POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

pl. M. Skłodowskiej-Curie 5, 60-965 Poznań

# COURSE DESCRIPTION CARD - SYLLABUS

Course name

Aircraft control systems

## Course

| Field of study | Year/Semester |
|---|---|
| Aerospace Engineering | 1/3 |
| Area of study (specialization) | Profile of study |
| Onboard systems and aircraft propulsion | general academic |
| Level of study | Course offered in |
| First-cycle studies | polish |
| Form of study | Requirements |
| full-time | elective |

## Number of hours

| Lecture | Laboratory classes | Other (e.g. online) |
|---|---|---|
| 15 | 15 | |
| Tutorials | Projects/seminars | |
| | 15 | |

## Number of credit points

4

## Lecturers

Responsible for the course/lecturer:

Dr Eng. Wojciech Prokopowicz

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Faculty of Environmental Engineering and Energy

ul. Piotrowo 3; 60-965 Poznań

Responsible for the course/lecturer:

## Prerequisites

Student has basic knowledge necessary to understand profile subjects and specialist knowledge about the construction, methods of construction, manufacturing, operation of aviation technology, management of safety systems, economic, social and environmental impact in the field of aviation for selected specialties: Aviation Engineering.

Student has general knowledge related to selected issues in the field of building control systems for manned and unmanned aircraft, including their main components.

Student has basic ordered, theoretically founded knowledge in the field of: avionic on-board systems, aircraft propulsion, on-board and ground systems supporting the operation of aircraft, systems for analysis and decryption of flight parameters.

Student has a basic knowledge of frequency and voltage converters, power electronics as well as automation systems, microcontrollers, control algorithms, electronic navigation systems used in machines in the aviation industry.

Student has general knowledge covering key issues in the field of on-board systems as well as on-board and terrestrial electronic communication systems.

Student has a basic knowledge of programming languages used in on-board control systems.

## Course objective

The aim of the course is to provide students with specialist knowledge and the necessary skills in the field of construction and design of flight control systems, navigation and telemetry used in civil and military aviation on manned and unmanned aircraft.

## Course-related learning outcomes

### Knowledge

Student has detailed knowledge related to selected issues in the field of manned and unmanned aerial vehicles, including on-board systems and their main components. Has extended knowledge of technical vocabulary, in particular specialized terminology used in aviation engineering. Has an ordered, theoretically founded knowledge of mathematics used to analyze the results, create mathematical models and adapt them to the numerical code. Has a basic knowledge of frequency and voltage converters, power electronics as well as automation systems, microcontrollers, control algorithms, electronic navigation systems used in machines in the aviation industry. Has ordered, theoretically founded general knowledge covering key issues in the field of on-board systems as well as on-board and terrestrial electronic communication systems.

### Skills

Student can use the language sufficiently to understand technical texts in the field of aviation (knowledge of technical terminology). Can prepare and present a short verbal and multimedia presentation on the results of an engineering task. He can use one additional foreign language in verbal communication at the level of everyday language, can use this language to describe issues related to the field of study he is studying. He can organize and plan the process of designing and maintenance of an uncomplicated on-board device, machine or technical flying object from the group covered by the selected specialty. Has the ability to self-educate with the use of modern didactic tools, such as remote lectures, websites and databases, teaching programs, e-books. Can communicate using various techniques in the professional and other environments using the formal notation of construction, technical drawing, concepts and definitions of the field of study studied. He can obtain information from literature, the Internet, databases and other sources. Can integrate the obtained information, interpret and draw conclusions from it. Can develop a safety instruction for a simple to medium complex on-board unit, machine or technical flying object under certain environmental conditions. Can create a system diagram, select elements and perform basic calculations of the mechanical, aerodynamic, automatic, electrical and electronic components of a machine or aviation equipment. Can assess material and environmental costs as well as labor costs for the implementation of aviation modules and on-board devices. Can use basic technical standards for safety

Social competences

Student can think and act creatively and enterprisingly. Is aware of the importance of the proposed rules of operation and understands the effects of engineering activities, including its impact on flight safety. Is able to properly define the priorities in the operation of the airframe and aircraft engine with regard to ensuring an appropriate level of flight safety while maintaining the required economic criterion.

## Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

The knowledge acquired during the lecture is verified by two 45-minute tests carried out during the 15th and 30th lecture. Each test consists of 5 (open) questions, with different scores. Passing threshold: 70% of points. Passing issues on the basis of which the questions are developed do not go beyond the content presented during the lectures. During the laboratories, students create sample control systems (software and hardware) based on selected types of microcontrollers. The system software is made in the Labview environment. As part of the project classes, students prepare a presentation on the basis of a self-developed aircraft control system and present it during classes. At the end of the course, they present a description of the control system design with the software in the Labview environment and submit it for evaluation.

## Programme content

- Classification and construction of control and regulation systems

- Electric control systems

- Pneumatic control systems

- Mathematical description of linear systems

- Basic linear and nonlinear elements

- Construction of aircraft control systems, some terms / definitions. "Levels" of control system analysis

- Determining the requirements and structure of the bottom-up approach

- Sensors and effectors of control systems

- Construction of VOR / DME, TACAN, ILS, NDB navigation systems, basic characteristics of processed signals

- Inertial platforms and navigation data processing algorithms

- Data exchange buses design solutions and design

- Construction and design of navigational information display systems

- Autopilot examples of solutions for the design of flight control systems

- Terrestrial segment of avionic systems, telemetric data exchange

- LabVIEW environment, programming of flight control systems

## Teaching methods

Lecture: multimedia presentation, illustrated with examples given on the board.

Laboratories: presentation illustrated with examples given on the blackboard and carrying out the tasks given by the teacher.

Project: presentation by the audience on a selected technical problem. Development of an exemplary technical solution of avionics systems and presenting it in the form of a technical description.

## Bibliography

### Basic

Bilski J., Polak Z., Rypulak A., Awionika, przyrządy i systemy pokładowe, WSOSP, Dęblin 2001

T. Kaczorek i inni, Podstawy teorii sterowania, WNT, Warszawa 2005.

T. Kaczorek, Teoria sterowania i systemów, PWN, Warszawa 1996.

T. Kaczorek, Teoria sterowania, PWN Warszawa t.1,1977, t.2,1981.

W. Pełczewski, Teoria sterowania, WNT, Warszawa 1980.

S. Bociek, J. Gruszecki, Układy sterowania automatycznego samolotem, OWPRz, Rzeszów 1999.

K. Ogata, Metody przestrzeni stanów w teorii sterowania, WNT,Warszawa, 1974.

Kornowicz-Sot A: Automatyka i robotyka. Układy regulacji automatycznej . WSiP, Warszawa 1999.

Dokumentacja techniczna systemów awioniki wybranych statków powietrznych

### Additional

H. Górecki, Optymalizacja systemów dynamicznych, PWN, Warszawa 1993.

J. Zabczyk, Zarys matematycznej teorii sterowania, PWN, Warszawa 1991.

M. Chłędowski, Podstawy automatyki w ćwiczeniach i zadaniach, OWPRz, Rzeszów 2019.

H. Nijmeijer, A. van der Schaft, Nonlinear Dynamical Control Systems, Springer-Verlag, New York 1990.

R. Vinter, Optimal Control, Birkhauser, Boston 2000.

Thomas Eismin, Aircraft Electricity and Electronics, McGraw-Hill Education 2019

Mike Tooley i inni, Aircraft Communications and Navigation Systems: Principles, Maintenance and Operation, Butterworth-Heinemann 2007

Mike Tooley i inni, Aircraft Electrical and Electronic Systems: Principles, Maintenance and Operation 1st Edition, Maintenance and Operation, Butterworth-Heinemann 2008

Pallet E.H.J., Aircraft Instrument Systems, IAP, 1993

Pallet E.H.J., Aircraft Instruments and Integrated Systems,Longman Scientific and Technical Series, 1992

Stola M., Wyposażenie samolotów, Wydawnictwo PW, Warszawa, 1978

Tomczyk A., Pokładowe cyfrowe systemy sterowania samolotem, Oficyna Wydawnicza Politechniki Rzeszowskiej, Rzeszów 1999.

John R. Newport, Avionic Systems Design, CRC Press 1994

Shri P.N.A.P. Rao, Avionics Systems Design Development and Integration, DESIDOC 2019

Guoqing Wang Wenhao Zhao, The Principles of Integrated Technology in Avionics Systems, Academic Press 2020

R. P. G. Collinson, Introduction to Avionics Systems, Springer, Boston, MA 2003

## Breakdown of average student's workload

| | Hours | ECTS |
|---|---|---|
| Total workload | 88 | 4,0 |
| Classes requiring direct contact with the teacher | 51 | 2,5 |
| Student's own work (literature studies, preparation for classes, preparation for tests) [1] | 37 | 1,5 |

[1] delete or add other activities as appropriate