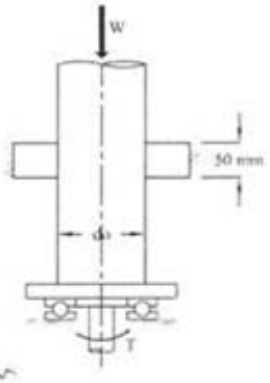
College of Engineering & Technology

Department: Mechanical Engineering — Marks: 10
Lecturer: Dr. Rola Afify — Time: 3.00 - 4.00
Course Code: ME356 — Date: 27/11/2012

Answer the following questions:

Question one (8 marks)



1) If it is required to lift a load (W) using single square threads with outer diameter 48 mm, pitch 8 mm and the friction coefficient between screw and the nut is 0.15 and the lifting torque is 40 N.m. determine:

   a) The load (W).
   b) The power screw efficiency.
   c) Find the bearing stress between the screw and the nut teeth.

$d_o = 48$ mm , $P = 8$ mm , $\mu = 0.15$, $T = 40 * 10^3$ N.mm

$\therefore d_i = d_o - P = 40$ mm , $d_m = 44$ mm , $L = P = 8$ mm

$\therefore T = W * \frac{d_m}{2} \left[\frac{\mu \pi d_m + L}{\pi d_m - \mu L}\right]$ (6 Mins)

$W = 8670.6$ N → ①

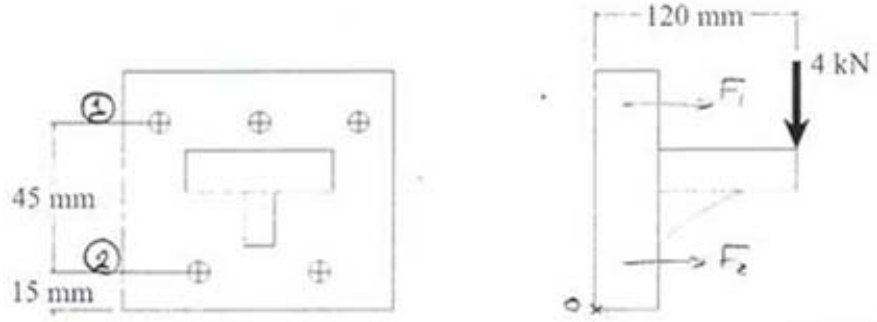
for $\mu = 0$ $\quad T_o = \frac{WL}{2\pi} = \frac{8670.6 * 8}{2\pi} = 11039.8$ N.mm

$\eta = \frac{T_o}{T} = \frac{11039.8}{40 * 10^3} \Rightarrow \eta = 27.6\%$ → ②

$\sigma_{br} = \frac{2W}{\pi d_m H} = \frac{2 * 8670.6}{\pi * 44 * 50} \Rightarrow \sigma_{br} = 2.51$ MPa → ③

Question two (6 marks)

For the bolted Joint shown in following figure; find the maximum normal and shear stresses if the outer diameter of the bolts is 10 mm.



$L_1 = 60$ mm , $L_2 = 15$ mm , $F = 4000$ N

$L = 120$ mm , $d_o = 10$ mm

$M = F * L = 4000 * 120 = 480 * 10^3$ N.mm

$\because M = 3F_1L_1 + 2F_2L_2$

$480 * 10^3 = 180 F_1 + 30 F_2 \quad \rightarrow (1)$

$\because \frac{F_1}{L_1} = \frac{F_2}{L_2} \Rightarrow F_2 = \frac{F_1 L_2}{L_1} = 0.25 F_1 \quad \rightarrow (2)$

sub (2) in (1)

$480 * 10^3 = 180 F_1 + 7.5 F_1 \Rightarrow F_1 = 2560$ N

$F_2 = 640$ N

shear force (F') $F' = \frac{F}{n} = \frac{4000}{5} = 800$ N

10 Mins

Max force on Bolt (1)

