

(faculty stamp)

COURSE DESCRIPTION

1. Course title: DIAGNOSTIC SYSTEMS FOR MACHINES		2. Course code:		
3. Validity of course description: 2018/2019				
4. Level of studies: 2 nd cycle of higher education (MSc)				
5. Mode of studies: intramural studies				
6. Field of study: Automatic Control and Robotics				
7. Profile of studies: general				
8. Programme: SYSTEMY POMIAROWE I INFORMACYJNE				
9. Semester: 2				
10. Faculty teaching the course: Institute of Automatic Control (RAu1)				
11. Course instructor: dr inż. Sebastian Budzan				
12. Course classification: programme courses				
13. Course status: elective				
14. Language of instruction: English				
15. Pre-requisite qualifications: It is assumed that the student prior to learning of this course have knowledge of the measurements, industrial measurements, reliability and Intrinsic, measurement procedures, image processing and computer vision.				
16. Course objectives: The aim of the course is to familiarize students with the methods of determining the state of the machine with special emphasis on hardware. For this purpose, a procedure based on objective measurements of various physical quantities and advanced analysis algorithms and processing of the measurement results implemented on a PC platform and embedded systems. Technical diagnosis is used to increase the durability, reliability and efficiency of the machine.				
17. Description of learning outcomes:				
Nr	Learning outcomes description	Method of assessment	Teaching methods	Learning outcomes reference code
1	Has knowledge of the symptoms and sources of processes, which characterize the machine damages	SP	WT,WM	K_W22
2	Has knowledge of diagnostics allows to plan and carry out diagnostic experiment	SP	WT,WM	K_W10; K_W15
3	Has knowledge of advanced measurement systems used in machine state diagnosis	SP, CL	WT,WM	K_W04
4	Can identify the symptoms of machine damages types, and the best method of diagnosis	CL	L	K_U25; K_U26
5	Can carry out the task of machine diagnostics using modern measuring systems and specialized software	CL, PS	L	K_U11; K_U12;; K_U25
6	Able to independently plan, develop and present a diagnostic task of the specific machine	OS	L	K_K01; K_K02; K_K04; K_K06
18. Teaching modes and hours Lecture: 30 / BA /MA Seminar / Class / Project / Laboratory: 30				
19. Syllabus description: Lectures: Diagnostic systems for machines, the feasibility of a state of the machine, the role of diagnostics in the life cycle of				

the machine, the complexity of production systems, harvesting methods and means of diagnosis, residual processes, the economics and reliability of diagnostics.

Vibroacoustic diagnostics: Source of vibroacoustic processes (unbalance, couplings, backlash, gears, bearings, cavitation), measures of vibroacoustic signals, selection of measurement methods and sensors, signal processing noise and vibration in the time domain and frequency, diagnostic reasoning, application examples vibroacoustic diagnostics in industry.

Ultrasonic flaw detection: ultrasound, ultrasound theoretical basis, production and measurement of ultrasonic waves, heads and ultrasonic, ultrasonic testing methods, identification and assessment of defect size.

Overview of the LabVIEW programming tools Sound & Vibration. Selection of a diagnostic signal processing algorithm according to the nature of it (periodic, no periodic, fixed or variable in time, etc.). Time-Frequency Analysis of the STFT (Short-Time Fourier Transform), the use of wavelet analysis. Examples of the use LabVIEW Sound and Vibration in order analysis. The use of modern measuring systems and development tools for the diagnosis of technical machines. Programming hardware platforms running real-time and FPGA (CompactRIO, sbRIO).

Thermography and infrared thermometry: the theoretical basis of measurements of infrared (thermal radiation, emissivity), the technical black body, thermal radiation detectors, pyrometers, construction and operation of thermal cameras, types and applications of thermal cameras, infrared measurement errors, evaluation and calibration of meteorological parameters infrared cameras. Standardization of measurements in technical diagnostics.

Thermal Diagnostics: thermal phenomena in machines, diagnostic procedures, selection of the measuring circuit elements, passive thermography, active thermography, pulsed thermography, pulse-phase thermography, synchronous thermography, vibrothermography. Methods and algorithms for thermal image processing. The processing in the frequency domain, wavelet analysis.

Machine vision diagnostics: machine vision system design, selection of the parameters of the vision system (sensor, optics, lighting), the calibration of the vision system, digital image acquisition, image analysis methods, methods and algorithms for image processing for detection and assessment of damage to the machines. The use of methods of segmentation, morphological operations, Fourier transform, feature extraction, and statistical methods. Use of the IMAQ LV.

Laboratory:

1. Ultrasonic flaw detection.
2. Online systems of the vibroacoustics diagnostics.
3. Vibration measurements and vibration signals processing (LV Sound&Vibration).
4. Nondestructive testing with active thermography.
5. Analysis and processing of the thermal images.
6. Use of the machine vision in technical diagnostics (LV IMAQ).
7. Use of the sbRIO and cRIO platforms in technical diagnostics.
8. End of Line testers.
9. Diagnostics in automotive industry.

20. Examination: No

21. Primary sources:

1. Cempel C.: Diagnostyka wibroakustyczna maszyn, PWN, Warszawa 1989r.
2. Piersol A., Paez T.: Harris' Shock and Vibration Handbook, McGraw-Hill, New York, 2010
3. Cholewa W., Kaźmierczak J.: Diagnostyka techniczna maszyn. Przetwarzanie cech sygnałów, Skrypty uczelniane Politechniki Śląskiej nr 1693, Gliwice, 1992
4. Cholewa W., Moczulski W.: Diagnostyka techniczna maszyn. Pomiary i analiza sygnałów, Skrypty uczelniane Politechniki Śląskiej nr 1758, Gliwice, 1993.
5. Davies E.R.: Machine Vision, Third Edition: Theory, Algorithms, Practicalities (Signal Processing and its Applications), Morgan Kaufmann Elsevier, 2005
6. Minkina W.: Pomiary termowizyjne – przyrządy i metody. Wyd. Pol. Cz., Częstochowa, 2004.
7. Madura H.: Pomiary termowizyjne w praktyce, PAK, 2004.
8. Więcek B., De Mey G.: Termowizja w podczerwieni. Podstawy i zastosowania. PAK, 2011.

22. Secondary sources:		
1. Lewińska - Romicka A.: Badania nieniszczące, podstawy defektoskopii WNT, Warszawa 2001		
2. D. Świsulski: Komputerowa technika pomiarowa. Oprogramowanie wirtualnych przyrządów pomiarowych w LabVIEW, PAK, 2006.		
3. Lectures notes.		
23. Total workload required to achieve learning outcomes		
Lp.	Teaching mode :	Contact hours / Student workload hours
1	Lecture	30 / 30
2	Classes	/
3	Laboratory	30 / 30
4	Project	/
5	BA/ MA Seminar	/
6	Other	/
	Total number of hours	60 / 30
24. Total hours: 120		
25. Number of ECTS credits: 5		
26. Number of ECTS credits allocated for contact hours: 3		
27. Number of ECTS credits allocated for in-practice hours (laboratory classes, projects): 3		
26. Comments:		

Approved:

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 (date, Instructor's signature)

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 (date, the Director of the Faculty Unit signature)