COURSE SPECIFICATION

Course code	full-time programme:	**M#2-S2-ME-PT-115**
	part-time programme:	
Course title in Polish	**Dynamika układów mechanicznych**	
Course title in English	**Dynamics of Mechanical Systems**	
Valid from (academic year)	**2024/2025**	

GENERAL INFORMATION

Programme of study	**MECHANICAL ENGINEERING**
Level of qualification	**second-cycle**
Type of education	**academic**
Mode of study	**full-time programme**
Specialism	**Design and Manufacturing**
Department responsible	**Department of Automotive Engineering and Transport**
Course leader	**dr inż. Andrzej Zuska**
Approved by	**dr hab. Jakub Takosoglu, prof. PŚk, Dean of the Faculty of Mechatronics and Mechanical Engineering**

COURSE OVERVIEW

Course type		**specialism-related**
Course status		**compulsory**
Language of instruction		**English**
Semester of delivery	full-time programme	**Semester I**
	part-time programme	**Semester I**
Pre-requisites		
Examination required (YES/NO)		**NO**
ECTS value		**2**

Mode of instruction		**lecture**	**class**	**laboratory**	**project**	**seminar**
No. of hours per semester	full-time programme	**15**		**15**		
	part-time programme					

LEARNING OUTCOMES

Category of outcome	**Outcome code**	**Course learning outcomes**	**Corresponding programme outcome code**

Knowledge	W01	Has a structured knowledge of the basic concepts and problems of the dynamics of mechanical discrete systems.	MiBM2_W01 MiBM2_W07
	W02	Has a structured knowledge of the modeling of mechanical discrete systems as an oscillating system.	MiBM2_W01 MiBM2_W07
	W03	Has a structured knowledge of the components of the models, with particular emphasis on the susceptible components.	MiBM2_W01 MiBM2_W07
	W04	Has a basic theoretical knowledge of the construction of the equations of vibration of discrete systems. Is familiar with Lagrange's Equations of the second kind.	MiBM2_W01 MiBM2_W07
	W05	Has basic theoretical knowledge of selected issues of classical analysis of mechanical vibrations of discrete systems (time domain analysis).	MiBM2_W01 MiBM2_W07
	W06	Has basic theoretical knowledge of spectral analysis of vibrations.	MiBM2_W01 MiBM2_W07
Skills	U01	Can determine the characteristics of susceptible elements (linear and nonlinear), used in modeling the dynamics of discrete systems.	MiBM2_U02 MiBM2_U11
	U02	Can apply the operator method to determine the characteristics of linear susceptible elements.	MiBM2_U02 MiBM2_U11
	U03	Be able to build an algorithm and computational program for vibration analysis of a mechanical model of a discrete system in the time domain (in different coordinate systems).	MiBM2_U02 MiBM2_U11
	U04	Can build an algorithm and computational program to analyze the vibration of a mechanical model of a discrete system in the frequency domain.	MiBM2_U02 MiBM2_U11
Competence	K01	Understands the need for and knows the possibilities of improving his professional skills.	MiBM2_K01

