FINAL
ALTERNATIVE ASSESSMENT

(COVER PAGE)

Session	:	**August 2020**
Programme	:	Diploma in Mechanical Engineering (DMEN)
Course	:	**EGM2169: Machines Component Design**
Date of Examination	:	13 December 2020 (Sunday)
Time	:	4.00pm – 6.20pm Reading Time : Nil
Duration	:	2 Hours 20 Minutes

Special Instructions :

This paper consists of **FOUR (4)** questions. Answer **ALL** questions. All questions carry equal marks.

Material permitted : Non-Programmable Scientific Calculator

Materials provided : Nil

Examiner(s)	:	**Phua Chin Lai**
Chief Moderator	:	Soo Swee Yoong

*This paper consists of **11** printed pages, including the cover page*

DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)
EGM2169: MACHINE COMPONENTS DESIGN
FINAL ALTERNATIVE ASSESSMENT: AUGUST 2020 SESSION

Instructions: This paper consists of **FOUR (4)** questions. Answer **ALL** questions. All questions carry equal marks.

Question 1

(a) Determine the permissible load P for riveted joint in Figure Q1a, if the resultant shearing stress for the most highly stressed rivets is 100 MPa. Rivets are 25 mm in diameter.

(14 marks)

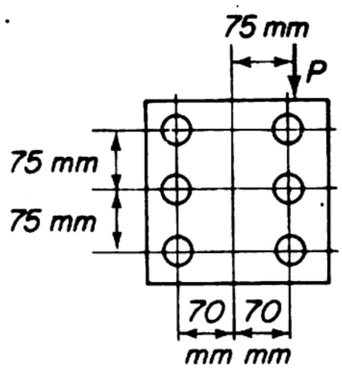


Figure Q1a

(b) A cylindrical shaft made of steel of yield strength 700 MPa and its shear strength is half of the yield strength. The shaft is subjected to static loads consisting of a bending moment of 10 kNm and a torsional moment of 30 kNm. Determine the diameter of the shaft using two different theories of failure and assuming a factor of safety of 2.

(11 marks)

Question 2

(a) A flat belt necessary to transmit 10 kW to a pulley 300 mm diameter, if the pulley rotates 1600 r.p.m. and the coefficient of friction between the belt and the pulley is 0.22. Assume the angle of contact as 210° and the maximum tension in the belt is not to exceed 8N/mm width. Determine the width of the flat belt.

(7 marks)

(b) A 125 × 95 × 10 mm angle is welded to a frame by two 10 mm fillet welds, as shown in Figure Q2b. A load of 16 kN is applied normal to the gravity axis at a distance of 300 mm from the centre of gravity of welds. Determine maximum shear stress in the welds, assuming each weld to be 100 mm long and parallel to the axis of the angle.

(18 marks)

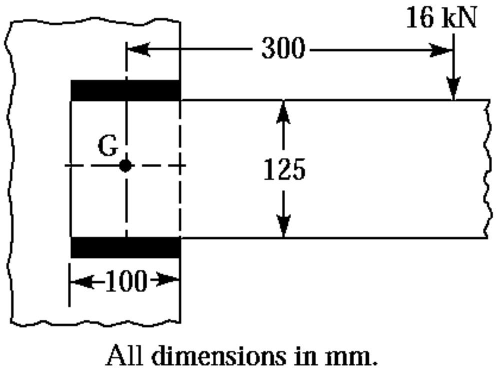


Figure Q2b

Question 3

(a) A single block brake has a drum diameter of 720 mm, as shown in Figure Q3a. If the brake sustains 225 Nm torque at 500 r.p.m.; The coefficient of friction given as 0.3. Determine,

(i) The required force (P) to apply the brake for clockwise rotation of the drum,

(6 marks)

(ii) The required force (P) to apply the brake for counter clockwise rotation of the drum,

(3 marks)

(iii) The location of the fulcrum to make the brake self-locking for clockwise rotation of the drum.

