Diagnostics and Condition Monitoring

Code: MK5DIAFG04G117_EN

ECTS Credit Points: 4

Evaluation: exam

Year, Semester: 2nd year, 1st semester

Its prerequisite(s): Electrical measurement and signal processing

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

The aim of the subject is expanding the knowledge in technical diagnostics and condition monitoring acquired through bachelor program: use of up-to-date methods, application of reliability-based and risk-based approach in maintenance, effective identification of failures of machines and machine elements.

Time-domain analysis and statistical parameters, kurtosis, skewness. Trendanalysis. Wavelet transform. FIR and IIR filter design. Energy and entropy for wavelet selection. Transient analysis. Machine learning in diagnostics.

Literature:

Compulsory:

- Czichos, H. (ed.), Handbook of Technical Diagnostics (Fundamentals and Application to Structures and Systems), Springer, 2013.
- Harris, C. M., Piersol, A. G. (ed.), Harris' Shock and Vibration Handbook, McGraw-Hill, 2002
- Taylor, J.: The Vibration Analysis Handbook VCI, 2000
- Taylor, J.: The Gear Analysis Handbook, VCI, 2000
- Taylor, J., Kirkland, D.W.: The Bearing Analysis Handbook, VCI, 2000
- Moubray, J., Reliability-Centered Maintenance: Industrial Press Inc., 2001.
- Smith, D. J., Reliability, Maintainability and Risk: Practical Methods for Engineers, Elsevier, 2011

Schedule

1st week: Registration week

2nd week: **Lecture:** Maintenance strategies. Reliability-based and risk-based approach in Maintenance, RCM analysis, FMEA. Role of Technical Diagnostics in Maintenance (TPM and Lean systems), condition-based maintenance. **Practice:** Practice for FMEA for diagnostics. Quality management methods in the applied diagnostics.	**3rd week:** **Lecture:** The main fields of technical diagnostics: vibration diagnostics, acoustics, ultrasound analysis, thermography, endoscopy, oil analysis. **Practice:** Practical measurements of devices.
4th week: **Lecture:** Generalization of signals. Noise signals in diagnostics. Sampling theorem. **Practice:** Introduction to the signals in Labview.	**5th week:** **Lecture:** Theoretical background of vibration: sources and types of vibration, statistical evaluation of

	vibration signals, Fourier spectrum of periodic and non-periodic signals, Fourier transform. **Practice:** Balancing.
6th week: **Lecture:** Short time Fourier transform. Discrete Fourier transform, FFT. Skewness. Kurtosis. Statistical analysis of non-perodical signals. **Practice:** Transforms in practice.	**7th week:** **Lecture:** Sampling, information content in discrete signal (aliasing, leakage). Shannon sampling principle. Parseval theorem. Power spectrum. **Practice:** Measurements and analysis of signals.
8th week: 1st drawing week	
9th week: **Lecture:** Windowing, averaging, filtering. FIR and IIR filters. Design of filters. Csebisev and Butterworth filters. Elliptic filters. Parks-McClellan algorithm. **Practice:** Filter design.	**10th week:** **Lecture:** Application of wavelet transform in condition monitoring. **Practice:** Bearing condition evaluation with shock pulse method.
11th week: **Lecture:** Mother wavelets. Symlet and Daubechies, Morlet wavelets, Complex Morlet wavelets. **Practice:** Mother wavelets for transient analysis.	**12th week:** **Lecture:** Z transform and inverse Z transform, Cepstrum analysis. Machine learning, ANN, ANFIS, SVM for fault classification. **Practice:** Application of digital transforms in practice. Machine learning applications in softwares.
13th week: **Lecture:** Machine failures and related symptoms in machine elements: bearing fault analysis and gear fault analysis. **Practice:** Measurements of gears and bearings with devices.	**14th week:** **Lecture:** Machine failures and related symptoms in dynamic systems and machines: unbalance, shaft and coupling alignment problems, looseness, bearing and gear faults, electric motor failures. **Practice:** Measurements with devices of integrated machines.
15th week: 2nd drawing week	

Requirements

A, for a signature:

Participation at practice classes is compulsory. Students must attend practice classes and may not miss more than three practice classes during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't take part in any practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certification needs to be presented. Missed practice classes must be made up for at a later date, being discussed with the tutor.

During the semester there are two tests: the mid-term test is on the 10th week and the end-term test is on the 15th week. Students must sit for the tests.

B, for a grade:

The course ends in exam grade. The grade for the test is given according to the following table:

Score	Grade
0-59	fail (1)

60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, the student once can take a retake test of the whole semester material.