

MSE.482 Advanced Tribology
Exam 13.05.2022
Responsible: Arto Lehtovaara

Literature and use of calculator are allowed. Answers can be given by using English or Finnish language.

1. The hydrodynamic bronze bearing inner nominal diameter is $D = 70$ mm and length $B = 30$ mm. The shaft rotating speed is 1500 rpm and bearing loading 6 kN. Bearing effective temperature is 70 °C. Mineral oil VG150 is used (oil density 900 kg/m³). Choose bearing mean relative clearance according to DIN-standard (lecture) recommendations. You need not to take into account the effect of temperature on mean relative clearance. What is bearing minimum film thickness and power loss? What is your recommendation for surface roughness Ra-value of the shaft and bearing?

2. There are six claims. You can answer yes, no or blank. Correct answer gives 1 point, wrong answer - 0,5 points and blank 0 points (total minimum points 0).

- In optimal loading conditions, the new refined fatigue life equation of rolling bearings $L_{naa} = a_1 a_{ISO} L_{10}$, can give over ten times longer life time than corresponding L_{10} life.
- Couette (linear) velocity profile in sliding bearing fluid film is due to the shear induced flow
- Diamond and diamond like coatings (DLC) in tribological contact gives high hardness, low friction and good corrosion resistance.
- Leaded tin bronze is recommended sliding bearing material especially for starved lubrication conditions.
- Molybdenum disulphide is generally used solid lubricant
- In dry plastic bearings the surface roughness Ra of steel shaft is typically around 0,02 µm.

3 a) Explain in detail and give statement of reasons, what factors makes possible the formation of elasto-hydrodynamic lubrication condition? b) Describe the main features of self-lubricating bearings.

4. Cylindrical roller bearing radial loading $F_r = 35000$ N and rolling speed 500 rpm. Bearing outer diameter is 190 mm and inner diameter 90 mm. a) Choose correct lubricant (VG class) and calculate film thickness in inner race, when the operating temperature is 60 °C (lubrication factor $F = 1.0$). Utilize Mobil method.

5. The geometrical (input) values of cylindrical spur gearset is defined as follows: module $m = 2,75$ mm, width 45 mm, shafts center distance $a_w = 91,5$ mm, normal pressure angle in pitch plane $\alpha_{wt} = 23,38^\circ$, number of teeth's $z_1 = 26$ ja $z_2 = 39$. Subscript 1 refers for drive gear and subscript 2 for driven gear. The power to be transferred is $P = 50$ kW and rotating speed $n_1 = 1500$ rpm. Gears are manufactured from steel ($E = 206 \cdot 10^9$ Pa, Poisson ratio 0,3) and VG150 lubricant is used, which viscosity-pressure exponent is $2.0 \cdot 10^{-8}$ m²/N. Calculate the minimum film thickness in pitch point, when the operating temperature is 60 °C (Do not use Mobil method).