PG_00060097		
Field of study	Civil Engineering		
Date of commencement of studies	October 2023	Academic year of realisation of subject	2023/2024
Education level	first-cycle studies	Subject group	
Mode of study	Part-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	2	ECTS credits	8.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Structural Mechanics Department -> Faculty of Civil and Environmental Engineering		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Karol Winkelmann	
	Teachers		

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	0.0	0.0	60

Subject objectives

Introduction to the main principles of structural statics and classification of structural systems.
Learning vector algebra - solving systems of forces.
Presentation of internal forces and relationships between the load and internal forces.
Analysis of beams: straight and continuous; and frames: straight, non-rectangular, three-jointed.
Analysis of arches. Design in line with the pressure line.
Analysis of flat and spatial trusses.
Analysis of complex and mixed systems; of flat grates and angled girders.
Presentation of influence lines, their extreme loading and envelopes of internal forces.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K6_U02] Analyse & solve engineering issues & problems in the field of civil engineering by applying appropriate and relevant established analytical, numerical and experimental methods.	The student knows how to calculate the support reactions and internal forces in simple beams and is able to plot diagrams of internal forces without writing their equations. The student is able to solve multi-element structures: pin-joint continuous beams, beams with a non-rectangular mesh of bars, simple frames, frames with a non-rectangular mesh of bars, three-hinged systems, arches. The student is able to form bar structures in accordance with their pressure line. The student is able to solve flat truss structures by the method of nodal equilibrium and the method of cross-sections. The student is able to solve structural gratings, girders, complex and mixed systems. The student knows how to draw influence lines, how to load them extremely, and how to draw envelopes of internal forces on their basis. The student is able to conduct a reverse analysis, thus is able to show what load was applied to the structure based on the calculated values and diagrams of internal forces. Based on the investigated structural response, the Student is able to examine the level of safety of an engineering structure. The student understands numerical simulation techniques and their wide application in modern-day civil engineering. The student understands the coupling between the ability to analyze the structure and its implementation in the numerical computing.	[SU1] Assessment of task fulfilment
	[K6_W02] Demonstrate knowledge and understanding of the processes and established methods of analysis / solution of engineering issues & problems in the field of civil engineering and of their limitations.	The student knows the main concepts and principles of theoretical mechanics. The student has the ability to use vector notation to solve mechanical problems. The student has a full understanding of bar systems in terms of their statics. The student understands the need to express engineering issues and construction-related problems in a straightforward and systematic way and is able to creatively solve them. The student knows the limitations imposed on the analysis of structural systems and sees the need to impose them. The student is able to classify structural systems and systems of forces. The student is able to transform a real engineering object into a series of appropriate static schemes. The student correctly identifies statically determinate and indeterminate structures. The student knows the types of structural interactions. The student knows the basic information about the strengths of construction materials and the rules for their determination. The student knows the relationships between the structure (strength of its component materials) and its load. The student is aware of the principles of general shaping of the structure, understands the need to provide the structure with the required level of operational reliability.	[SW3] Assessment of knowledge contained in written work and projects

Course outcome	Subject outcome	Method of verification
[K6_U01] Apply knowledge and understanding of mathematics as well as sciences and engineering disciplines underlying civil engineering to solve engineering problems and issues.	The student knows how to use vector algebra for the analysis of civil engineering structural systems. The student knows how to calculate static systems of forces and how to reduce them. The student is able to analyze special cases of systems of forces. The student understands the balance of static systems. On the basis of key mathematical theorems, the student solves simple models of bar structures. The student is able to use calculus to track the relationship between the load and internal forces. The student uses graphical integration to trace the relationship between different types of internal forces.	[SU1] Assessment of task fulfilment

