Maintenance and Repairing Technologies

Code: MK5KJATG04G117_EN

ECTS Credit Points: 4

Evaluation: exam

Year, Semester: 2nd year, 2nd semester

Its prerequisite(s): Engineering Systems and Modelling

Further courses are built on it: Yes/No

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

Topics:

Type of maintenance strategies: corrective, preventive, predictive. Prognostics and health management (PHM). Remaining useful life estimation based on mathematical methods. (RUL). Autoregressive (AR) model, neural networks (NNs) and neural fuzzy (NF) systems. Support Vector Machines (SVM) for machine learning based RUL estimation. The concept and basics of reliability-centered maintenance (RCM), total productive maintenance (TPM), Root cause analysis (RCA) and Root cause failure analysis (RCFA), Computerized maintenance management system (CMMS), basics of TQM. Terotechnology. Aims of machine repairig, Fault Tree. Event Tree, FMEA. Machine fault diagnosis: vibration diagnosis, thermography, endoscopy. Fourier (FFT) and wavelet transform (WT). CWT and DWT. Envelope spectrum with Hilbert transform. HFRT. Fault frequency detection of machines. Filtering by Butterworth and Chebysev filters. Cepstrum analysis before repairing. Traditional and advanced machining technologies in machine repairing. Modern thin layer techniques, plasma beam technique, laser beam technique, nano-techniques. High energy technology to increase surface integrity. Advanced EDM technologies and machines and ultrasonic machining (USM).

Literature:

Compulsory:

- R. K. Mobley, An Introduction to Predictive Maintenance, Butterworth-Heineman, 2002.
- R. K. Mobley, Maintenance Fundamentals, Butterworth-Heineman, 2004.
- R. K. Mobley, L. R. Higgins, D. J. Wikoff : Maintenance Engineering Handbook, McGraw-Hill, 2008.
- J. Moubray: Reliability-Centered Maintenance: Industrial Press Inc., 2001.
- Heinz P. Bloch, Fred K. Geitner: Machinery Component Maintenance And Repair, Elsevier, 2004.ISBN: 978-0-7506-7726-4
- Allan G. Piersol, Thomas L.Paez: Harris's Shock and Vibration Handbook, Sixth Edition, McGrraw-Hill,2010. ISBN 978-0-07-163343-7

Recommended:

- Fred K. Geitner, Heinz P. Bloch: Maximizing Machinery Uptime, Gulf Professional Publishing, 2006.
- Ricky Smith, R. Keith Mobley: Industrial Machinery Repair: Best Maintenance Practices Pocket Guide, Elsevier, 2003

Schedule

1st week: Registration week	
2nd week:	3rd week:
Lecture: Maintenance methods in mechanical engineering. Corrective, Preventive, Predictive	Lecture: Selecting proper prognostics algorithmstochastic models such as the

Maintenance. Some case study. The concept and basics of reliability-centered maintenance (RCM). The concept and basics of total productive maintenance (TPM). Examples from industrial environment. Advanced "bathtube curve theory" Prognostics and health management (PHM). Remaining useful life (RUL). Prognostics ad probablity estimation based on mathematical functions. Effects of fatigue and mechanical stress development for RUL.

Practice: RCM in the machine industry. TPM in the machine industry in mechanical engineering practice. RUL estimation calculation and simulation by mathematical softwares.

autoregressive (AR) model, neural networks (NNs) and neural fuzzy (NF) systems. Support Vector Machines (SVM) for machine learning based RUL estimation for maintenance time calculations.

Practice: RUL estimation by statistical processes with mathematical softwares.

4th week:

Lecture: Root cause analysis (RCA) and Root cause failure analysis (RCFA). Examples from industrial environment.

Computerized maintenance management system (CMMS). Examples from industrial environment.

Practice: RCA analysis of examples. Using of CMMS and interpretation.

5th week:

Lecture: Monitoring based machine repairing methods. Online and offline monitoring. Parameter selection for maintenance and diagnosis before machine repairing. Connection with CMMS systems for total monitoring (TM).

Practice: Industrial monitoring methods.

6th week:

Lecture: Maintenance and TQM, quality control in maintenance. Examples from industrial environment.

Maintainability. Design for Maintainability

Practice: TQM analysis of examples.

7th week:

Lecture: Terotechnology. Objectives of terotechnology, Principles of terotechnology, Costs of implementing terotechnology. Introducing terotechnology to an organisation.

Practice: Terotechnology in the industry. Case studies.

8th week: 1st drawing week

9th week:

Lecture: Tribology, wear, wear types, wear mechanism. Causes of machine faults. Aim of machine repairing and repairing technologies. Wear analysis of bearing elements, outer and inner rings. Mechanical stress developement.

Yu and Harris's fatigue life model for ball bearings, Paris and Erdogan's crack growth model.

Practice: Wear analysis by optical microscope and surface testers.

10th week:

Lecture: Probabilistic risk assessment. Fault Tree. Event Tree. Failure Mode and Effect Analysis (FMEA) in manufacturing and repairing with examples. Ishikawa diagram before machine repairing with application examples

Practice: How to create FMEA for analysis in machine industry. System modelling in mechanical engineering.

11th week:

Lecture: Machine fault diagnosis before repairing. Vibration measurement methods. ISO 10816 standard. SPM method.

Fourier (FFT) and wavelet transform (WT). CWT and DWT. Thermography. Infrared theory. Endoscopy. Eddy-current testing. Acoustic emission (AE).

12th week:

Lecture: Advanced analysis methods before reparing. Time-domain analysis by kurtosis and skewness. Cepstrum analysis by logaritmical inverse Mother wavelets for filter banks: Symlet and Daubiches. Morlet filter bandwidth and center frequency optimization. Optimization by genetic algoritm and

Practice: Measurements and data analysis. Some practical device presentation (NI DAQ and SPM Leonova). Labview and Matlab applications.	differential evolution algorithm. Envelope spectrum with Hilbert transform. HFRT. Fault frequency detection. Filtering: Butterworth and Chebysev filters. **Practice:** Cepstrum, wavelet and HRFT by Labview and Matlab.
13th week: **Lecture:** Traditional machining processes and machining tools in machine repairing. Turning, boring, drilling, milling, grinding of re-manufactured machine elements. Reaming. Threading. Superfinishing. Welding. Glueing. Basic methods and purpose of heat treatment after repairing by cutting technologies. Advanced machine processing I. EDM technologies and machines. Ultrasonic machining.(USM). **Practice:** Case studies with applications of repairing technologies.	**14th week:** **Lecture:** Advanced machine repairing techniques. Chemical machining. WJM technologies. Abrasive jet machining. Laser beam machining. Plasma machining. Electrochemical grinding. Laser welding. Fast prototyping. Modern thin layer techniques, plasma beam technique, laser beam technique, nano-techniques. High energy technology to increase surface integrity. **Practice:** Case studies with applications of advanced repairing technologies.
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 8th week and the end-term test is on the 15th week. Students must sit for the tests.

B, for 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)