GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Multibody systems, PG_00064799		
Field of study	Mechatronics		
Date of commencement of studies	February 2027	Academic year of realisation of subject	2027/2028
Education level	second-cycle studies	Subject group	Specialty 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	Polish
Semester of study	2	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Division of Applied Mechanics and Biomechanics -> 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	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_U01] utilizes acquired analytical, simulation, and experimental methods, as well as mathematical models for analysis and evaluation of stationary and non-stationary mechatronic systems/processes with continuous and discrete operation	is able to use the acquired analytical and simulation methods as well as mathematical models to analyze and evaluate mechatronic systems/processes, in particular their multi-body components	[SU5] Assessment of ability to present the results of task [SU3] Assessment of ability to use knowledge gained from the subject [SU1] Assessment of task fulfilment
[K7_W01] explains and describes, based on general knowledge in the field of scientific disciplines forming the theoretical foundations of Mechatronics, the construction and principles of operation of mechatronic systems, processes and their components, as well as methods and means of their integration	can describe the usefulness of theorems, definitions, methods and tools (including programming methods and computer-aided design) to solve a complex engineering task typical of mechatronics	[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge
[K7_U15] evaluates the feasibility of advanced methods and tools for solving complex engineering tasks of a practical nature, characteristic of the field of study, and selects and applies appropriate methods and tools for this purpose	is able to assess the usefulness of advanced methods and tools (including programming methods and computer-aided design and manufacturing) to solve a complex practical engineering task typical of mechatronics and to select and apply the appropriate method and tools	[SU1] Assessment of task fulfilment [SU3] Assessment of ability to use knowledge gained from the subject [SU5] Assessment of ability to present the results of task
[K7_W04] demonstrates knowledge encompassing selected issues in the field of detailed knowledge, particularly in the scope of methods, techniques, tools, and algorithms specific to Mechatronics	has theoretically based detailed knowledge in the field of analytical mechanics, dynamics of multi-body systems and machine dynamics issues, with particular emphasis on the operation of multi-body systems within a device designed in accordance with the principles of mechatronics	[SW1] Assessment of factual knowledge

Subject contents

Course content – lecture

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	
Practical activites within the subject	Not applicable	

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