$d_i = 0.85 * 10 = 8.5$ mm

$\sigma_t = \frac{F_1}{A} = \frac{F_1}{\frac{\pi}{4} d_i^2} = \frac{2560}{\frac{\pi}{4}(8.5)^2} = 45.1$ MPa

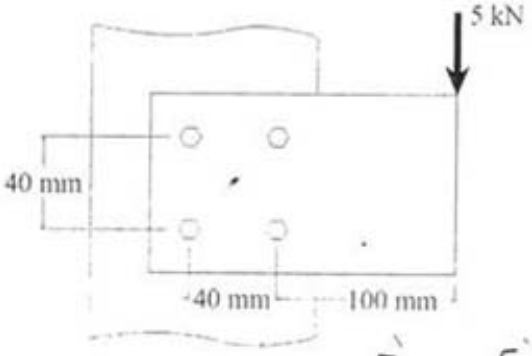
$\tau = \frac{F'}{A} = \frac{F'}{\frac{\pi}{4} d_i^2} = \frac{800}{\frac{\pi}{4}(8.5)^2} = 14.1$ MPa

$\sigma_{max} = \frac{\sigma_t}{2} + \sqrt{(\frac{\sigma_t}{2})^2 + \tau^2} = \frac{45.1}{2} + \sqrt{(\frac{45.1}{2})^2 + (14.1)^2} = 49.1$ MPa

$\tau_{max} = \sqrt{(\frac{\sigma_t}{2})^2 + \tau^2} = 26.6$ MPa

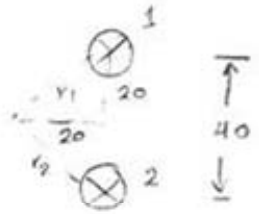
Question three (6 marks)

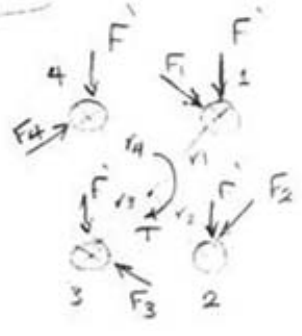
For the bolted Joint shown in following figure; find the outer diameter of the bolts if the Yield strength 320 MPa and factor of safety 3.



$F = 5000$ N , $L = 190$ mm

$r_1 = 20\sqrt{2}$





Good Luck

Dr. Rola Afify

Primary Shear (F)

$$F' = \frac{F}{n} = \frac{5000}{4} = 1250\ N$$

secondary shear

$$T = F * L = 5000 * 120 = 600 * 10^3\ N.mm$$

$$\because \frac{F_1}{r_1} = \frac{F_2}{r_2} = \frac{F_3}{r_3} = \frac{F_4}{r_4} \qquad (r_1 = r_2 = r_3 = r_4 = 20\sqrt{2})$$

$$T = F_1 r_1 + F_1 r_1 + F_1 r_1 + F_1 r_1 = 4 F_1 r_1$$

$$600 * 10^3 = 4 F_1 * 20\sqrt{2} \qquad \Rightarrow F_1 = 5303.3\ N$$

$\theta = 45^\circ$ from Square relations between F_1 & F' as bolt (1) or bolt (2) has the maximum stress value (small θ as r equal)

$$F_{total} = \sqrt{F_1^2 + F'^2 + 2 F_1 F' \cos\theta}$$

$$F_{total} = \sqrt{(5303.3)^2 + (1250)^2 + 2(5303.3)(1250)\cos 45}$$

$$F_{total} = 6250\ N$$

$$\because \tau = \frac{F_{total}}{\frac{\pi}{4} d_i^2} = \frac{0.5\, S_y}{f.s}$$

12 Mins

$$\frac{6250}{\frac{\pi}{4}(d_i)^2} = \frac{0.5 * 320}{3}$$

$$d_i = 12.2\ mm$$

$$d_o = \frac{d_i}{0.85} = \frac{12.2}{0.85}$$

$$d_o = 14.4\ mm$$

Take $d_o = 16$ mm