COURSE DESCRIPTION CARD - SYLLABUS

Course name
Technical diagnostics [S1ETI2>DT]

Course

Field of study
Education in Technology and Informatics

Year/Semester
3/5

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

2,00

Coordinators

Lecturers

Prerequisites

Student knows fundamentals of theory of machines and mechanisms, engineering metrology and measurements as well as methods of results analysis. Student is able to perform basic measurements. Ability for self-learning and knowledge acquiring, basing on library (including e-resources) and Internet resources (e.g. eKURSY).

Course objective

Students receive basic knowledge in the field of technical diagnostics (in particular vibroacoustic diagnostics). Students improve their skills in assessing the technical condition of machines and subassemblies, as well as in the detection and identification of damage.

Course-related learning outcomes

Knowledge:
After completing the course, the student has knowledge of the goals and methods of technical diagnostics at the stage of construction, production and operation of technical objects.
Student knows the typical causes and effects of operational damage and malfunctions of machines and their components. Student knows the methods and techniques of machinery condition monitoring.
The student knows how to assess the technical condition of machines. Student knows the methods and techniques used to identify defects, damage (including the NDT -methods) and malfunctions in the

operating of machines and devices and knows how to eliminate them.

Skills:
After completing the course, student is able to assess the general technical condition of machines (in particular rotating machines). Student is able to make the right decisions regarding the operation of machines.
Student is able to measure and analyse vibroacoustic signals as well as interpret the results of the analysis. Student is able to identify damages, defects, malfunctions in the operating of machines and devices .
Student is able to selectively analyse the content of standards, publications and other source materials in the field of technical diagnostics .

Social competences:
Student after completing the course is aware of the necessity for continuous self-learning. Student understands the importance of technical diagnostics in economic terms and the safety of people and the environment. Student is aware of the importance of engineering activities and responsibility for decisions . Student is able to organize teamwork and to actively cooperate while performance of tasks.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

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

Lecture: Basic terminology. Symptom life curve of a technical object. Place of diagnostics in individual stages of the life of technical systems (design diagnostics, post-production diagnostics, operational diagnostics, technological processes). Methods of diagnostic tests of machines and their components. Methods and techniques of detecting and identifying defects, damages of machines and their components. Laboratories: Laboratory exercises carried out on real objects and on laboratory stands (small-size models of aggregates, machines). Their aim is to exemplify the content of lectures. Assessment of technical condition based on vibration measurements and standard recommendations (PN ISO standards) - (the exercise is carried out on a fan station). Subsequent exercises performed on laboratory stands containing typical machine components such as: rotors, shafts, bearings, belt transmission, gear transmission, gear pump. Detection of leaks in compressed air systems. Acquiring skills necessary to carry out tests using selected non-destructive testing techniques (NDT). Laboratory stations are equipped with measurement and analysis systems and devices enabling the detection and identification of defects and damage to machine components.

Course topics

Lectures.
1. The area of theoretical and practical issues of technical diagnostics. Basic concepts and terminology: diagnosis, genesis, prognosis, diagnostic symptom and their classification, sympom life curve of a technical object, residual processes (dynamic and semistatic) as sources of diagnostic information.
2. Diagnostic testing methods: visual testing (VT) , penetrant testing, magnetic particle testing (MPT) , eddy current, radiographic, ultrasonic testing (passive and active), wear product testing, thermal and vibroacoustic methods (idea, varieties, instrumentation and equipment, sample applications, defects, limitations, advantages, disadvantages).

