GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Kinematics and dynamics of machines, PG_00055405		
Field of study	Mechatronics		
Date of commencement of studies	October 2026	Academic year of realisation of subject	2027/2028
Education level	first-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	2	Language of instruction	Polish
Semester of study	3	ECTS credits	6.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Institute of Mechanics and Machine Design -> Faculty of Mechanical Engineering and Ship Technology -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Krzysztof Lipiński	
	Teachers		

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	30.0	0.0	15.0	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	6.0	69.0	150

Subject objectives

Acquainting with definitions of the most fundamental terms: machine/mechanism; link; pair and kinematic chain. Overview of the commonly used mechanisms. Acquainting with the most important terms of structural analysis: classification of links and pairs; mobility, single-degree chains; functional and structural classification. Presentation of the most important methods of positions, velocities and accelerations problems. Presentation of methods of dynamics of mechanisms. Introduction to problems of free and forced vibrations of systems of one degree and of many degrees of freedom.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_U03] has self-learning skills	has the ability to self-study and to independently solve problems formulated in mechanics; theory of mechanisms and dynamics of machines; as well as in vibrations in mechanical systems	[SU4] Assessment of ability to use methods and tools [SU1] Assessment of task fulfilment
[K6_U01] is able to acquire information from literature, databases and other, properly chosen sources, integrate these information, interpret them, draw conclusions and formulate opinions	is able to obtain information in the field of general mechanics, theory of mechanisms and dynamics of machines and vibrations, using the literature, databases and other sources, is able to integrate the obtained information, interpret it, as well as draw conclusions and formulate and justify opinions	[SU1] Assessment of task fulfilment
[K6_W04] has organized and theoretically supported, advanced knowledge in the field of general mechanics, strength of materials, theory of mechanisms and machine dynamics, fluid dynamics, hydraulics and pneumatics, machine construction and engineering graphics	has an ordered and theoretically founded knowledge about mechanics; theory of mechanisms; dynamics of machines; as well as knowledge about vibrations in mechanical systems	[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge

<table>
<tr><td>Subject contents</td><td>Course content – lecture
Machine and mechanism; the need of a simultaneous transfer of movement and force; The most important structural elements of machines and mechanisms; open and closed kinematic chains; classification of kinematic pairs; classification of kinematic links. Tasks of analysis and synthesis. Planning the trajectory. Direct and invert tasks. Overview of the most popular types of mechanisms. Functional classification; Structural analysis, mobility of mechanisms; structural equation of mobility of mechanisms; single-degree mobility of the kinematic chains; apparent constraints; local mobility; partial and complete mobility. Structural classification; family; structural group; class, order, and form of a structural group. Method of solving the task of studying positions, velocities and accelerations of elements of mechanisms. Diagrammatic, analytical and numerical methods. Methods of marked trajectory. Differentiation of constraint equations; kinematics of relative motion; plans of velocities and of accelerations; instantaneous centres of speed and acceleration. Dynamics of mechanisms: types of forces; methods used to mark the reaction forces; kinetostatics equations; resolving of forces in kinematic pairs; three-mass analogy; differential equations of motion of mechanisms; parameters reduced on the shaft. Balancing of planar mechanisms. Free vibrations of systems with one degree of freedom for systems with and without damping. Logarithmic decrement of damping. Correlation between the damping on the frequency of vibrations. Forced vibrations of systems with one degree of freedom for systems with and without damping. Homogeneous and heterogeneous solution. Frequency of forced vibrations. Resonance (amplitude) and phase characteristics. Correlations between damping on the amplitude and phase characteristics. Initial conditions in case of forced vibrations. Free and forced vibrations of systems with many degrees of freedom. Matrix of masses and stiffness. The shape and frequency of free vibration. Conditions for the existence of a non-trivial solution. Eigenvalues and eigenvectors of matrices.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>Mechanics including statics, kinematics, dynamics of mechanical systems.
Mathematics including algebra, matrix calculus, differential and integral calculus, linear differential equations.</td></tr>
<tr><td>Assessment methods and criteria</td><td>
<table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>colloquia with solving practical problems</td><td>56.0%</td><td>25.0%</td></tr>
<tr><td>note of final evaluation of the project</td><td>56.0%</td><td>50.0%</td></tr>
<tr><td>final test of the theory</td><td>56.0%</td><td>25.0%</td></tr>
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</td></tr>
<tr><td>Recommended reading</td><td>
<table>
<tr><td>Basic literature</td><td>1. J.E. Shigley, J.J. Uicker, Theory of Machines and Mechanisms, McGraw-Hall book Company, 1981;
2. J.J. Uicher, G.R. Pennock, J.E. Shigley, Theory of Machines and Mechanisms, Oxford University Press, 2017
3.S.G.Kelly, Mechanical Vibrations, theory and applications, Cengage Learning, 2012
4. W. T. Thomson, Theory of vibration with applications, Prentice Hall, 1992</td></tr>
<tr><td>Supplementary literature</td><td>1. Askok G Ambekar, Mechanism and Machine Theory, Perntice-Hall of India New Dehli, 2007
2. Dan B Marghitu, Mechanism and Robots Analysis with Matlab, Springer, London 2009;
3. L. Meirovitch, Fundamentals of vibrations, McGraw Hill, 2001</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
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<tr><td>Example issues/ example questions/ tasks being completed</td><td>1. the most important methods of classification of kinematic pairs;
2. the structural equation of the mobility of mechanisms, and comments on the causes of its unreliability;
3. what is a structural group, methods of their classification;
4, what is a marked trajectory and how to use it to estimate the speed and acceleration of the mechanism;
5. what parameters determines the frequency of free vibration of systems with one degree of freedom with damping;
6. homogeneous and heterogeneous solution of forced vibrations of systems with one degree of freedom;
7. resonance (amplitude) and phase characteristics of forced vibrations of systems with one degree of freedom;
8. The form and the frequency of free vibrations of systems with many degrees of freedom.</td></tr>
<tr><td>Practical activites within the subject</td><td>Not applicable</td></tr>
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