GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Applied Structural Engineering, PG_00067187						
Field of study	Smart Renewable Energy Engineering						
Date of commencement of studies	October 2025		Academic year of realisation of subject		2025/2026		
Education level	second-cycle studies		Subject group		Optional subject group 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		English Some elements regarding the vocabulary will be, only at the Students' requests, translated into polish.		
Semester of study	1		ECTS credits		6.0		
Learning profile	general academic profile		Assessment form		assessment		
Conducting unit	Department of Structural Mechanics -> Faculty of Civil and Environmental Engineering -> Wydziały Politechniki Gdańskiej						
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	20.0	30.0	15.0	10.0	0.0	75
	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	75		9.0	66.0		150

Subject objectives	**Mechanics and Strength of Materials Part:** Introduction to the fundamental principles of structural mechanics and classification of structural systems. Solving systems of forces, including planar force systems. Presentation of internal forces and the relationships between loads and internal forces. Analysis of simple beams, planar trusses, and spatial trusses. Introduction to the fundamentals of material strength. Definition of stress and strain. The relationships between internal forces, stresses, and strains. Identification of stress states in engineering structures and their application in technical dimensioning based on ULS/SLS criteria: axial compression/tension, simple and two-dimensional bending, eccentric compression, shear, and free torsion. Analysis of complex stress states. Calculation of displacements in statically determinate systems. Dynamic modeling of engineering structures, including dynamic forces, equations of motion, and free vibrations. Elements of theory of elasticity and fundamentals of analysis of two-dimensional structures. Geotechnics Part: Basics of soil mechanics. Fundamentals of geotechnical engineering. Theoretical and practical background of foundation engineering.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W101] is able to make an in-depth identification of key objects and phenomena related to the field of study, as well as theories that describe them and applicable analytical and design methods	The student knows the principles of structural mechanics as well as the construction and analysis of static diagrams. The student builds equilibrium equations, determines reactions and internal forces in frame systems: simple beam systems and truss systems. The student calculates stresses and deformations in planar and two-dimensional structures. The student identifies the stress states and the mechanical response of structures. The student knows the basics of geotechnical engineering and foundation engineering related to assessment of soil behaviour under load, as well as construction behaviour founded on shallow and deep foundations.	[SW1] Assessment of factual knowledge
[K7_K01] is prepared to evaluate projects and operations in wind energy systems, demonstrating competencies in designing and optimizing renewable energy systems, including wind power	The student identifies strength cases, calculates stresses and deformations based on internal forces. The student performs the structural dimensioning of cross-sections of frame elements according to limit states of strength and serviceability. The student selects permissible loads for bar systems. The student analyzes basic surface structures and assesses their safety. The student is competent to critically assess engineering projects related to renewable energy systems.	[SK2] Assessment of progress of work
[K7_U01] is able to apply analytical thinking and solve technical problems related to renewable energy systems, including wind power, using engineering methodologies	The student calculates internal forces and stresses in frame systems. The student determines the geometric characteristics of cross-sections of elements. The student draws projections of stresses onto a plane. The student calculates internal forces, stresses, and displacements in surface structures. The student calculates the natural frequencies of systems. The student is able to solve problems related to the behaviour of a construction founded on soil, especially constructions of renewable energy systems, including wind turbines.	[SU2] Assessment of ability to analyse information

Subject contents	**Mechanics and Strength of Materials Part:** 1) Tasks of Mechanics and Strength of Materials in the Analysis of Engineering Structures and Systems. Fundamental concepts of theoretical mechanics: force and moment of force, resultant vector, and resultant moment. Reduction of general force systems. 2) Special Cases of Force Systems. Planar force systems. Application of equilibrium conditions in engineering. 3) Classical Assumptions in Mechanics and Strength of Materials. Classification of structural elements and systems. Frame (bar) elements. Boundary and support conditions for frame systems. Kinematics of planar frame systems. 4) Simple Beams. Support reactions and internal forces. Differential relationships between loads and internal forces. Computer-aided analysis of simple beams. 5) Planar and Spatial Truss Structures. Support reactions and internal forces. Solving trusses using the node equilibrium method. Computer-aided analysis of truss structures. 6) Fundamentals of Strength of Materials. Definitions of stress and strain. Relationships between internal forces, stresses, and strains. 7) Axial Tension and Compression. Dimensioning of frame systems with respect to axial stresses. 8) Geometric Characteristics of Plane Figures. Static moments and centroids. Moments of inertia (central and principal moments).. 9) Simple Bending. Dimensioning of planar frame systems with respect to normal stresses. 10) Two-dimensional Bending and Eccentric Compression. Dimensioning of spatial bar systems with respect to normal stresses. 11) Shear Stress. Shear in bending. Free torsion. Dimensioning of bar systems with respect to shear stresses. 12) Complex Stress States. Strength hypotheses. Dimensioning of bar systems with respect to equivalent (reduced) stresses. 13) Displacements in Statically Determinate Systems. Dimensioning of frame systems with respect to serviceability. 14) Structural Dynamics. Dynamic modeling of engineering structures. Dynamic forces acting on structures. Equations of motion for structures. Free vibrations of single-degree-of-freedom discrete systems. Examples of dynamic analysis applications in engineering structures. 15) Elements of Theory of Elasticity. Airys stress function (plates), deflection function (slabs). Fundamentals of shell analysis, including circular shells. Internal forces in shell systems. 16) Computer Modeling of Frame and Shell Structures. Numerical analysis of stress states and displacements in engineering structural models. **Geotechnics Part:** 1. Soil as a building material. Soil classification according to modern European building codes. 2. Basic physical quantities related to soil. State of fine-grained and coarse-grained soils.

