COURSE DESCRIPTION CARD - SYLLABUS

Course name

Vibroacoustics and intelligent structures

Course

Field of study

Aviation

Year/Semester

4/7

Area of study (specialization)

Aircraft engines and airframes

Profile of study

general academic

Level of study

First-cycle studies

Course offered in

polish

Form of study

full-time

Requirements

compulsory

Number of hours

Lecture

30

Laboratory classes

Other (e.g. online)

Tutorials

15

Projects/seminars

Number of credit points

4

Lecturers

Responsible for the course/lecturer:

Dr eng. Wojciech Prokopowicz

email: wojtek379@wp.pl

phone +48 606 638 410

Faculty of Transport Engineering

ul. Piotrowo 3; 60-965 Poznań

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 extended and in-depth knowledge of mathematics including algebra, analysis, theory of differential equations, probability, analytical geometry as well as physics covering the basics of classical mechanics, optics, electricity and magnetism, solid state physics, thermodynamics, useful for formulating and solving complex technical tasks related to engineering aeronautical and modeling

2. has ordered and theoretically founded general knowledge in the field of key technical issues and detailed knowledge of selected issues related to air transport, knows the basic techniques, methods and tools used in the process of solving tasks related to air transport, mainly of an engineering nature

3. has knowledge of the method of presenting test results in the form of tables and graphs, performing the analysis of measurement uncertainties

4. has basic knowledge of research methods and how to prepare and conduct research, and knows the rules of editing a scientific work

5. has basic knowledge of metal, non-metal and composite materials used in machine construction, in particular about their structure, properties, methods of production, heat and thermo-chemical treatment and the influence of plastic processing on their strength, as well as fuels, lubricants, technical gases, refrigerants e.t.c.

6. has basic knowledge of environmental protection in transport, is aware of the risks associated with environmental protection and understands the specificity of the impact of mainly air transport on the environment as well as social, economic, legal and other non-technical conditions of engineering activities

7. has the ability to self-study with the use of modern teaching tools, such as remote lectures, websites and databases, teaching programs, e-books

Skills

1. is able to obtain information from various sources, including literature and databases, both in Polish and in English, integrate them properly, interpret them and make a critical evaluation, draw conclusions and exhaustively justify the opinions they formulate

2. is able to properly use information and communication techniques, applicable at various stages of the implementation of aviation projects

3. is able to properly plan and perform experiments, including measurements and computer simulations, interpret the obtained results, and correctly draw conclusions from them

4. can, when formulating and solving tasks related to civil aviation, apply appropriately selected methods, including analytical, simulation or experimental methods

5. is able to properly select materials for simple aviation structures, and can indicate the differences between the fuels used in aviation

6. is able to communicate using various techniques in the professional environment and other environments using the formal notation of construction, technical drawing, concepts and definitions of the scope of the study field of study

7. is able to design elements of means of transport with the use of data on environmental protection

8. student can use theoretical probability distributions. Student is able to analyze and interpret statistical data. Student is able to use the methods and tools of mathematical statistics in engineering practice

9. can use the language of mathematics (differential and integral calculus) to describe simple engineering problems.

10. Student is able to make a comprehensive assessment of the ecological parameters of an aircraft propulsion unit based on the values of emission factors for harmful gaseous compounds and particulate matter

11. is able to prepare a short research paper while maintaining the basic editorial rules. He can choose appropriate methods for the conducted research and is able to carry out a basic analysis of the results.

12. is able to organize, cooperate and work in a group, assuming various roles in it, and is able to properly define priorities for the implementation of a task set by himself or others

13. is able to plan and implement the process of own permanent learning and knows the possibilities of further education (2nd and 3rd degree studies, postgraduate studies, courses and exams conducted by universities, companies and professional organizations)

Social competences

1. understands that in technology, knowledge and skills very quickly become obsolete

2. is aware of the importance of knowledge in solving engineering problems and knows examples and understands the causes of faulty engineering projects that have led to serious financial and social losses, or to a serious loss of health and even life

3. is aware of the social role of a technical university graduate, in particular understands the need to formulate and provide the society, in an appropriate form, with information and opinions on engineering activities, technological achievements, as well as the achievements and traditions of the engineer profession

4. correctly identifies and resolves dilemmas related to the profession of an aerospace engineer

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	100	4,0
Classes requiring direct contact with the teacher	45	2,0
Student's own work (literature studies, preparation for tutorials, preparation for tests) [1]	55	2,0

[1] delete or add other activities as appropriate