Philadelphia University
Faculty of Engineering

Student Name:
Student Number:
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Final Exam, Second Semester: 2015/2016
Mechanical Engineering Department

Course Title: machine design 2	**Date:** 8/06/2016
Course No: 0620434,	**Time:** 2 hours
Lecturer: Dr. Muhammad gogazeh	**No. of pages:** 6

Instructions:

- **ALLOWED**: Non-programmable calculator, pens and drawing tools (**no red colour**).
- **NOT ALLOWED**: Papers, literatures and any handouts. Otherwise, it will lead to the non-approval of your examination.
- **Shut down** Telephones, and other communication devices**.**

Please note:

- Write your name and your matriculation number on every page of the solution sheets.
- All solutions together with solution methods (explanatory statement) must be inserted in the labelled position on the solution sheets.
- Support your answer with diagrams, equations and examples when possible
- You can submit your exam after the first hour.

Q1 : a . what are the main ratings used to describe the performance of the ball bearings ? explain using charts ,equations if needed ? 5 marks

Q 2 : define , explain the following parameters ,terms using sketches , equations ? 8 marks

A . peel strength ?

B . fillet weld is defined as ?

C . backlash and gear involute ?

D . pressure angle of spur gear ?

E . the general form of the magnitude of von misses stress of fillet weld is ?

F . the maximum operating temperature to prevent vaporization of lighter lubricant components in journal bearings is . ?

Question 3 : 7 marks

An 02- series ball bearing is to be selected to carry load of 8 KN and a thrust load of 4 KN . The desired life is to be 5000h with an inner ring rotation rate of 900 rev/min . what is the basic load rating that should be used in selecting a bearing for a reliability goal of .99 ?

Choose a 02-series ball bearing from manufacturer #2, having a service factor of 1. For $F_r = 8$ kN and $F_a = 4$ kN

$$x_D = \frac{5000(900)(60)}{10^6} = 270$$

Eq. (11-5):

$$C_{10} = 8\left\{\frac{270}{0.02 + 4.439[\ln(1/0.90)]^{1/1.483}}\right\}^{1/3} = 51.8 \text{ kN}$$

Trial #1: From Table (11-2) make a tentative selection of a deep-groove 02-70 mm with $C_0 = 37.5$ kN.

$$\frac{F_a}{C_0} = \frac{4}{37.5} = 0.107$$

Table 11-1:

$$F_a/(V F_r) = 0.5 > e$$
$$X_2 = 0.56, \quad Y_2 = 1.46$$

Eq. (11-9):

$$F_e = 0.56(1)(8) + 1.46(4) = 10.32 \text{ kN}$$

Eq. (11-6): For $R = 0.90$,

$$C_{10} = 10.32\left(\frac{270}{1}\right)^{1/3} = 66.7 \text{ kN} > 61.8 \text{ kN}$$

Trial #2: From Table 11-2 choose a 02-80 mm having $C_{10} = 70.2$ and $C_0 = 45.0$.

Trial #2: From Table 11-2 choose a 02-80 mm having $C_{10} = 70.2$ and $C_0 = 45.0$.

Check:

$$\frac{F_a}{C_0} = \frac{4}{45} = 0.089$$

Table 11-1: $X_2 = 0.56$, $Y_2 = 1.53$

$$F_e = 0.56(8) + 1.53(4) = 10.60 \text{ kN}$$

Eq. (11-6):

$$C_{10} = 10.60\left(\frac{270}{1}\right)^{1/3} = 68.51 \text{ kN} < 70.2 \text{ kN}$$

$\therefore$ Selection stands.

