Space Robotics

- ***COURSE SYLLABUS***

1.	**Course title:**	
	Space Robotics	
2.	**Lecturer:**	
	Dr hab. Inż. Karol Seweryn, Prof. dr inż. Jerzy Sąsiadek	
3.	**Field, type and level of studies, year of study:**	
	Space Technology, Robotics, Control systems, all levels of studies, all years of study	
4.	**Course character:**	
	GeoPlanet interdisciplinary lecture	
5.	**Teaching method:**	
	Hybrid	
6.	**Language:**	*English*
7.	**Course type and number of hours:**	
	Lecture 18	
8.	**Estimated load of student's independent work:**	*12h*
9.	**Total workload and number of ECTS points:**	*30 h, 3 ECTS*
10.	**Short description and main focus of the course:**	
	The following topics will be described and discussed during lectures: • Introduction to robotics and space applications. Overview and history of robots in space. On-orbit robotics and planetary robotics. • Key environmental aspects impacting space robot design and operation. • Types of space robots and its components (joints, links, actuators, sensors, control systems, on board computers) • Methods of space robots design: Homogenous Transformation. Denavit-Hartenberg Equation. Direct and inverse kinematics. Robot dynamics. • Control systems in robots. • On-orbit manipulators – introduction to non-holonomic systems • Planetary robotics – mobile robots navigation, autonomous systems, robotics operations on planets and moons surfaces • End effectors used in space – gripers, regolith sampling tools, standard interfaces • Optimal estimation of dynamic systems. Introduction to deterministic and stochastic filtering.	

	• Data and sensor Fusion. Sensors and robots perception. • Motion planning in joint and task space. Guidance and Navigation. Collision avoidance. • AI methods • Control systems and its implementation on on-board computers • Testing infrastructure This course will include student projects. Teams of students will be asked to propose their own robotic missions to investigate chosen phenomena in space.	
11.	**References:**	
	Saeed B. Niku, *Introduction to Robotics - Analysis, Control, Applications*, 3-rd Edition, John Wiley and Sons 2020, ISBN **978-1-119-52762-6** E-Book **978-1-119-52760-2** *Mark W. Spong, Seth Hutchinson, M. Vidyasagar, "Robot Modeling and Control", 2nd Ed., John Wiley and Sons, Inc., 2020* *Andrew J. Kurdila and Pinhas Ben-Tzvi, "Dynamics and Control of Robotics Systems", John Wiley and Sons, Inc., 2020* *Schaub, H. and Junkins, J. L. 2003. Analitical Mechanics of Space System. Reston : American Institute of Aeronautics and Astronautics, 2003* *Xu, Y. and Kanade, T. 1993. Space Robotics: Dynamics and Control. Massachusetts : Kluwer Academic Publisher, 1993* *Ellery, A. An Introduction to Space Robotics. Chichester : Praxis Publishing Ltd, 2000*	
12.	**Prerequisites:**	
	Knowledge of mathematics and physics at basic level, as well as, interests of engineering	
13.	**Educational outcomes:**	**PQF level 8 codes:**
	Knowledge: *this course gives an overview of space robotics with focus on two aspects: (i) methodologies used in robotics, in particular in space robotics with component development and (ii) application of these components in various fields of science and engineering*	*P8S_WG, P8S_WK*
	Practical Skills: *Students will acquire methods to analyze and design various type of robotics systems such as: control systems, actuators, sensors. Students will learn how advanced autonomous systems impact and influence space missions scenarios and planning.*	*P8S_UW, P8S_UK, P8S_UO*
	Social Skills: *Students will be ready to conduct independent research which would contribute to existing scientific and engineering knowledge; Students will be ready to develop models of good practice in team working and managing themselves to reach predefined goals.*	*P8U_K*
14.	**Evaluation of the educational outcomes:**	
	Presentation of team projects. Selection of projects will be provided during first month of lectures.	
15.	**Criteria to complete the course:**	
	Attendance (40%) plus team presentation of selected project (60%)	

16.	**Contact with the lecturer:**
	kseweryn@cbk.waw.pl, jsasiadek@cbk.waw.pl