COURSE DESCRIPTION CARD - SYLLABUS

Course name

Vibroacoustics and intelligent structures

Course

Field of study	Year/Semester
Aerospace Engineering	3/6
Area of study (specialization)	Profile of study
Aircraft engines and airframes	general academic
Level of study	Course offered in
First-cycle studies	polish
Form of study	Requirements
full-time	compulsory

Number of hours

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

Number of credit points

2

Lecturers

Responsible for the course/lecturer:

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Faculty of Transport Engineering

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Responsible for the course/lecturer:

Prerequisites

1 Knowledge: In the field of vibroacoustics, signal processing, structures and intelligent materials.

2 Skills: Can apply the scientific method in solving problems

3 Social competences: Knows the limits of own knowledge and skills; can work in a group

Course objective

The aim of the course is to shape theoretical and practical knowledge in the field of possible application and current trends in the development of intelligent materials and structures, including piezoelectric, thermoelectric, shape memory, electroactive polymers and bionic coatings. Develop students' knowledge of modeling methods and simulation testing of properties in selected materials and self-diagnostic structures (SHM - Self Health Monitoring Structures). Preparing students for active functioning in society as engineers involved in the design, construction and use of products in the broadly understood aerospace industry based on new construction materials.

Course-related learning outcomes

Knowledge

1. has basic knowledge about the properties and applications of intelligent, metal, non-metallic and composite materials used in the construction of aircraft and their internal structure, elastic properties, manufacturing technology and research at the stage of production and operation.

2. has basic knowledge of the main departments of technical mechanics: vibroacoustic testing, acoustic emission and thermographic emission of aircraft airframe structures, and testing of aircraft structures with the use of signal processing methods based on the signal spectrum and the combined time and frequency domain.

3. has basic knowledge in the field of strength of materials, including the basics of the theory of elasticity and plasticity, effort hypotheses, methods of calculating beams, membranes, shafts, joints and other simple structural elements of an aircraft airframe, as well as methods of testing material strength and the state of deformation and stress in aircraft constructions

Skills

1. has the ability to self-study. Knows the need to search for new solutions regarding the creation of aircraft airframe structures. Is able to apply knowledge about intelligent materials in aviation.

2. is able to use formulas and tables, technical calculations using MATLAB software, spreadsheets, and put data and measurement results in a simple relational database

3. is able to analyze objects and technical solutions, search in the catalogs and on manufacturers' websites the vibration sensors and SHM systems for diagnostic applications in to aircraft structures, assess their suitability for use in their own technical and organizational projects. He knows the methods of analyzing the information obtained about the structure of the aircraft and individual elements of their structure.

Social competences

1. is aware of the importance of the human factor in the process of aviation technology exploitation and compliance with professional ethics

2. understands the need for continuous verification and deepening of their knowledge in the field of aircraft constructions, their production and service in the context of the use of new construction materials.

3. is able to organize and plan the design and maintenance process of aircraft diagnostic systems. Student knows how to apply modern materials and technologies in the construction of aircraft airframe structure and engines.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

- Oral exam

- Written test

Programme content

General characteristics of intelligent materials used in aviation and their types. Classification of materials, intelligent and self-diagnostic structures by type. Basic manufacturing processes, properties and applications of intelligent structures in metals, polymers and composites. Methods for testing airframe structures using materials based on SHM structures. Internal construction of intelligent materials with the use of many types of sensors, including microelectromechanical sensors MENS and others. Design principles for intelligent materials in terms of response to external stimulation. Determining the basis for adaptation of intelligent structures to environmental conditions in terms of improving their properties, increasing durability, energy saving and adapting to the conditions for improving the strength properties of hook-and-go construction and human comfort. Demonstrate the ability of intelligent structures to self-replicate, repair or damage as needed to increase aviation efficiency.

PART - 66 (THEORY - 11.25 hours)

MODULE 5. ELECTRONIC INSTRUMENT SYSTEMS, DIGITAL TECHNIQUES

5.8 Integrated circuits

Operation and use of encoders and decoders;

Functions of the codec types;

Use of medium, large and very large scale of integration. [-]

5.9 Multiplexing

Operation, application and identification in logic diagrams of multiplexers and demultiplexers. [-]

Teaching methods

Lectures

Bibliography

Basic

1. A. Hendelman, Load tracking of Unamnned Aerial Vehicle by fiber optic sensors, LAP Lambert Academic Publishing.

2. J. Moczko, L. Kramer, Cyfrowe metody przetwarzania sygnałów biomedycznych, Wydawnictwo UAM, Poznań 2001.

3. C. Cempel, Diagnostyka wibroakustyczna maszyn, PWN, Warszawa 1989.

4. C. Cempel, Podstawy wibroakustycznej diagnostyki maszyn, Wydawnictwo Naukowo-Techniczne Warszawa 1982.

5. C. Cemperl, Wibroakustyka stosowana, Państwowe Wydawnictwo Naukowe.

6. W. Soluch, Wstęp do piezo elektroniki. WKŁ, Warszawa, 1980.

7. A. A. Vives [ed.], Piezoelectric Transducers and Applications. Springer, 2008.

8. D. M. Rowe, Handbook of thermoelectrics. CRC Press, 1995.

9. D. C. Lagoudas D.C. [ed.], Shape memory alloys. Modeling and engineering applications. Springer, 2008.

10. K. J. Kim, Tadokoro S. [ed.], Electroactive polymers for robotic applications: artificial muscles and sensors, Springer, 2007.

11. H. P. Konka, M. Wahab, K. Lian, Piezoelectric fiber composite transducers for health monitoring in composite structures, „Sensors and Actuators" 2012, A 194

Additional

1. J. L. Rose, Ultrasonic waves in Solid Media,Cambridge Univercity Press.

2. S. I. Rokhlin, D. E. Chimenti, P. B. Nagy, Phisical ultrasonic of composites, Oxford Univercity Press 2011.

3. G. Akhras, Smart materials and smart systems for the future, "Canadian Military Journal", Autumn 2000.

4. A. Ćwikła, Lotnicze zastosowania materiałów inteligentnych, „Prace Instytutu Lotnictwa" 2011, nr 211.

5. A. Ćwikła, Medyczne zastosowania materiałów inteligentnych, VII konferencja informatyki stosowanej, Chełm 2008.

6. L. A. Dobrzański, Podstawy nauki o materiałach i materiałoznawstwo, Wydawnictwo Naukowo-Techniczne, Warszawa 2002.

7. J. Frautschi, Finite element simulation of shape memory alloy actuator in adaptive structures, Mechanical and Aerospace Engineering, 2003.

8. V. Giurgiutiu, C. Rogers, J. Zuidevaart, Incrementally adjustable rotor-blade tracking tab using SMA composite, Proceedings of the 38th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, and Adaptive Structures Forum, Kissimmee, FL, April 7–10, 1997, Paper #97-1387.

Breakdown of average student's workload

	Hours	ECTS
Total workload	56	2
Classes requiring direct contact with the teacher	30	1,0
Student's own work (literature studies, preparation for tutorials, preparation for tests) [1]	26	1,0

[1] delete or add other activities as appropriate