	3. Water in soil. Stressss in soil: geostatic and external stresses, total and effective stresses, vertical and horizontal stresses. 4. Soils under load behaviour: compressibility of soils and settlements. 5. Soils under load behaviour: soil shear strength Mohr-Coulomb criterion. 6. Introduction to foundation engineering: shallow and deep foundations.
Prerequisites and co-requisites	Mathematics Physics

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Geotechnics Part: assessment of project problems	60.0%	40.0%
M$SoM Part: written test	60.0%	60.0%

Recommended reading

Basic literature

Mechanics and Strength of Materials Part:

1. Branicki C.: Structural Mechanics in Exercises (in polish). Part 1. GUT Publishing Office. Gdańsk 1975.

2. Górski J., Przewłócki J., Skowronek M., Winkelmann K.: Mechanics and Strength of Materials (in polish). GUT Publishing Office. Gdańsk 2015.

3. Bielewicz E.: Strength of Materials (in polish). GUT Publishing Office. Gdańsk, 1992.

4. Szymczak C., Skowronek M., Witkowski W., Kujawa M.: Strength of Materials in Exercises (in polish). GUT Publishing Office. Gdańsk, 2002.

5. Rucka M., Wilde K.: Structural Dynamics with Examples in MATLAB (in polish). GUT Publishing Office, Gdańsk, 2019.

6. Kmiecik M., Wizmur M., Bielewicz E.: Nonlinear Analysis of Plates and Shells (in polish). GUT Publishing Office, Gdańsk, 1995.

7. Burzyński S., Chróścielewski J., Daszkiewicz K., Sobczyk B., Witkowski W.: Introduction to FEM Modeling in ABAQUS (in polish). GUT Publishing Office, Gdańsk 2014.

Geotechnics Part:

1. Wiłun Z.: Basics of Geotechnics (in polish). WKiŁ,1982, 2013.

2. Jeż T., www.tajnikigeotechniki.pl. Politechnika Poznańska.

3. Verruijt A.: Soil Mechanics. TU Delft, 2012.

4. Das B.M.: Principles of Foundation Engineering. Cengage Learning, 2023.

5. Virtual Laboratory in Soil Mechanics - app (in polish).

	Supplementary literature	**Mechanics and Strength of Materials Part:** 1. Cywiński Z., Structural Mechanics in Exercises. Part 1 (in polish). WN PWN. Warsaw 1999. 2. Niezgodziński T., Structural Mechanics (in polish). WN PWN. Warsaw 2002. 3. Jastrzębski P., Mutermilch J., Orłowski W.: Strength of Materials. Part 1 & 2 (in polish). Arkady Publishing Office, Warsaw, 1985. 4. Niezgodziński M., Niezgodziński T.: Strength of Materials (in polish). WN PWN Warsaw, 1984. 5. Rucka M., Burzyński S., Sabik A.: Matrix Analysis of Frame Structures in MATLAB (in polish). GUT Publishing Office, Gdańsk, 2019. 6. Brunarski L., Kwieciński M. Introduction to the Theory of Elasticity and Plasticity (in polish). WUT Publishing Office, Warsaw 1984. 7. Chróścielewski J., Makowski J., Pietraszkiewicz W.: Statics and Dynamics of Multi-Panel Shells: Nonlinear Theory and Finite Element Method (in polish). IPPT PAN Publishing Office, Warsaw 2004. **Geotechnics Part:** 1. Norm PN-EN 1997-1:2004. Eurocode 7. Geotechnical Design. 2. Norm PN-EN-ISO 14688-1. Geotechnical Surveys. Designation and classification of soils. Part 1: Designation and description (in polish). 3. Norm PN-EN-ISO 14688-2. Geotechnical Surveys. Designation and classification of soils. Part 2: Rules of classification (in polish). 4. Pisarczyk S.: Soil Mechanics (in polish). OWPW, 2005. 5. Glazer Z.: Soil Mechanics (in polish).Wydawnictwa Geologiczne, 1985.
	eResources addresses	

Example issues/ example questions/ tasks being completed	**Mechanics and Strength of Materials Part:** 1) Calculate the internal forces in three vertical truss members supporting a rigid plate/shell. 2) Determine the internal force diagrams (N - normal, V - shear, M - bending moments) for a simply supported beam subjected to a given load. 3) Calculate the axial forces (S) in all members of a simply supported truss subjected to a given load. 4) Compute the numerical values of normal stresses due to axial compression/tension or simple bending. Verify if the material strength is exceeded due to normal stresses. Determine the required cross-sectional dimensions or the allowable load. 5) Calculate the numerical values of shear stresses due to shear/torsion. Verify if the strength of the shear connection is exceeded. 6) Create a drawing of the projection of normal/shear stress tensors onto the plane of the cross-section. 7) Calculate the extreme reduced stresses (HMH) in a complex stress state. 8) Calculate the displacement of the system. Verify if the displacement exceeds the allowable limits. 9) Calculate the natural frequency of a single-degree-of-freedom discrete system. 10) Compute the internal forces in a two-dimensional/shell structure. Compare the results of theoretical calculations with the corresponding outcome of the numerical model of the structure. **Geotechnics Part:** 1. Prepare a geotechnical model of the soil basing on the data provided. 2. Prepare vertical geostatic stresses charts for a given system of soil layers. 3. Prepare vertical external stresses charts in the soil acting from a wind turbine tower. 4. Assess settlements of a shallow-founded wind turbine tower. 5. Compute the minimal dimensions of a shallow foundation for a given construction. 6. Compute the bearing capacity of a given foundation pile.
Work placement	Not applicable

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