Warsaw University
of Technology

COURSE OFFERED IN THE DOCTORAL SCHOOL

Code of the course	4606-ES-00000BH-0016	Name of the course	Polish	**Identyfikacja systemów w inżynierii lotniczej**
			English	**System identification in aerospace engineering**
Type of the course	specialized			
Course coordinator	Piotr Lichota, PhD, DSc			
Implementing unit	The Faculty of Power and Aeronautical Engineering	Scientific discipline / disciplines*	Mechanical Engineering/ Automation, electronic, electrical engineering and space technologies	

Level of education	PhD	Semester	winter		
Language of the course	english				
Type of assessment:	Credit with a grade	Number of hours in a semester	30	ECTS credits	2
Minimum number of participants	12	Maximum number of participants	20	Available for students (BSc, MSc)	**Yes**/No

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week	1			1	
	in a semester	15			15	

* does not apply to the Researcher's Workshop

1. Prerequisites

Basic knowledge of flight mechanics, mathematical analysis, automation and control.

2. Course objectives

The course aims to familiarize the course participants with system identification methods used in aeronautical engineering. After completing the study, the participant can plan identification experiments and define the requirements for measurement data adequate for aircraft motion modeling. The course participant can choose the appropriate estimation method, carry out the system identification for typical flight dynamics problems and validate the results.

3. Course content (separate for each type of classes)

Lecture

Experiment planning, measurement and data compatibility check, equation error methods, output error methods, filter error methods, identification from frequency responses, artificial neural networks, online identification, dynamically unstable aircraft identification, mathematical models, model validation.

Laboratory

Basic systems identification methods, equation error method, maximum likelihood principle, designing system identification experiments.

4. Learning outcomes

	Learning outcomes description	Reference to the learning outcomes of the WUT DS	Learning outcomes verification methods*
	Knowledge		
K01	The course participant has basic knowledge of system identification and flight mechanics for identifying mathematical models describing aircraft movement.	SD_W2, SD_W3	Written test
K02	The course participant knows the types of signals used to identify models that are describing the aircraft motion and can determine their capabilities and limitations.	SD_W2, SD_W3	Written test, report evaluation

K03	The course participant knows the basic assumptions of carrying out measurements, mathematical models of the measurement sensors used, and data validation methods used to identify mathematical models describing the aircraft motion.	SD_W2, SD_W3	Written test
K04	The course participant knows the basic estimation methods used to identify mathematical models describing the aircraft motion and their applicability range.	SD_W2	Written test, report evaluation
K05	The course participant knows modifications of the primary identification methods used to describe the aircraft motion for near real-time estimation and dynamically unstable aircraft.	SD_W2, SD_W3	Written test
K06	The course participant knows how to determine the form and structure of the mathematical model describing the aircraft's motion under test.	SD_W2	Written test, report evaluation
K07	Uczestnik kursu ma wiedzę w zakresie określania formy i struktury modelu matematycznego opisującego ruch badanego statku powietrznego.	SD_W2, SD_W3	Written test, report evaluation
Skills			
S01	The course participant can plan the identification experiment by themselves.	SD_U1	Written test, report evaluation
S02	The course participant can select the appropriate estimation method for the identified aircraft at given flight conditions.	SD_U1	Written test
S03	The course participant can choose a method for the identification task and carry out the parametric or non-parametric identification process for simple problems.	SD_U1, SD_U2, SD_4	Written test, report evaluation
S04	The course participant can determine the structure of the mathematical model of the identified aircraft and update it.	SD_U1, SD_U2	Report evaluation
S05	The course participant can use validation methods to analyze the result.	SD_U2	Written test, report evaluation
Social competences			
SC01	The course participant formulates priorities in the investigated problems and independently works in searching for information and achieving the assumed goal.	SD_K4	Report evaluation
SC02	The course participant is aware of their knowledge and skills and understands the need for further professional improvement and personal development.	SD_K1, SD_K2	Report evaluation

*Allowed learning outcomes verification methods: exam; oral exam; written test; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

5. Assessment criteria

During the semester, one test is planned (max. 20 points), laboratory work is assessed (max. 4 points in total), and the presence and activity in the laboratory are monitored (max. 1 point). The student receives a final grade based on the number of points obtained.

6. Literature

Primary literature:

[1] Jategaonkar, R. V.: "Flight Vehicle System Identification: A Time Domain Methodology," Progess in Astronautics and Aeronautics, AIAA, Reston, VA, 2006.

[2] Klein, V., Morelli, E. A.: "Aircraft System Identification: Theory and Practice," AIAA Education Series, AIAA, Reston, VA , 2006.

[3] Tischler, M.B., Remple, R. K., "Aircraft and Rotorcraft System Identification: Engineering Methods with Flight Test Examples", AIAA Education Series, AIAA, Reston, VA, 2006.

Secondary Literature:

[1] Goodwin, G. C. , Payne, R. L. :“Dynamic system identification Experiment design and data analysis,” Academic
[2] Press, New York, 1977

[3] Ljung L.: “System Identification: Theory for the User”, Prentice Hall, Upper Saddle River, 1998

[4] Soedersrtoem T., Stoica P.: Identyfikacja systemów, PWN, Warsaw, 1997.

7. PhD student’s workload necessary to achieve the learning outcomes**		
No.	Description	Number of hours
1	Hours of scheduled instruction given by the academic teacher in the classroom	30
2	Hours of consultations with the academic teacher, exams, tests, etc.	5
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	20
4	Amount of time devoted to the preparation for exams, test, assessments	5
	Total number of hours	**60**
	ECTS credits	**2**

** 1 ECTS = 25-30 hours of the PhD students work (2 ECTS = 60 hours; 4 ECTS = 110 hours, etc.)