GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Multibody systems, PG_00057034		
Field of study	Mechatronics		
Date of commencement of studies	February 2022	Academic year of realisation of subject	2022/2023
Education level	second-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	1	Language of instruction	Polish None
Semester of study	2	ECTS credits	2.0
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	15.0	0.0	0.0	15.0	0.0	30

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	30	4.0	16.0	50

Subject objectives

Students are familiarized with some methods of determination of the position; orientation; velocity andacceleration of a body in space.Students are familiarized with the idea of system description in absolute, normal and joint coordinates.Formulation and solution of constrain equations for closed kinematic chains.Students are familiarized with the main aspects and equations of open kinematic chains dynamics and ofclosed kinematical chains, using the Lagrange equations .

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W03] has detailed, supported by the theory knowledge in terms of analytical mechanics, theory of mechanisms and machine dynamics, multibody systems, micromechanisms and microdrives	has theoretically founded detailed knowledge in the field of analytical mechanics, theory of mechanisms and dynamics of machines, multibody systems,	[SW1] Assessment of factual knowledge
[K7_U04] is able to utilise known methods and mathematical models, as well as computer simulations for analysis and evaluation of non-stationary continuous and discrete mechatronic systems and processes	can use the known methods and mathematical models, as well as computer simulations to analyze and evaluate dynamics of mechanical and mechatronic systems	[SU1] Assessment of task fulfilment
[K7_U05] is able to formulate and test hypothesis concerning problems of nonstationary systems and processes and simple research problems	is able to formulate and test hypotheses related to the problems of dynamics of systems of many solids connected by constraints	[SU4] Assessment of ability to use methods and tools

Subject contents	The students are familiarized with some methods of determination of the position and orientation of a body in space, presentatio of a vector as a matrix product of a column matrix (a vector) of coordinates and a table of unit vectors, he is familiarized with use of the orientation matrices, how calculate the products of the matrices and the column matrix of coordinates of a vector, and and how to formulate the elements of the orientation matrices as a functions of the system coordinates. The students are familiarized with the idea of system description in absolute, normal and joint coordinates. Presentation of description methods useful in description of the system topology. Formulation and solution of constrain equations for closed kinematic chains. Presentation of the selection methods useful in dependent coordinates selection. Presentation of the relationship arising from the derivation of the constrain equations, constrain equations at level of speeds and accelerations of the multibody system coordinates. Presentation of methods used to determine the dynamics equations of a particle and of a rigid body. Presentation of methods used to transform the dynamics equations between the selected types of system coordinates. The students are familiarized with the main aspects and equations of open kinematic chains dynamics and of closed kinematical chains, using the Lagrange equations of the second kind, using the Lagrange equations of the first kind and the elimination of dependent coordinates. The students are familiarized with the methods of eliminating of violations of the constraints equations. Presentation of example descriptions and analyzes of dynamics time variable configurations of the multibody systems.
Prerequisites and co-requisites	Passed coursed in subjects Matematyka, Mechanika I, Mechanika II, Theory of mechanisms and machines (or Kinematics and Dynamics of Machines)

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
written exam	56.0%	100.0%

Recommended reading

Basic literature	Wittenburg J.: Dynamics of systems of rigid bodies. B.G. Teubner, Stuttgart, 1977 Blajer W.: Methods of dynamics of multibody system. Monografie Nr 35, Wydawnictwo Politechniki Radomskiej, Radom 1998. Frączek J. Wojtyra M.: Kinematics of multibody systems, calculation methods, Warszawa, WNT, 2008.
Supplementary literature	Fisette P., Samin J-C.: Symbolic Modeling of Multibody System. Kluwer Academic Publishers, Dordrecht 2003 Wittbrodt E., Adamiec-Wójcik I., Wojciech S.: Dynamics of flexible multibody systems. Rigid finite element method. Springer-Verlag, Berlin 2006 Garcia de Jalon J. Bayo E.: Kinematics and Dynamics Simulation of Multibody Systems. Springer verlag, 1994
eResources addresses	

Example issues/ example questions/ tasks being completed	1. Reasons of non-linearity of models of multibody systems2. Differences between a multibody system with an open structure and a closed structure3. Description in independent coordinates - advantages and disadvantages4. Description in dependent coordinates - advantages and disadvantages5. Description in absolute coordinates - advantages and disadvantages6. Description in joint coordinates - advantages and disadvantages7. Description in natural coordinates - advantages and disadvantages8. Constraint equations and their applications in the dynamics of multibody systems9. constraints for position, velocity and acceleration, Jacobian of the constraint equations10. Gauss elimination algorithm and passive constraints11. The Newton-Raphson algorithm for solving a system of nonlinear equations12. Lagrange equations of I kind (Lagrange multipliers technique)13. Elimination of multipliers and dependent coordinates14. The orientation matrix in dynamics of the spatial (3D) multibody systems15. Euler angles / Cardan angles / Euler parameters16. The derivatives of the orientation matrix and angular velocity17. Transformations of dynamics equations to alternative coordinates18. Equations of kinematics and dynamics of the open kinematic chain
Work placement	Not applicable