COURSE CONTENT

Mode of instruction	Topics covered

lecture	Basic concepts and problems of vertical dynamics of mechanical discrete systems. Features of fundamental motion and perturbations of fundamental motion. Assumptions made in classical vibration theory of discrete systems. Modeling in machine dynamics. The process of building dynamic models: determination of the structure of the model, description of mass quantities, coordinates of the system, determination of the number of degrees of freedom, determination of data and description of the forcing acting on the system. Components of a dynamic model. Mass elements: methods of experimental determination and approximate estimation of moments of inertia of the entire discrete system and other model bodies. Deformable elements - basic models of linear elements. Operator method of determining characteristics of linear elements; operator stiffness. Characteristics of parallel and series connection of two linear elements. Nonlinear prone elements. Methods of determining the characteristics of nonlinear elements. Method of extracting the characteristics: elastic and damping characteristics from the characteristics determined in the form of an inelastic hysteresis loop. The concept of a weakly nonlinear element - linearization of nonlinear characteristics of susceptible elements. Vibration excitations - classification of signals. Construction of the equations of vibration of a mechanical discrete system. Lagrange equations of the second kind. Total kinetic and potential energy of the system. Use of Lagrange's equations to derive the equations of motion of a spatial model of a discrete system with 3 degrees of freedom. Use of the operator method to introduce linear susceptible elements with different characteristics into the model. Introduction of the postulate of symmetry of the model with respect to the xOz-plane - decoupling of vibrations in the longitudinal and transverse planes. Notation of equations of vibration in matrix form. Selected issues of classical analysis of vibrations of a mechanical discrete system (analysis in the time domain) Natural frequencies of systems with multiple degrees of freedom - the method of determination. The problem of decoupling of vibrations of partial sub-systems (Mandelstam's conditions). Spectral analysis of vibrations of a mechanical discrete system. Spectral analysis of periodic oscillations. Fourier series. Discrete (strip) spectra: amplitude-frequency and phase-frequency. Fourier integral transformation. Properties of the Fourier transform. Spectra of non-periodic oscillations (continuous spectra). Application of the Fourier transform to solve the equation of vibration of a system with one degree of freedom. Spectral transmittance of a system. Graphical representation of transmittance: real and imaginary part of transmittance; amplitude-frequency and phase-frequency characteristics (modulus and argument). Transmittance of the input of a system with kinematic forcing. Spectral analysis of vibrations of systems with multiple degrees of freedom. Transmittance matrix and its properties.
laboratory	Determination of characteristics of susceptible elements used in modeling a) linear elements b) elements with nonlinear and complex characteristics. Application of the operator method to determine the characteristics of linear prone elements. Determination of characteristics of parallel and series connection of two susceptible elements. Development of a program to analyze the motion of the model in solid coordinates. Develop a program to analyze the motion of the model in point coordinates. Development of a program to determine the natural frequency of the system. Development of a program to determine the transmittance modulus and power spectral densities of the system response.

ASSESSMENT METHODS

Outcome code	Methods of assessment					
	Oral examination	Written examination	Test	Project	Report	Other
W01			X			
W02			X			

W03			X			
W04			X			
W05			X			
W06			X			
U01					X	
U02					X	
U03					X	
U04					X	
K01						X

ASSESSMENT TYPE AND CRITERIA

Mode of instruction	Assessment type	Assessment criteria
lecture	non-examination assessment	Successful completion of the colloquium, obtaining at least 50% of the points
laboratory	non-examination assessment	Passing the reports, obtaining at least 50% of the points.

OVERALL STUDENT WORKLOAD

ECTS weighting												
No.	Activity type	Student workload										Unit
		full-time programme					part-time programme					
		L	C	Lb	P	S	L	C	Lb	P	S	
1.	Scheduled contact hours	**15**		**15**								h
2.	Other contact hours (office hours, examination)	**2**		**2**								h
3.	**Total number of contact hours**	**34**										h
4.	**Number of ECTS credits for contact hours**	**1,4**										ECTS
5.	**Number of independent study hours**	**16**										h
6.	**Number of ECTS credits for independent study hours**	**0,6**										ECTS
7.	**Number of practical hours**	**25**										h
8.	**Number of ECTS credits for practical hours**	**1,0**										ECTS
9.	**Total study time**	**50**										h
10.	**ECTS credits for the course** *1 ECTS credit = 25-30 hours of study time*	**2**										ECTS

READING LIST

1. Mitschke M. Dynamika samochodu. Drgania. WKiŁ, Warszawa, 1989.
2. Kasprzyk T., Prochowski L. Obciążenia dynamiczne zawieszeń. WKiŁ, Warszawa, 1990.
3. Osiecki J., Gromadowski T., Stępiński B., Badania Pojazdów Samochodowych i ich zespołów na symulacyjnych stanowiskach badawczych. Wydawnictwo Instytutu Technologii i Eksploatacji, Radom, 2006.

4. Kamiński E., Pokorski J. Dynamika zawieszeń i układów napędowych pojazdów samochodowych. WKiŁ, Warszawa, 1983. 5. Blajer W. Metody dynamiki układów wieloczłonowych. Wyd. Politechniki Radomskiej, Radom, 1998.