Makeup

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 (5 marks)

10 min

A) Define:

i) Machinability: It is the property of a material which refers to a relative ease with which a material can be cut.

ii) Resilience: It is the property of a material to absorb energy and to resist shock and impact loads.

B) What are the main considerations should be taken while choosing the factor of safety?

(1) Material Properties aren't known exactly
(2) Effect of size, heat treatment and type of loading.
(3) Effect of wear, time and environment on M/C life.
(4) assumptions may not be exact.
(5) Overall Concern for human safety.
(6) Shut down and maintainance may take loss of cost.

Question two (5 marks)

10 Min

A shaft is required to transmit 600 kW at 110 r.p.m. The shear stress is not to exceed 60 MPa and twist in a length of 1.5 meters not to exceed 2 degrees. Find the diameter of the shaft. Take modulus of rigidity as 84 GPa.

power = 600 kW , $n = 110$ rpm , $\tau_{max} = 60$ MPa , $L = 1500$ mm , $\theta = 2^\circ$
$G = 84 \times 10^3$ MPa , d?

$$\because Power = T \times \omega$$

$$600 \times 10^3 = T \times \frac{2\pi \times 110}{60}$$

$$T = 52.1 \times 10^3 \ N.m = 52.1 \times 10^6 \ N.mm$$

$$\because \frac{T}{J} = \frac{\tau_{max}}{r} = \frac{G\theta}{L}$$

$$\frac{32T}{\pi d^4} = \frac{2\tau_{max}}{d} = \frac{G\theta}{L}$$

$$\frac{32 \times 52.1 \times 10^6}{\pi d^4} = \frac{2 \times 60}{d} = \frac{84 \times 10^3 \times 2 \times \pi/180}{1500}$$

$$\underbrace{\frac{530.7*10^6}{d^4}}_{①} = \underbrace{\frac{120}{d}}_{②} = \underbrace{1.95}_{③}$$

Considering the strength of the shaft ① = ②

$d = 164.1$ mm

Considering the stiffness of the shaft ① = ③

$d = 128.4$ mm

Take d ↑↑ $\therefore d = 165$ mm

Question three (5 marks) $\boxed{10\ \text{Min}}$

An electric motor driven power screw moves a nut in a vertical plane against a car weight of 30 kN at 50 r.p.m. The screw has a single square thread of 6 mm pitch on a major diameter of 40 mm. The coefficient of friction at screw threads is 0.1. Estimate:

i) The power of the motor.
ii) The power screw efficiency.

$W = 30*10^3$ N , $n = 50$ rpm , $L = P = 6$ mm , $d_o = 40$ mm , $\mu = 0.1$

Req power & η

$\because P = d_o - d_i \Rightarrow d_i = 34$ mm , $d_m = \frac{d_o + d_i}{2} = 37$ mm

for lifting $T = W\frac{d_m}{2}\left[\frac{\pi \mu d_m + L}{\pi d_m - \mu L}\right] = 30*10^3 * \frac{37}{2}\left[\frac{(\pi*0.1*37)+6}{(\pi*37)-(0.1*6)}\right]$

$T = 84.6*10^3$ N.mm $= 84.6$ N.m

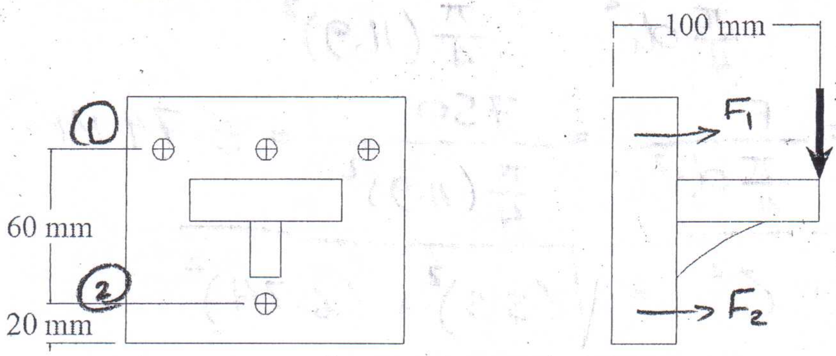
$\therefore$ Power $= T*\omega = 84.6 * \frac{2\pi*50}{60} \Rightarrow$ Power = 443 watt

$\because T_o = \frac{WL}{2\pi} = \frac{30*10^3*6}{2\pi} = 28.6*10^3$ N.mm

$\therefore \eta = \frac{T_o}{T} = \frac{28.6*10^3}{84.6*10^3} \Rightarrow \eta = 33.8\ \%$

Question Four (5 marks) $\boxed{10\ \text{Min}}$

For the bolted Joint shown in following figure find the maximum shear stress if the outer diameter of the bolts is 14 mm.



Good Luck

Dr. Rola Afify

$\because F = 3000\ N$, $L = 100\ mm$, $L_1 = 80\ mm$, $L_2 = 20\ mm$

$d_o = 14\ mm$

$$\because M = F * L = 3000 * 100 = 3*10^5\ Nmm$$

$$\because M = 3F_1 L_1 + 1F_2 L_2$$

$$3*10^5 = 240 F_1 + 20 F_2 \longrightarrow ①$$

$$\because \frac{F_1}{L_1} = \frac{F_2}{L_2}$$

$$\frac{F_1}{80} = \frac{F_2}{20}$$

$$F_2 = \frac{F_1}{4} = 0.25 F_1 \longrightarrow ②$$

sub ② in ①

$$3*10^5 = 240 F_1 + 5 F_1$$

$$F_1 = 1224.5\ N$$

sub in ②

$$F_2 = 306.1\ N$$

<u>shear force</u>

$$F' = \frac{F}{n} = \frac{3000}{4} = 750\ N$$

Max force on Bolt (1)

$$d_i = 0.85 * 14 = 11.9\ mm$$

$$\sigma_t = \frac{F_1}{A} = \frac{1224.5}{\frac{\pi}{4} d_i^2} = \frac{1224.5}{\frac{\pi}{4}(11.9)^2} = \underline{11}\ MPa$$

$$\tau = \frac{F'}{A} = \frac{F'}{\frac{\pi}{4} d_i^2} = \frac{750}{\frac{\pi}{4}(11.9)^2} = 6.74\ MPa$$

$$\tau_{max} = \sqrt{\left(\frac{\sigma_t}{2}\right)^2 + \tau^2} = \sqrt{(5.5)^2 + (6.74)^2}$$

$$\tau_{max} = 8.7\ MPa$$