GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Kinematics and Dynamics of Machines, PG_00055380		
Field of study	Mechanical Engineering		
Date of commencement of studies	October 2021	Academic year of realisation of subject	2022/2023
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	4.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Institute of Mechanics and Machine Design -> Faculty of Mechanical Engineering and Ship Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Krzysztof Lipiński	
	Teachers	dr hab. inż. Krzysztof Lipiński	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	0.0	0.0	15.0	0.0	45

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	45	6.0	49.0	100

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_U06] is able to use mathematical and physical models for analysing the processes and phenomena occurring in mechanical devices within the range of material strength, thermodynamics and fluid mechanics	can use mathematical and physical models to analyze the processes and phenomena occurring in mechanical devices in terms of their kinematics and dynamics	[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools
[K6_W04] possesses knowledge on mechanics, including the processes of modelling mechanical systems, statics, kinematics and dynamics of rigid objects and basic knowledge on vibrations	has knowledge about mechanics, including the process of modeling of mechanical systems, kinematics and dynamics of rigid bodies and of mechanisms, and basic knowledge of vibrations	[SW1] Assessment of factual knowledge

Subject contents	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.
Prerequisites and co-requisites	Mechanics including statics, kinematics, dynamics of mechanical systems. Mathematics including algebra, matrix calculus, differential and integral calculus, linear differential equations.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
note of final evaluation of the project	56.0%	50.0%
final test of the theory	56.0%	50.0%

Recommended reading

Basic literature	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
Supplementary literature	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
eResources addresses	

Example issues/ example questions/ tasks being completed	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.
Work placement	Not applicable