KING SAUD UNIVERSITY
COLLEGE OF ENGINEERING
MECHANICAL ENGINEERING DEPARTMENT

Subject Report

ME 305 Mechanical Engineering Design (2)

Contents

Course Description

The design of Mechanical Elements: Screws and Fasteners; Joining Components and Methods; Springs; Gears: Spur, Helical; Shafts, Brakes and Clutches, Flexible elements; Rolling Element Bearings; Journal Bearings.

Course Topics

1. Screws, Fasteners, and the Design of Nonpermanent Joints
2. Welding, Bonding, and the Design of Permanent Joints
3. Mechanical Springs
4. Rolling–Contact Bearings
5. Lubrication and Journal Bearings
6. Spur and Helical Gears
7. Bevel and Worm Gears
8. Clutches, Brakes, Couplings, and Flywheels
9. Flexible Mechanical Elements

Assessment Tools

Project (20%)

Quiz Homework Assignments (10%)

Midterms (30%)

Final Examination (40%)

Textbook

1. J. E. Shigley, C. R. Mischke and R. G. Budynas, Mechanical Engineering Design, 9th Edition, McGraw Hill, 2014.
2. Mechanical Analysis and Design, By Arthur B. Burr, Elsevier
3. Fundamentals of Machine component Design, By Robert Juvinall and Kurt Marshek, Wiley

Course objectives

To develop an understanding of the relationship between Mechanical Elements

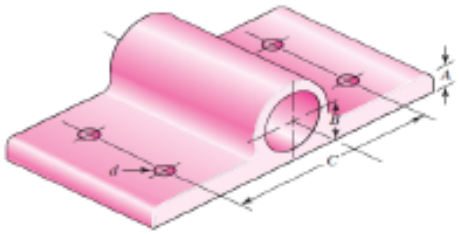
To show proficiency in mathematics and basic sciences required to solve structural engineering and mechanics problem.

To develop analytical and graphical problem solving skills.

Exams samples

Student Name: **NO. :**

The figure shows a cast-iron bearing block that is to be bolted to a steel ceiling joist and is to support a gravity load. Bolts used are M20 ISO 8.8 with coarse threads and with 3.4-mm-thick steel washers under the bolt head and nut. The joist flanges are 20 mm in thickness, and the dimension A, shown in the figure, is 20 mm. The modulus of elasticity of the bearing block is 135 GPa.

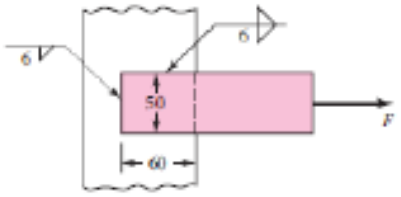


(*a*) Find the wrench torque required if the fasteners are lubricated during assembly and the joint is to be permanent.

(*b*) Determine the load factor for the design if the gravity load is 15 kN.

Student Name: **NO. :**

The weldment shown in the figure is subjected to an alternating force F. The hot-rolled steel bar is 10 mm thick and is of AISI 1010 steel. The vertical support is likewise of 1010 steel. The electrode is 6010. Estimate the fatigue load F the bar will carry if three 6-mm fillet welds are used.



Exam answers

Table 8-11: $Sp = 600$ MPa

Eq. (8-30): $Fi = 0.9At\ Sp = 0.9(245)(600)(10^{-3}) = 132.3$ kN

Table (8-15): $K = 0.18$

Eq. (8-27) $T = 0.18(132.3)(20) = 476$ N · m *Ans.*

Washers: $t = 3.4$ mm, $d = 20$ mm, $D = 30$ mm, $E = 207$ GPa ⇒ $k1 = 42\ 175$ MN/m

Cast iron: $t = 20$ mm, $d = 20$ mm, $D = 30 + 2(3.4)\tan 30° = 33.93$ mm,

$E = 135$ GPa ⇒ $k2 = 7885$ MN/m

Steel: $t = 20$ mm, $d = 20$ mm, $D = 33.93$ mm, $E = 207$ GPa ⇒ $k3 = 12\ 090$ MN/m

$km = (2/42\ 175 + 1/7885 + 1/12\ 090)^{-1} = 3892$ MN/m

Bolt: $l = 46.8$ mm. Nut: $H = 18$ mm. $L > 46.8 + 18 = 64.8$ mm. Use $L = 80$ mm.

$LT = 2(20) + 6 = 46$ mm, $ld = 80 - 46 = 34$ mm, $lt = 46.8 - 34 = 12.8$ mm,

$At = 245$ mm2, $Ad = \pi 202/4 = 314.2$ mm2

$kb = Ad\ At\ E$

$Adlt + At\ ld$

$= 314.2(245)(207)$

$314.2(12.8) + 245(34)$

$= 1290$ MN/m

$C = 1290/(1290 + 3892) = 0.2489$, $Sp = 600$ MPa, $Fi = 132.3$ kN

$n = Sp\ At - Fi$

$C(P/N)$

$= 600(0.245) - 132.3$

$0.2489(15/4)$

$= 15.7$ *Ans.*

Weldment, subjected to alternating fatigue, has throat area of

$A = 0.707(6)(60 + 50 + 60) = 721$ mm2

Members' endurance limit: AISI 1010 steel

$Sut = 320$ MPa, $S\_e = 0.5(320) = 160$ MPa

$ka = 272(320)^{-0.995} = 0.875$

$kb = 1$ (direct shear)

$kc = 0.59$ (shear)

$kd = 1$

$kf = 1/Kfs = 1/2.7 = 0.370$

$Sse = 0.875(1)(0.59)(0.37)(160) = 30.56$ MPa

Electrode's endurance: 6010

$Sut = 62(6.89) = 427$ MPa $S\_e = 0.5(427) = 213.5$ MPa

$ka = 272(427)^{-0.995} = 0.657$

$kb = 1$ (direct shear)

$kc = 0.59$ (shear)

$kd = 1$

$kf = 1/Kfs = 1/2.7 = 0.370$

$Sse = 0.657(1)(0.59)(0.37)(213.5) = 30.62$ MPa .=

30.56

Thus, the members and the electrode are of equal strength. For a factor of safety of 1,

$Fa = \tau a\, A = 30.6(721)(10^{-3}) = 22.1$ kN *Ans.*

Student results

Will be completed by the end of semester.