GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

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| Subject name and code | Engineering Mechanics , PG_00044370 | | |
| Field of study | Civil Engineering | | |
| Date of commencement of studies | October 2021 | Academic year of realisation of subject | 2021/2022 |
| Education level | first-cycle studies | Subject group | Obligatory subject group in the field of study<br>Subject group related to scientific research in the field of study |
| 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 | Department of Structural Mechanics -> Faculty of Civil and Environmental Engineering | | |
| Name and surname of lecturer (lecturers) | Subject supervisor | dr inż. Karol Winkelmann | |
| | Teachers | dr inż. Magdalena Oziębło<br>dr inż. Karol Winkelmann | |

**Lesson types and methods of instruction**

| Lesson type | Lecture | Tutorial | Laboratory | Project | Seminar | SUM |
|---|---|---|---|---|---|---|
| Number of study hours | 30.0 | 25.0 | 0.0 | 0.0 | 0.0 | 55 |

E-learning hours included: 0.0

Adresy na platformie eNauczanie:

**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 | 55 | 7.0 | 138.0 | 200 |

**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 |
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| | [K6_U03] can analyze simple rod constructions in scope of: calculations of constructions statically determined and undetermined; determining of modal frequencies; calculations of linear stability and bearing capacity in critical and boundary states | The student knows how to calculate static systems of forces, and how to reduce them.<br>The student knows how to analyze specific cases of systems of forces.<br>The student knows how to calculate support reactions and internal forces in simple beams and is able to plot internal forces without writing their equations.<br>The student knows how to solve multi-element structures: continuous pin-jointed beams, non-rectangular beams, simple frames, frames with non-rectangular element mesh, three-pin-joint systems.<br>The student knows how to solve flat truss structures by the method of node-wise determination and the method of sections.<br>The student knows how to solve grates, girders, complex and mixed systems.<br>The student knows how to draw influence lines, how to load them extremely and how to draw envelopes of internal forces on their basis. | [SU1] Assessment of task fulfilment |
| | [K6_W04] has knowledge of general mechanics, strength of materials and general rules of construction | The student knows the main concepts and principles of statics and theoretical mechanics.<br>The student has the ability to use vector notation to solve mechanics problems and to determine internal forces in statically determinate flat beam systems.<br>On this basis, the Student is aware of the principles of general technical dimensioning of structures. | [SW3] Assessment of knowledge contained in written work and projects |
| | [K6_W05] knows laws of mechanics used in rod constructions in scope of statics and stability, has an elementary knowlege on dynamics | The student has a full understanding of the beam systems in terms of their static analysis.<br>The student knows how to classify structural systems and systems of forces, the student also knows the types of structural interactions.<br>The student is able to transform a real-life engineering object into a series of appropriate static diagrams.<br>The student correctly identifies statically determinate and indeterminate structures. | [SW3] Assessment of knowledge contained in written work and projects |

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

Assessment methods and criteria

| Subject passing criteria | Passing threshold | Percentage of the final grade |
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| lecture-oriented test | 60.0% | 20.0% |
| practice-oriented test | 60.0% | 20.0% |
| 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.<br>2. Lubowiecka I., Skowronek M., Structural mechanics in computational examples. Gdansk University of Technology Publishing House, Gdańsk 2000.<br>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.<br>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<br>3. Niezgodziński T., Theoretical mechanics, WN PWN Warsaw 2002.<br>4. Nizioł J., Methodology of solving problems in mechanics, WNT Warsaw 2002.<br>5. Nowacki W., Structural mechanics. Volume 1, PWN Warsaw 1974.<br>6. Wilde P., Wizmur M., Theoretical mechanics. PWN Warsaw 1984.</td></tr>
<tr><td>eResources addresses</td><td></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.<br><br>Determine the diagrams of internal forces (N - normal, V - shear, M - bending moments) in a free-supported beam, subjected to a given load.<br><br>Determine the diagrams of internal forces (V - shear, M - bending moments) in a continuous pin-joint beam, subjected to a given load.<br><br>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.<br><br>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.<br><br>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.<br><br>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.<br><br>Determine the values of axial forces (S) in all elements of a simply supported truss subjected to a given load.<br><br>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).<br><br>Draw the diagrams of internal forces for the specified structural grating (V - shear force, M - bending moments).<br><br>Draw the diagrams of internal forces for the specified girder (V - shear force, M -bending moments, Ms - torsional moments).<br><br>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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