COURSE DESCRIPTION CARD - SYLLABUS

Course name
Advanced issues of machine diagnostics

Course

Field of study
Mechatronics
Area of study (specialization)
Automation and Supervision of Production Systems
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	Laboratory classes	Other (e.g. online)
15	15	0
Tutorials	**Projects/seminars**	
0	0	

Number of credit points

2

Lecturers

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

Prerequisites

Fundamentals of machinery diagnostics, systems and devices of machine diagnostics, basics of metrology, basics of digital signal processing. Ability for self-learning and knowledge acquiring, basing on library (including e-resources) and Internet resources (e.g. Moodle).

Course objective

Students receive theoretical knowledge and practical skills in applying advanced methods and techniques of machine diagnosing.

Course-related learning outcomes

Knowledge

After completing the course, the student has knowledge on advanced methods and techniques of analysis and processing of vibroacoustic signals, which allow to detect various types of damage and malfunctions of machines. The student knows the basic features, advantages, disadvantages and limitations of advanced diagnostic methods and techniques. The student knows the forms of the results

(including the imaging of the results) obtained by various methods. Student knows the rules of results interpretation.

Skills

After completing the course, the student is able to propose an advanced diagnostic method or technique that allows the detection or identification of various types of defects and damages or phenomena occurring in machines and devices. The student is able to assess the usefulness of advanced diagnostic methods and techniques. The student knows how to configure advanced diagnostic systems and is able to choose the optimal signal processing parameters. The student knows how to interpret the results of analyzes obtained as a result of applying advanced techniques or methods of signal processing. Based on the results, the student is able to formulate a diagnosis and operational recommendations.

Social competences

Student after completing the course is well aware of the necessity for continuous self-learning. He is aware of the role of the engineering staff in searching for new innovative solutions and developing new and effective methods and techniques for diagnosing machines and devices. He is able to organize teamwork and to cooperate while carrying out tasks.

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. Necessary condition to pass the laboratory: passing a set of laboratory exercises and getting the required number of points from entry tests and reports.

Lectures

Written or remote tests (via MOODLE 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:

Sources of vibroacoustic processes in machines and devices . Methods of selecting diagnostic signals (spectral selection, selection in the time domain, spatial selection). Advanced methods and techniques of signal analysis and their application in machine diagnostics: synchronous averaging (TSA) and multi-synchronous (MSA), cepstral analysis, methods of polyharmonic decomposition, spectral analysis of the signal envelope (Hilbert transform), methods of time-frequency analysis (short-time Fourier transform, wavelet transform), Tiger-Kaiser energetic indicator.

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 transverse overload of rotors, shaft cracking.
Presentation of the latest achievements and solutions in the field of technical diagnostics of machines.

Laboratory classes:

Laboratory exercises are carried out on dedicated laboratory stands
Exercises:
Detection of damage to rolling element bearing elements based on the spectrum of the signal envelope and Cepstral analysis. Application of synchronous averaging to separation of phenomena in asynchronous motors. Poliharmonic decomposition of gear vibrations (MSA method). Shaft orbit parameterization. Cascade spectrum analysis of relative vibrations (during rotor start-up or coast-down) and oil whirl detection). Determination and critical speeds of the shaft based on the Bode's characteristics. STFT analysis of non-stationary processes (in terms of amplitudes and frequencies).

The current list of exercises is available on the Moodle platform.

Teaching methods

Lectures: 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 didactic stands equipped with diagnostic devices and systems.
Lectures and laboratories are fully supported on the Moodle 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.

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.

Additional

1. Selected publications in journals: Diagnostics; Mechanical systems and signal processing; Journal of Vibroengineering etc.
2. The technical specifications of devices and diagnostic systems.

Breakdown of average student's workload

	Hours	ECTS
Total workload	60	2,0
Classes requiring direct contact with the teacher	35	1,0
Student's own work (literature studies, self-education based on e-learning resources, preparation for laboratory classes, reports, preparation for tests/exam) [1]	25	1,0

[1] delete or add other activities as appropriate