COURSE DESCRIPTION CARD - SYLLABUS

Course name
Monitoring and dynamics of machines

Course

Field of study
Mechatronics
Area of study (specialization)

Level of study
Second-cycle studies
Form of study
full-time

Year/Semester
1/2
Profile of study
general academic
Course offered in
Polish
Requirements
compulsory

Number of hours

Lecture
15
Laboratory classes
15
Other (e.g. online)

Tutorials
Projects/seminars

Number of credit points

2

Lecturers

Responsible for the course/lecturer:
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Responsible for the course/lecturer:
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Prerequisites

Fundamentals of mechanics, the basics of diagnostics and the basics of measuring physical quantities. Ability for self-learning and knowledge acquiring, basing on library (including e-resources) and Internet resources (e.g. eKursy and others).

Course objective

Students receive theoretical knowledge and practical skills in the field of dynamics of mainly rotating machines as well as methods and techniques used to monitor their dynamic state. Inspiring students to search for innovative solutions to reduce the dynamic impact of machines.

Course-related learning outcomes

Knowledge

Student after the end of the course has knowledge of advanced methods and techniques that allow to identify and supervise the dynamic state of machines. Student knows the basic features, advantages and limitations of advanced methods and techniques for the identification of dynamic parameters of mechanical systems; knows the forms of results (imaging of results) obtained by various methods and knows the rules of their interpretation. Student knows the methods of limiting the dynamic impact of the machine.

Skills

After completing the course, the student is able to propose advanced methods or techniques enabling the detection and identification of the dynamic state or phenomena occurring in machines and devices. The student is able to evaluate the usefulness of dynamic tests. He knows how to interpret the results and characteristics provided by the advanced systems of supervising the dynamic condition of machines. Based on the results, the student is able to formulate an assessment of the dynamic state and operational recommendations.

Social competences

Student after completing the course is well aware of the necessity for continuous self-learning . Student is aware of the role of engineering activities in creating new innovative solutions in the field of mechatronics and the importance of these solutions in the development of technology. Student knows how to think and act creatively and proactively.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Laboratory classes:

Short entry tests before each laboratory exercise. Assessment of knowledge and skills, as well as activity during carried out experiments. Evaluation of mastery of course content, skills and acquired competencies based on the quality of individually prepared reports. The substantive and computational correctness, report completeness and the ability to specifying conclusions, remarks and observations are verified. Necessary condition to pass the laboratory: passing a set of laboratory exercises and getting the required number of points from entry tests and reports.

Lecture:

Written or remote tests (via eKursy platform): 10-20 issues covering the entire lecture material and issues indicated for own studies (self-studying).

Grading scale both laboratory and lecture (exam): below 60% unsatisfactory; 60-67% satisfactory, 68-75% satisfactory plus; 76-83% good; 84- 91% good plus; 92 -100% very good.

Programme content

Lectures:
Vibrations of systems with many degrees of freedom. Dynamics of rotating machines - torsional vibrations of shafts, bending vibrations of shafts. Forms and frequencies of natural vibrations. Vibration isolation and elemination of vibrations. Harmonic, impulse and noise dynamic tests. Methods of measurement and analysis of relative rotor vibrations for steady and unsteady conditions: shaft orbit analysis, Bode and Nyquist characteristics, cascade spectra, shaft center position analysis. Critical speeds of shafts / rotors. Identification of unstable operation of hydrodynamic bearings (oil whirl, oil whip). Detection of abrasions, transverse overload of rotors, shaft cracks. Presentation of the latest achievements and solutions in the field of supervising the dynamic condition of machines.

Laboratory exercise topics:
Parameterization of the shaft orbit on the basis of relative rotor vibrations.
Identification of the rotor dynamic instability on the basis of the analysis of the cascade spectrum of relative vibrations (during rotor start-up or coast-down) - oil whirl detection.
Determination of critical shaft speeds on the basis of Bode's characteristics.
Harmonic test (sweep test) - configuring the measuring and analyzing system and carrying out the test for the indicated mechanical system. Determination of the frequency and mode of free vibrations of the plate system (Chladni figures). Investigation of the influence of imperfections on the forms of natural vibrations.
Random test - configuration of the measuring and analyzing system, determining the amplitude-frequency characteristics of the indicated electro-acoustic system.
Impulse test - configuration of the measuring and analyzing system; carrying out a test for the indicated mechanical system. Selection of parameters of the inducement system (modal hammer); experimental determination of: inertance, admittance and mobility.
Testing of vibro-isolating properties of various types of materials and mechanical systems.
Selection of parameters of the vibration isolation system of a rotating machine.
Vibration elimination - dynamic eliminator
The use of dynamic characteristics (amplitude-frequency) to minimize dynamic interactions

Teaching methods

Lecture: multimedia presentation. The content of lectures is available in electronic form before the beginning of the class, which allows comfortable and active participation in lectures.

Laboratories: the experiments are carried out on specialized didactic stands equipped with dedicated measuring and analysing systems.

Lectures and laboratories are fully supported on the eKursy e-learning platform. There are available: lectures, multimedia, off-line webinars, source literature (magazines, selected publications, technical

notes), instructions for laboratory exercises, report templates, sample reports. It is also possible to perform exercises remotely based on prepared photo and video tutorials and individual data sets. Tests, competitions and quizzes, sets of exam questions, criteria on the basis of which reports are assessed are also available there.

Bibliography

Basic

1. Randall B., Vibration-based Condition Monitoring: Industrial, Aerospace and Automotive Applications, Wiley 2011.
2. Eisenmann R., Machinery Malfunction. Diagnosis and correction, Pearson Education , Inc. 2005
3. Broch J.T., Techanical Vibration and Shock Measurements, Bruel&Kjaer Denmark 1984
4. Fiebig Wiesław. Drgania i hałas w inżynierii maszyn. PWN 2019 .

Additional

1.Selected publications in journals:
Diagnostyka; Mechanical systems and signal processing; Journal of vibroengineering
2. Technical specifications of diagnostic devices and systems
3. Supplementary materials available on the eKursy e-learning platform.

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2,0
Classes requiring direct contact with the teacher	30	1,0
Student's own work (literature studies, self-education based on e-learning resources, preparation for laboratory classes, individual programming, reports, preparation for exam) [1]	20	1,0

[1] delete or add other activities as appropriate