BASICS OF MACHINE OPERATION

Laboratory · Exercise 2

Maintenance and repair of a rolling bearing or gearbox

Tools · consumables · maintenance plan



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1. Goal and assumptions

Goal. Select the tools and consumables for maintaining and repairing a machine assembly and write a complete, safe maintenance and repair plan. The exercise is analytical – no real tools are used; manufacturer catalogues and documentation available online are the sources.

Variants. Teams with an odd number do **variant A – rolling bearing**; teams with an even number do **variant B – gear transmission**.

Organisation.

- Teams of 3–4 students; one report per team.
- In class (about 80 min): condition analysis (Task 1), calculations (Task 2) and first selection of tools (Task 3).
- At home: maintenance and repair plan and the report.
- Report as PDF, file name: BMO_Ex2_<team number>.pdf.

2. Key terms

Rolling bearing – allows rotation with minimum friction (ball, cylindrical roller, tapered roller bearings). Its life depends on lubrication, load, contamination and mounting quality.

Gear transmission – two or more gears that transmit power and change speed and torque (spur, helical, bevel, worm). Gears wear by friction, dynamic loads and poor lubrication.

Preventive maintenance – lubrication, cleaning, inspection of wear, periodic replacement. **Repair** – replacement of worn bearings, gears, shafts or seals with special tools for dismounting and mounting.

$$L_{10} = \left(\frac{C}{P}\right)^{p} \ [10^6\,\mathrm{rev}] \qquad L_{10h} = \frac{10^6}{60\,n} L_{10} \ [\mathrm{h}] \qquad G = 0.005 \cdot D \cdot B \ [\mathrm{g}] \qquad f_{\mathrm{mesh}} = z \cdot \frac{n}{60} \ [\mathrm{Hz}]$$

C – dynamic load rating, P – equivalent load, p = 3 (ball) or 10/3 (roller), n – speed [rpm], D – outside diameter [mm], B – width [mm], z – number of teeth.

3. Data

3.1 Input data

Variant	Assembly	Operating conditions
A	fan drive: deep groove ball bearing 6310 (d = 50 mm, D = 110 mm, B = 27 mm), C ≈ 61.8 kN	1 500 rpm, radial load P = 6 kN, 16 h/day, dusty, 60 °C
B	conveyor gearbox: two-stage helical, 15 kW, ratio 20, oil bath	input 1 450 rpm, shocks at start-up, 2 shifts, 45 °C

Add missing data from manufacturer catalogues and state your assumptions.

3.2 Example tools and consumables

Group	Variant A – rolling bearing	Variant B – gear transmission
Dismounting	mechanical or hydraulic puller, hydraulic nut	gear puller, hydraulic press
Mounting	induction heater, fitting tool kit, soft-face hammer	hydraulic press, induction heater
Fastening	socket and open-end spanners, torque wrench	torque wrench (housing bolts)
Measurement	caliper, micrometer, thermometer, vibration pen	caliper, micrometer, feeler gauges, contact pattern paste, backlash gauge
Alignment	laser shaft alignment tool	laser shaft alignment tool
Consumables	bearing grease (e.g. lithium complex, NLGI 2, high temperature), degreaser, seals	gear oil (e.g. CLP ISO VG 220), gear grease, degreaser, gasket set

Catalogues: SKF, Schaeffler (FAG), Timken, Facom, Loctite, Shell or Mobil lubricants, Rexnord, Bosch Rexroth.

4. Tasks

Task 1: Condition analysis

List the most common damage of your assembly and its causes. Variant A: fatigue (spalling), wear from contamination, corrosion, wrong lubrication, misalignment, electrical erosion, mounting damage. Variant B: pitting, scuffing, abrasive wear, tooth breakage, bearing damage, oil leaks. For each: symptom, cause, detection method (vibration, temperature, oil analysis, visual check) and a preventive measure.

Result: damage table – symptom, cause, detection, prevention.

Task 2: Calculations

- Variant A: L10 life in hours; effect of a 50% higher load; grease replenishment quantity.
- Variant B: required oil viscosity grade (ISO VG) and oil quantity from the manufacturer's data; oil change interval; gear mesh frequency for a pinion with z = 19 on the input shaft.

Result: calculations: formula → numbers → result with unit → interpretation.

Task 3: Tools and consumables

Select tools for dismounting, mounting and checking, and consumables, with a specification (type, size or range, manufacturer, catalogue number) and a justification. Use at least two manufacturer catalogues.

Result: table of tools and consumables with justification.

Task 4: Maintenance and repair plan

1. Preparation and safety: isolation of energy (lockout/tagout), work permit, PPE.
2. Dismounting: pullers, hydraulic nut or press, induction heater – never hammer blows on rolling elements.
3. Inspection: cleaning, measurement of fits and wear, photo documentation.

4. Mounting: heating the bearing (max. about 110 °C) or pressing on the correct ring; lubrication; torque values; shaft alignment.
5. Start-up and check: running-in, temperature and vibration measurement.
6. Schedule: lubrication, inspections, oil changes, condition monitoring.

Result: procedure, maintenance schedule and safety recommendations.

Task 5: Report

Max. 8 pages: assembly and operating conditions, damage analysis, calculations, tools and consumables, procedure, schedule, safety recommendations, assumptions and sources.

Safety rules: isolate and lock out all energy sources and check zero energy; wear gloves, safety glasses and safety shoes (heat-resistant gloves when heating bearings); use lifting equipment for parts over 20 kg and never stand under a suspended load; use the right tool for each step; dispose of used oil and grease as hazardous waste.

5. Assessment

Criterion	Weight
Selection of tools and consumables	40%
Consistency and logic of the plan	40%
Quality of presentation	20%