COURSE DESCRIPTION CARD

Course name	**Magnetic levitation systems**				
Course type	**optional**	**Course code**	**SDPB0008**	**ECTS credits**	**2**
Forms and number of hours	**lecture: 10 h** **project: 10 h**	**Scientific discipline**	**automation, electronic and electrical engineering;** **mechanical engineering**		
Course objectives	The aim of the course is to familiarize PhD students with magnetic levitation systems and their application in systems, machines and devices. In particular, getting acquainted with the structure and work operation of the active magnetic bearings and their design and control methods.				
Course content	Lecture: 1. Structure and operation of an active magnetic bearing controlled using the feedback control. 2. Heteropolar and homopolar magnetic bearings. 3. Mathematical modelling and simulation of active magnetic bearing. 4. Control algorithms of the active magnetic bearing (linear control, optimal methods, robust control, iterative learning control, control using linearizing feedback, control Lapunov functions). 5. Rapid prototyping and implementation of control algorithms in the dSpace processor. 6. Design and modelling of passive magnetic bearings. 7. Hybrid magnetic bearings and electrodynamic linear drives. 8. Bearingless electric motors. 9. Applications of magnetic levitation systems in industry (vibration control of rotating machines, kinetic energy storage, electro-spindles, magnetic grippers, vibration inductors, etc.) Project: 10. Modelling of the active magnetic bearing. 11. Designing control and linearization algorithms. 12. Conducting and developing the results of simulation tests.				
Teaching methods	Lecture: informative-problem lecture, discussion; case study; students' own studies based on the indicated sources. Project: project tasks realization; preparation of a report.				
Assessment method	Lecture: Written exam. Project: project report, presentation of the simulation control system.				
Symbol of learning outcome	**Learning outcomes**		**Reference to the learning outcomes for the field of study for the 8th level of Polish Qualification Framework (PRK)**		**Methods of assessing the learning outcomes**
LO1	knowledge of the structure and operation of an active magnetic bearing		SD_W1, SD_W2		Exam

LO2	knowledge of the modelling methods and control design of active magnetic bearing	SD_W1, SD_W2	Exam
LO3	practical modelling skills of active magnetic bearing as a dynamic simulation system	SD_U1, SD_U2	Exam Project tasks
LO4	skills to provide simulations of an active magnetic bearing operation	SD_U1, SD_U2	Exam Project tasks
LO5	technical design of an active and passive magnetic bearings	SD_U1, SD_U2	Project tasks

Student workload (in hours)	
Lecture / classes / project / laboratory / seminar	10 /0 / 10 / 0 / 0
Consultations	2
The unassisted student work	20
Implementation of project tasks and preparation for and participation in exams/tests	10
Total	**32**
ECTS credits	**2**

Basic references	1. Didactic resources of the teacher. 1. G. Schweitzer, E. Maslen, et al, Magnetic Bearings: Theory, Design, and Application to Rotating Machinery, Springer, 2009. 2. Z. Gosiewski, K. Falkowski, Wielofunkcyjne łożyska magnetyczne, Wydawnictwa Naukowe Instytutu Lotnictwa, 2003. 3. A. Chiba, Ed., Magnetic Bearings and Bearingless Drives, Elsevier 2005 4. K. Falkowski, Pasywne zawieszenia magnetyczne, WAT, Warszawa, 2016. 5. A. Mystkowski, Sterowanie odporne drganiami wirnika łożyskowanego magnetycznie, Akademia Górniczo-Hutnicza im. Stanisława Staszica w Krakowie (AGH), 2007.
Supplementary references	1. Yoon, Se Young, Lin, Zongli, Allaire, Paul E., Control of Surge in Centrifugal Compressors by Active Magnetic Bearings. Theory and Implementation, Springer, 2016.
Author of the programme	Arkadiusz Mystkowski, PhD (Eng), DSc, Assoc. Prof.
Date of issuing the programme	05.03.2021