

Repairing Technology

Code: MK3JAVTG05G117-EN

ECTS Credit Points: 5

Evaluation: exam

Year, Semester: 3rd year, 2nd semester

Its prerequisite(s): Theory of Damage

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 3+2

Topics:

The aim of the subject is expanding the knowledge in repairing technology 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.

Literature:

Compulsory:

- 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

Recommended:

- Czichos, H. (ed.), Handbook of Technical Diagnostics (Fundamentals and Application to Structures and Systems), Springer, 2013.

Schedule

1st week Registration week

2nd week: Role of machine repairing. Machine lifetime, bathtub curve, wear periods, maintenance strategies, CM (Condition Monitoring). Methods for condition monitoring.

Technical and economy aspects of repairing.

Practice:

Measurements in practice before repairing.

4th week:

Lecture: Friction, static friction, rolling friction, fluid friction, lubricated friction, Laws of dry friction, Coulomb's Law of Friction, coefficient of friction,

3rd week:

Lecture: Fault analysis before repairing. Probabilistic risk assessment (PRA). Fault tree analysis (FTA), FTA analysis involves steps. Event Tree Analysis (ETA). Failure Mode and Effects Analysis (FMEA). Thermography and vibration analysis, non-destructive testing methods before repairing. SEM and AFM equipments.

Practice: Fault analysis by modern methods before repairing.

5th week:

Lecture: Lubrication, Reducing friction, Hydrodynamic lubrication, Elastohydrodynamic lubrication, Boundary lubrication Lubricants, characteristics and

Effect of Sliding Velocity on coefficient of friction. Tribology basics.

Practice:

Calculation of friction parameters. Measurements of friction ratios. Examples.

6th week:

Lecture: Parts cleaning methods, Manual washing, Ultrasonic cleaning, type of Contaminations, Cleaning equipment and procedure, part washer Solvent degreasing, vapor degreasing, abrasive blasting. CO2 cleaning.

Practice: Case studies for cleaning technology.

8th week: 1st drawing week

9th week:

Lecture: Soldering and brazing technologies, desoldering and resoldering. Welding and cutting. Heat and filler Metal, shielding and fluxing, Shielded Metal Arc Welding (SMAW). Flux Cored Arc Welding (FCAW), Gas Tungsten Arc Welding (GTAW). Submerged Arc Welding (SAW), Gas Metal Arc Welding (GMAW). Gas welding and repair welding.

Practice: Examples, case studies for welding repairing technology.

11th week:

Lecture: Adhesives, pressure-sensitive adhesives, contact adhesives, hot adhesives, multi-part adhesives. Synthetic adhesives, joining metal with adhesives. Surface enhancement technology.

Practice: Analysis of adhesives. Technology.

13th week:

Lecture: Repair and of maintenance mechanical equipment: diagnosis of used bearings. Normal Appearance and Wear. Reconditioning. Cold Mountings. Temperature Mountings. Induction heater, Dismounting. Repair, diagnosis and maintenance of precision chain drives, gear tooth

purpose of lubricants, liquid lubricants, Viscosity Petroleum Oils, Synthetic oils, Additives, Lubricant Specification, Performance, Operational tolerance, Longevity, Grease, Soaps . lubrication of specific equipment, Internal-combustion-engine oils, additives, SAE viscosity grade system for engine oil

Practice: Analysis of lubricants applied in machines.

7th week:

Lecture: Cutting processes in machine repairing: turning, boring, drilling, reaming, threading, broaching. milling, milling cutters, gear manufacturing. Abrasive processes, grinders, grinding wheels, selection of abrasive.

Practice: Calculations of cutting parameters.

10th week:

Lecture: Hot-dip galvanization, composition of the baths, plating, chrome plating, zinc plating, nickel plating. Paints and protective coatings, paint ingredients. Coating methods. Coating with plastic. Corrosion, Type of corrosion, Stress corrosion cracking. Galvanic corrosion. Electropotential series. [Pitting corrosion](#). [Crevice corrosion](#), [Stress corrosion cracking](#) (SCC). Protection from corrosion, Applied coatings, Shrink wraps. Biofilm coatings. Cathodic protection. Corrosion in nonmetals. Corrosion of polymers and glasses.

Practice: Case studies of corrosion and protection.

12th week:

Lecture: Heat treatment, annealing, normalizing, stress relieving, quenching, tempering, case hardening, induction hardening after machine repairing.

Practice: Practical examples for heat treatment, applied methods.

14th week:

Lecture: Repair, diagnosis and maintenance of pumps, compressors, pneumatic and hydraulic systems, cylinders, pipeline networks, fittings and their repairing.

Practice: Case studies for repairing pneumatic and hydraulic systems.

wear and failure, tooth repair. Gear drives diagnosis and repair methods.

Practice: Case studies. Test rig analysis for bearing repairing technology, equipments.

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 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.