3. Place of diagnostics in the life phases of a technical object - objectives and methods (construction diagnostics, post-production diagnostics, monitoring the technical condition of machines - operational diagnostics).
4. Assessment of the technical condition and operating condition of machines based on vibration measurements. Idea, standard recommendations, machine classes, vibration intensity zones, technical condition. Vibration velocity limit values used to assess the technical condition. Principles of performing measurements: number of measurement points, location of vibration transducers, calibration of the measurement path. Test procedure. Method of reporting measurement results, assessing technical condition and formulating operating recommendations.
5. Diagnosing shafts and rotors. Typical defects and damage to rotors: unbalance, bending, misalignment, crack. Causes and effects of rotor imbalance. Methods of identifying imbalance. Methods of reducing rotor unbalance - balancing on balancing machines and in own bearings.
6. Diagnosing rolling bearings. Types of rolling bearings. Causes of rolling bearing damage. Phases of degradation of rolling bearings: noise, vibration and thermal phase. Methods of diagnosing rolling bearings: acoustic emission, ultrasonic methods including SPM, vibration and noise measurements and analyses, thermal methods.
7. Diagnosing gears and belt transmissions. Types of transmissions. Basic diagnostic methods: visual, vibroacoustic, testing of wear products in the lubricant. Typical forms of defects and damages in gear transmissions detected by visual methods, pitting, scuffing, overloading, material flow, cracking and breakage of teeth. Manufacturing defects in gear transmissions: misalignment, shaft non-parallelism, excessive clearances between teeth, tip clearances. Diagnosing gear transmissions based on spectral analysis of vibrations. Spectral composition of gear transmission vibrations: rotational frequencies, meshing frequency, modulation bands. Identification of defects and damages in gear transmissions based on the vibration spectrum (including misalignment, clearances, tooth wear). Identification of gear transmission damage based on microscopic observations of wear products in the lubricant (analytical ferrography). Diagnosing belt transmissions based on spectral analysis of vibrations. Determination of characteristic frequencies associated with damages to pulleys and V-belts.
8. Lecture final test.
Laboratories:
1. Assessment of the technical condition of a rotating machine - standard vibration measurements of rotating machines.
2. Rolling bearings - assessment of the technical condition using the SPM method.
3. Gearbox - assessment of the technical condition based on vibration measurements.
4. Rotors - identification of the type of unbalance
5. Unbalance of rigid rotors - testing the relationship between unbalance and vibrations recorded on the rotor bearing supports (optional exercises).
6. Ultrasonic defectoscopy - (pulse-echo techniques).
7. Detection of defects and damage using the magnetic-particle method
8. Detection of leaks in pneumatic systems (optional exercises)

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, sets of exam questions, criteria on the basis of which reports are assessed are also available there.

Bibliography

Basic:
1. Inżynieria Diagnostyki Maszyn. ed. B. Żółtowski i C. Cempel, PTDT ITE PIB Radom, 2004.
2. Handbook of condition monitoring, Edited by B.K.N. Rao, Elsevier Science Ltd. 1996.
3. Diagnostyka Maszyn, Zasady ogólne przykłady zastosowań, ed. C. Cempel i F. Tomaszewski, MCNEMT Radom, 1992.

4. Lewińska-Romicka A., Badania nieniszczące, podstawy defektoskopii, WNT W-wa, 2001
5. Barczewski R., Laboratory of Systems Diagnostics - instructions for laboratory exercises - electronic edition (Moodle).

Additional:
1. Cempel C., Diagnostyka Wibroakustyczna Maszyn, PWN Warszawa 1989.
2. Żółtowski B, Podstawy diagnostyki maszyn, WU ATR Bydgoszcz 1996,
3. Morel J., Drgania Maszyn i diagnostyka ich stanu technicznego (tłum.) PTDT, 1992.
4. Dwojak J. Rzepiela M., Diagnostyka drganiowa stanu maszyn i urządzeń, Biuro Gamma, Warszawa 2005.
5. Selected standards (PN-ISO), technical magazines: Główny Mechanik, Utrzymanie Ruchu, Maintenance and Reliability, Diagnostyka.
6. Encyclopaedia of condition monitoring, Coxmoor Publishing Company Oxford UK 2006.
7. Supplementary materials available on the eKURSY e-learning platform.

Breakdown of average student's workload

	Hours	ECTS
Total workload	55	2,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	25	1,00