COURSE DESCRIPTION CARD - SYLLABUS

Course name
Electromechanical propulsion systems [S1Lot2-SLiPL>ESN]

Course

Field of study
Aviation

Year/Semester
3/5

Area of study (specialization)
Aircraft Engines and Airframes

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
30

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

Aircraft systems for generating and distributing electrical energy and converting electrical energy into mechanical energy. Magnetic and electrical circuits in electromechanical converters: materials for magnetic cores, permanent magnets, windings, insulating materials. Rectifier transformers. Aircraft generators: brushless DC generators, synchronous and reluctance generators. Electric motors - operating principle and basic characteristics. Induction motors, synchronous motors, DC motors. High-speed machines in aviation. Heating of electrical machines. Aircraft cooling systems. Electric drive systems: load characteristics, power electronics power supply systems, control methods. Generator-starter system. Electromechanical actuators of on-board automation systems. MEA - new technologies in aircraft electric machines, superconducting systems, magnetic levitation systems, electrical energy storage. Hybrid and electric aircraft.

Course objective

To learn about the structure, principles of operation, characteristics, operating properties and basic methods of analysis and laboratory tests of aircraft generators and aircraft drive systems, including mechatronic systems and automation actuators, and in particular electromechanical transducers included in these systems. To indicate the direction of work aimed at introducing new "MEA" technologies in the aviation industry.

Course-related learning outcomes

Knowledge:
1. has extended and deepened knowledge of mathematics including algebra, analysis, theory of differential equations, probability, analytical geometry as well as physics including the basics of classical mechanics, optics, electricity and magnetism, solid state physics, thermodynamics, useful for formulating and solving complex technical tasks related to aeronautical engineering and modeling
2. has basic knowledge of generating and processing signals in the form of currents, electric voltages and electromagnetic fields
3. has detailed knowledge related to selected issues in the field of construction of aircraft propulsion systems
and design of their components as well as their life cycles and principles of technical description

Skills:
1. is able to obtain information from various sources, including literature and databases, both in Polish and English, integrate it properly, interpret and critically evaluate it, draw conclusions, and comprehensively justify
the opinions he formulates
2. is able to properly plan and perform experiments, including measurements and computer simulations, interpret obtained results, and correctly draw conclusions from them
3. is able to analyze technical objects and solutions, is able to search in catalogs and on manufacturers' websites for ready-made components of machines and devices, including means and devices, assess their suitability for use in one's own technical and organizational projects

Social competences:
1. understands that in technology knowledge and skills very quickly become outdated
2. is aware of the importance of knowledge in solving engineering problems and knows examples and understands the causes of malfunctioning engineering projects that led to serious financial or social losses or
serious loss of health or even life
3. is aware of the social role of a graduate of a technical university, in particular understands the need to formulate and communicate to the public, in an appropriate form, information and opinions regarding engineering activities, technical achievements, as well as the achievements and traditions of the engineering
profession

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture passed on the basis of a test of knowledge, skills and students' activity during classes. Passing the lecture is certified by appropriate grades.

Programme content

Aircraft systems for generating and distributing electrical energy and converting electrical energy into mechanical energy. Magnetic and electrical circuits in electromechanical converters: materials for magnetic cores, permanent magnets, windings, insulating materials. Rectifier transformers. Aircraft generators: brushless DC generators, synchronous and reluctance generators. Electric motors - operating principle and basic characteristics. Induction motors, synchronous motors, DC motors. High-speed machines in aviation. Heating of electrical machines. Aircraft cooling systems. Electric drive systems: load characteristics, power electronics power supply systems, control methods. Generator-starter system. Electromechanical actuators of on-board automation systems. MEA - new technologies in aircraft electric machines, superconducting systems, magnetic levitation systems, electrical energy storage. Hybrid and electric aircraft.
PART - 66 (THEORY - 22.5 hrs., PRACTICE - 11.25 hrs.)
MODULE 4. BASIC KNOWLEDGE FROM THE FIELD OF ELECTRONICS
a) Understanding the following terms: closed and open circuit system, feedback, further processing, analog transducer;
Principles of operation and exploitation of the following components and features of synchronous links: resolvers, differentials, control and torque, transformers, capacitive and inductive transmitter. [1]
b) Understanding the following terms: closed circuit, open circuit, further processing, servomechanism,

analog transducer, zero, damping, feedback, dead zone; Construction, operation and application of the transformers, inductive transmitter, capacitive transmitter, synchronous transmitter; Servo faults, synchronous weight reversal, synchronous machine swinging. [-]
MODULE 5. ELECTRONIC INSTRUMENT SYSTEMS FOR DIGITAL TECHNIQUES
5.14 Electromagnetic environment
Influence of the following phenomena on the maintenance of electronic systems:
EMC - Electromagnetic compatibility EMI - Electromagnetic interference
HIRF - High intensity radiated field Lightning protection [2]
5.15 Typical electronic/digital aircraft systems
General arrangement of typical electronic/digital aircraft systems and associated BITEs (Built-in test equipment), such as:
a) for B1 and B2 only:
ACARS-ARINC communication, addressing and reporting system EICAS - Engine indicator and crew notification systems FBW - Electronic artificial stability system
FMS - Flight management system
IRS - Inertial reference system
b) for B1, B2 and B3:
ECAM - Electronic centralized aircraft monitoring FIS - electronic flight instrument system
GPS - Global Positioning System
TRAS - Traffic Alert and Collision Avoidance System Integrated modular avionics systems Cabin systems
Information systems [2]

Course topics

Discussion of aircraft electrical power generation and distribution systems and electrical to mechanical energy
conversion. Discussion of magnetic and electrical circuits in electromechanical converters: materials for magnetic cores, permanent magnets, windings, insulating materials. Rectifier transformers. Aircraft generators:
brushless DC generators, synchronous and reluctance generators. Presentation of electric motors.

Teaching methods

1. Lecture: multimedia presentation, illustrated with examples given on the board.
2. Laboratory exercises: presentation illustrated with examples given on the board and carrying out tasks given by the instructor according to the instructions provided - practical exercises.

Bibliography

Basic:
1. Wykłady z elektromechanicznych przemian energii, Sobczyk T., Węgiel T., Wydawnictwo Politechniki Krakowskiej, Kraków 2014,
2. Maszyny Elektryczne, W. Przyborowski, G. Kamiński, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2014,
3. Electric Machines: steady-state theory and dynamic performance, M. S. Sarma, West Publishing Company, wyd. 2 1996
4. Wprowadzenie do napędu elektrycznego, W. Koczara, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2012.

Additional:
1. Zagadnienia obliczeniowe w eksploatacji maszyn elektrycznych. P. Staszewski, W. Urbański, Oficyna Wydawnicza, Politechniki Warszawskiej, Warszawa 2009,
2. Poradnik Inżyniera Elektryka, Praca zbiorowa, Tom 2, wyd.3, WNT Warszawa 2009,
3. Automatyka napędu elektrycznego, Deskur J., Kaczmarek T., Zawirski K., Wydawnictwo Politechniki Poznańskiej, Poznań 2012,
4. Recent Advances in Aircraft Technology Edited by Dr. Ramesh Agarwal, ISBN 978-953-51-0150-5, Hard cover, 544 pages, Publisher InTechPublished online 24, February, 2012, Published in print edition February, 2012,
5. J. F. Gieras, Advancements in Electric Machines (Power Systems), USA, NY, New York:Springer-Verlag, 2008.

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00