COURSE DESCRIPTION CARD - SYLLABUS

Course name
Electromechanical Propulsion Systems

Course

Field of study
Aerospace Engineering

Year/Semester
3 / 5

Area of study (specialization)
-

Profile of study
general academic

Level of study
First-cycle studies

Course offered in
english

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
15

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

4

Lecturers

Responsible for the course/lecturer:
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Responsible for the course/lecturer:
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Faculty of Automatic Control, Robotics and Electrical Engineering

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Prerequisites

A student starting this subject should have basic knowledge in mathematics, including algebra, analysis and theory of differential equations necessary to describe electrical machines and propulsion systems as well as knowledge in physics, covering the fundamentals of classical mechanics, electricity and magnetism, thermodynamics necessary to understand phenomena in electromechanical propulsion systems. In terms of skills a student starting this subject should have the ability to self-study with the use of modern teaching tools, such as remote lectures, websites and databases, teaching programs and international literature on modern propulsion systems and should be skilled to create simple diagrams

and connect electrical circuits. In terms of social competences a student starting this subject should understand the need for critical assessment of knowledge and continuous learning, as well as understand the principles of cooperation during research in laboratories.

Course objective

Understanding the construction, operating principles, characteristics, operational properties and basic methods of analysis and laboratory tests of the aircraft generators and the aircraft propulsion systems, including mechatronic systems and automation executive systems, in particular electromechanical converters included in these systems. An indication of the direction of efforts aimed at introducing new "MEA" technologies in the aviation industry.

Course-related learning outcomes

Knowledge

1. Has knowledge of materials used in electromechanical converters and knowledge of machine and mechanism theory, drive theory, mechatronic systems and automation executive systems

2. Has basic knowledge of electric drives in aircrafts, including, DC and AC motors, electric generators, frequency and voltage converters, and power electronics, as well as about automation systems, microcontrollers, control algorithms, systems used in machines in the aviation industry

3. Has fundamental knowledge of basic processes occurring in the life cycle of devices, objects and technical systems, as well as their technical description in the field of aviation engineering

Skills

1. Can create a description of the principle of operation of a simple drive system and motors and generators, as well as other components included in this system

2. Is able to create a system diagram, select elements and perform basic calculations and measurements of the electromechanical, aerodynamic, automatic, electrical and electronic systems of machine components or aviation devices 3. Is able to analyze objects and technical solutions, can search in the datasheets and on the manufacturers' websites components of machines and devices, including transport and storage devices and equipment, assess their suitability for use in own technical and organizational projects

Social competences

1. Is aware of the importance of maintaining the principles of professional ethics

2. Understands the need for critical assessment of knowledge and continuous learning

3. Can inspire and organize the learning process of other people

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture accepted on the ground of written tests checking knowledge and student classroom activity (test is scored)

Programme content

Aircraft systems for the generation and distribution of electricity and for the conversion of electricity into mechanical energy. Magnetic and electrical circuits in the electromechanical converters: materials for magnetic cores, permanent magnets, windings, insulation materials. Rectifier transformers. Aircraft generators: brushless direct current generators, synchronous and reluctance generators. Electric motors - operating principles and basic characteristics. Induction motors, synchronous motors, DC motors. High-speed machines in aviation. Electric machine heating. Airplane cooling systems. Electric drive systems: load characteristics, power electronics systems, control methods. Generator-starter system. Electromechanical actuators of on-board automation systems. MEA - new technologies in aviation electrical machines, superconducting systems, magnetic levitation systems, electricity storage. Hybrid and electric aircraft.

PART - 66 (THEORY - 22.5 hours, PRACTICE - 11.25 hours)
MODULE 4. BASIC INFORMATION ON ELECTRONICS
a) Understand the following terms: open and closed circuit system, feedback, further processing, analog transducer;
Principles of operation and exploitation of the following components and features of synchronous links: calculators, differentials, control and torque, transformers, capacitance and inductive transmitters. [1]
b) Understand the following terms: closed circuit, open circuit, downstream processing, servo, analog converter, zero, damping, feedback, deadband;
Construction, operation and application of the following components of synchronous connections: calculators, differentials, control and torque, transformers E and I, inductive transmitter, capacitive transmitter, synchronous transmitter;
Servo faults, reversal of synchronous weights, swaying of the synchronous machine. [-]
MODULE 5. ELECTRONIC INSTRUMENT SYSTEMS, DIGITAL TECHNIQUES
5.14 Electromagnetic environment
The impact of the following phenomena on the maintenance of systems
electronic:
EMC - electromagnetic compatibility
EMI - electromagnetic interference
HARF - field with high irradiation intensity
Lightning protection [2]
5.15 Typical electronic / digital aircraft systems
General arrangement of common electronic / digital systems on aircraft and associated BITEs (Inline Test Equipment) such as:
a) only for B1 and B2:
ACARS-ARINC communication, addressing and reporting system
EICAS - Engine Gauge Systems and Crew Notification
FBW - Electronic Artificial Stability System
FMS - flight management system
IRS - system of inertial systems
b) for B1, B2 and B3:

ECAM - Electronic Centralized Aircraft Monitoring
FIS - Electronic Flight Instrument System
GPS - Global Positioning System
ROUTE - traffic collision avoidance and alarm system
Integrated modular aviation electronics systems
Cabin systems
IT systems [2]

Teaching methods

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

2. Examples given on the board and performance of tasks given by the teacher according to written istruction - 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	100	4,0
Classes requiring direct contact with the teacher	46	1,8
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation)[1]	54	2,2

[1] delete or add other activities as appropriate