Decision: Specify a 02-80 mm deep-groove ball bearing. *Ans.*

Question 4 : 10 marks

A full journal bearing has a shaft jo
–0.01 mm. The bushing bore has a dia
The l/d ratio is unity. The bushing l
Analyze the minimum clearance asser
imum oil film thickness, the power los

$$c_{\min} = \frac{b_{\min} - d_{\max}}{2} = \frac{25.04 - 25}{2} = 0.02 \text{ mm}$$

$$r \doteq d/2 = 25/2 = 12.5 \text{ mm}, \quad l/d = 1$$

$$r/c = 12.5/0.02 = 625$$

$$N = 1200/60 = 20 \text{ rev/s}$$

$$P = \frac{1250}{25^2} = 2 \text{ MPa}$$

For $\mu = 50$ mPa · s, $\quad S = (625^2)\left[\frac{50(10^{-3})(20)}{2(10^6)}\right] = 0.195$

From Figs. 12-16, 12-18 and 12-20:

$$h_o/c = 0.52, \quad fr/c = 4.5, \quad Q_s/Q = 0.57$$

$$h_o = 0.52(0.02) = 0.0104 \text{ mm} \quad \textit{Ans.}$$

$$f = \frac{4.5}{625} = 0.0072$$

$$T = fWr = 0.0072(1.25)(12.5) = 0.1125 \text{ N} \cdot \text{m}$$

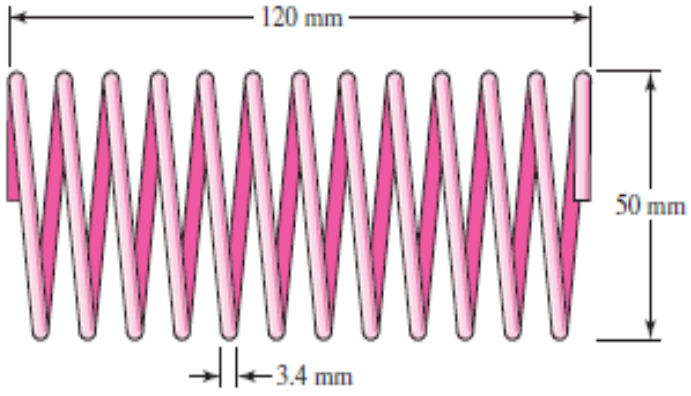
The power loss due to friction is

$$H = 2\pi T N = 2\pi(0.1125)(20) = 14.14\ \text{W} \quad Ans.$$

$$Q_s = 0.57Q \quad \text{The side flow is 57\% of } Q \quad Ans.$$

Question 5 : 10 marks

Consider the spring shown made of A227HD STEEL find …… The pitch , solid length , number of active turns , spring rate , the force Fs required to close the spring ??



From the figure: $L_0 = 120$ mm, OD $= 50$ mm, and $d = 3.4$ mm. Thus

$$D = \text{OD} - d = 50 - 3.4 = 46.6 \text{ mm}$$

(a) By counting, $N_t = 12.5$ turns. Since the ends are squared along $1/4$ turn on each end,

$$N_a = 12.5 - 0.5 = 12 \text{ turns} \quad Ans.$$

$$p = 120/12 = 10 \text{ mm} \quad Ans.$$

The solid stack is 13 diameters across the top and 12 across the bottom.

$$L_s = 13(3.4) = 44.2 \text{ mm} \quad Ans.$$

(b) $d = 3.4/25.4 = 0.1339$ in and from Table 10-5, $G = 78.6$ GPa

$$k = \frac{d^4 G}{8D^3 N_a} = \frac{(3.4)^4(78.6)(10^9)}{8(46.6)^3(12)}(10^{-3}) = 1080 \text{ N/m} \quad Ans.$$

(c) $F_s = k(L_0 - L_s) = 1080(120 - 44.2)(10^{-3}) = 81.9$ N $\quad Ans.$

(d) $C = D/d = 46.6/3.4 = 13.71$

$$K_B = \frac{4(13.71) + 2}{4(13.71) - 3} = 1.096$$

$$\tau_s = \frac{8K_B F_s D}{\pi d^3} = \frac{8(1.096)(81.9)(46.6)}{\pi(3.4)^3} = 271 \text{ MPa} \quad Ans.$$