Subject contents	The main principles of statics. Basic concepts of theoretical mechanics. Algebra of vectors. Force and moment. Main vector and main moment of the system of forces. Reduction and equilibrium of systems of forces. Reduction of the system of forces in relation to a point, the resultant of the system of forces. A force couple. Special cases of the system of forces: the system of convergent forces, the system of parallel forces, the flat system of forces. Degrees of Freedom. Center of gravity. The role of theoretical mechanics in structural analysis. Assumptions of structural mechanics. Classification of structural systems. Types of structural interactions. Boundary (support) conditions of structural systems. Static determination. Kinematics of flat beam systems. Straight beams. Support reactions and internal forces in straight beams. Differential relationships between load and internal forces. Ability to plot internal forces without writing their equations. Continuous pin-joint beams. Beams loaded indirectly. Beams with a non-rectangular mesh. Straight frames with a rectangular bar mesh. Analysis of internal forces transmission. The equilibrium of the corners of frame systems. Frames with a non-rectangular bar mesh. Three-hinged systems. Parabolic and circular arches. Pressure lines. Flat and spatial truss structures. Truss solving methods. The node-wise static determination method and the method of sections. Complex and mixed systems. Flat grates. Girders. Definition of internal forces in spatial systems. Influence lines for straight beams and continuous articulated beams. Truss influence lines. The influence lines of frames, three-hinged and complex systems. Extreme loading on the influence lines. Bending moment envelopes.
Prerequisites and co-requisites	Mathematics Physics
Assessment methods and criteria	

Subject passing criteria	Passing threshold	Percentage of the final grade
practice-oriented test	60.0%	40.0%
exam	60.0%	60.0%

<table>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>1. Branicki C., Structural mechanics in computational examples. Volume 1. Gdansk University of Technology Publishing House, Gdańsk 1975.
2. Lubowiecka I., Skowronek M., Structural mechanics in computational examples. Gdansk University of Technology Publishing House, Gdańsk 2000.
3. Górski J., Przewłócki J., Skowronek M., Winkelmann K., Mechanics and Strength of Materials. Gdansk University of Technology Publishing House, Gdańsk 2015.</td></tr>
<tr><td>Supplementary literature</td><td>1. Cywiński Z., Structural mechanics in computational examples. Volume I. PWN Warsaw 1999.
2. Konopińska-Zmysłowska V., Mleczek A., Oziębło M., Tomaszewska A., Selected problems of mechanics of beam systems. A set of calculational examples for Students of Environmental Engineering. Gdansk University of Technology Publishing House, Gdańsk 2016
3. Niezgodziński T., Theoretical mechanics, WN PWN Warsaw 2002.
4. Nizioł J., Methodology of solving problems in mechanics, WNT Warsaw 2002.
5. Nowacki W., Structural mechanics. Volume 1, PWN Warsaw 1974.
6. Wilde P., Wizmur M., Theoretical mechanics. PWN Warsaw 1984.</td></tr>
<tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:</td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="2">Calculate the values of internal forces in three vertical lattice bars supporting a rigid plane stress structure/ plate.

Determine the diagrams of internal forces (N - normal, V - shear, M - bending moments) in a free-supported beam, subjected to a given load.

Determine the diagrams of internal forces (V - shear, M - bending moments) in a continuous pin-joint beam, subjected to a given load.

Determine the diagrams of internal forces (N - normal, V - shear, M - bending moments) in a frame with a rectangular mesh of elements, subjected to a given load.

Determine the diagrams of internal forces (N - normal, V - shear, M - bending moments) in a frame with a non-rectangular mesh of elements, subjected to a given load.

Determine the diagrams of internal forces (N - normal, V - shear, M - bending moments) in a three-hinged frame with a rectangular mesh of elements, subjected to a given load.

Determine graphs and values of internal forces in the frame-truss system: N - normal, V - shear, M - bending moments in the frame elements, S - axial forces in the truss elements.

Determine the values of axial forces (S) in all elements of a simply supported truss subjected to a given load.

Draw the pressure line of the system under the specified load between the three given points (construction joints - A, B and C). Determine the key elevations of the optimal structure (pressure line).

Draw the diagrams of internal forces for the specified structural grating (V - shear force, M - bending moments).

Draw the diagrams of internal forces for the specified girder (V - shear force, M -bending moments, Ms - torsional moments).

For the given simply supported beam, draw the vertical reactions (Ra, Rb) influence lines and the internal force influence lines(Talfa, Malfa in the alpha section of the beam). Basing on the influence lines, set the load of a technical vehicle with a given axle weight so that Malfa bending moment reaches its extreme values. Determine the values. moment.</td></tr>
<tr><td>Work placement</td><td colspan="2">Not applicable</td></tr>
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