(3 marks)

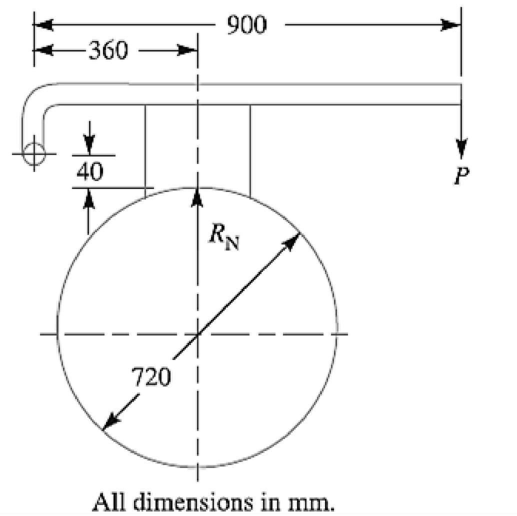


Figure Q3a

(b) A square threaded bolt of mean diameter 24 mm and pitch 5 mm is tightened by screwing a nut whose mean diameter of bearing surface is 50 mm. If the coefficient of friction for the nut and bolt is 0.1 and for the nut and bearing surfaces 0.16, Determine the force required at the end of a spanner 0.5 m long when the load on the bolt is 10 kN

(13 marks)

Question 4

(a) A compression helical spring to carry a load of 500 N with a deflection of 25 mm. The spring index may be taken as 8. Assume the following values for the spring material,

Permissible shear stress = 350 MPa,

Modulus of rigidity = 84 kN/mm^2,

Wahl's factor $K = \frac{4C-1}{4C-4} + \frac{0.615}{C}$, where C = spring index.

Determine,

(i) The diameter of wire,

(ii) The mean diameter of the coil spring,

(iii) The number of active coils.

(8 marks)

(b) A bronze spur pinion rotating at 600 r.p.m. drives a cast iron spur gear at a transmission ratio of 4:1. The allowable static stresses for the bronze pinion and cast iron gear are 84 MPa and 105 MPa respectively. The pinion has 16 standard 20° full depth involute teeth of module 8 mm. The face width of both the gears is 90 mm.

Determine the power that can be transmitted from the standpoint of strength.

The tooth form factor *y* can be taken as

$$y = 0.154 - \frac{0.912}{no\ of\ teeth}$$

(17 marks)

,

~THE END~

Subject: Machines Components Design (EGM2169)

Formula Sheet

Belt drive

$\frac{T_1}{T_2} = e^{\mu\theta}$ excluding the mass of belt

$\frac{T_1 - T_c}{T_2 - T_c} = e^{\mu\theta}$ taking into account the mass of belt

Open belt

$$L = \pi(r_1 + r_2) + 2x + \frac{(r_1 - r_2)^2}{x}$$

$$\sin\alpha = \frac{(r_1 - r_2)}{x}$$

$$\theta = 180° - 2\alpha$$

Cross belt

$$L = \pi(r_1 + r_2) + 2x + \frac{(r_1 + r_2)^2}{x}$$

$$\sin\alpha = \frac{(r_1 + r_2)}{x}$$

$$\theta = 180° + 2\alpha$$

Eccentrically loaded riveted joint

$$P \times e = \frac{F_1}{L_1}(L_1^2 + L_2^2 + L_3^2 + \cdots)$$

$$R = \sqrt{P_s^2 + F^2 + 2P_s \times F \times \cos\theta}$$

$P_s = \frac{P}{n}$, acting parallel to the load P

$$\bar{x} = \frac{x_1 + x_2 + x_3 + \cdots}{n}$$

$$\bar{y} = \frac{y_1 + y_2 + y_3 + \cdots}{n}$$

Simple Bending Equation

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

Simple Torsion Equation

$$\frac{T}{J} = \frac{\tau}{R} = \frac{G\theta}{L}$$

For Shaft Design

Equivalent Twisting Moment

$$T_e = \sqrt{M^2 + T^2}$$

Equivalent Bending Moment

$$M_e = \frac{1}{2}\left[M + \sqrt{M^2 + T^2}\right]$$

Maximum Normal Stress

$$\sigma_n = \left(\frac{\sigma_x + \sigma_y}{2}\right) + \frac{1}{2}\sqrt{\left(\sigma_x - \sigma_y\right)^2 + 4\tau^2}$$

Maximum Shear Stress

$$\tau_{max} = \frac{1}{2}\sqrt{\left(\sigma_x - \sigma_y\right)^2 + 4\tau^2}$$

For Journal Bearings

Coefficient of friction

$$\mu = (33 \times 10^{-8})\left(\frac{ZN}{p}\right)\left(\frac{d}{c}\right) + 0.002$$

Heat generated

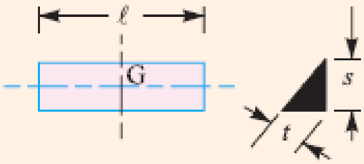
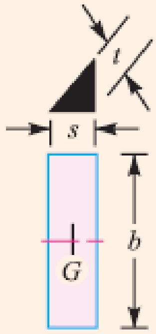
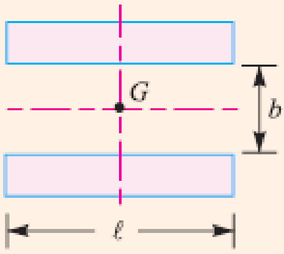
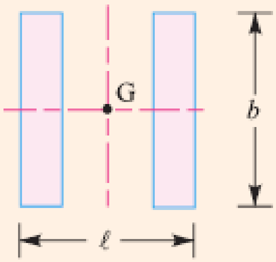
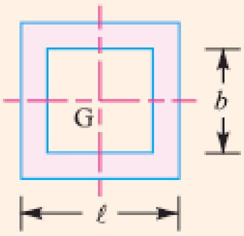
$$H_g = \mu WV$$

Heat dissipated

$$H_d = CA(t_b - t_a)$$

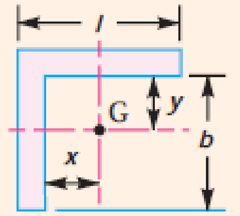
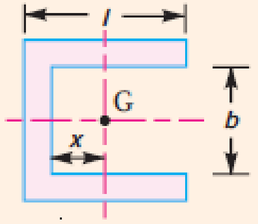
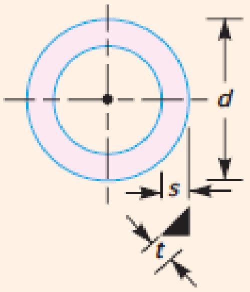
Welded joints

Table 10.7. Polar moment of inertia and section modulus of welds.

S.No	Type of weld	Polar moment of inertia (J)	Section modulus (Z)
1.		$\frac{t.l^3}{12}$	—
2.		$\frac{t.b^3}{12}$	$\frac{t.b^2}{6}$
3.		$\frac{t.l(3b^2+l^2)}{6}$	$t.b.l$
4.		$\frac{t.b(b^2+3l^2)}{6}$	$\frac{t.b^2}{3}$
5.		$\frac{t(b+l)^3}{6}$	$t\left(bl+\frac{b^2}{3}\right)$

Continue next page

Welded joints

S.No	Type of weld	Polar moment of inertia (J)	Section modulus (Z)
6.	 $x = \frac{l^2}{2(l+b)}, \; y = \frac{b^2}{2(l+b)}$	$t\left[\frac{(b+l)^4 - 6b^2l^2}{12(l+b)}\right]$	$t\left(\frac{4l.b+b^2}{6}\right)$ (Top) $t\left[\frac{b^2(4lb+b)}{6(2l+b)}\right]$ (Bottom)
7.	 $x = \frac{l^2}{2l+b}$	$t\left[\frac{(b+2l)^3}{12} - \frac{l^2(b+l)^2}{b+2l}\right]$	$t\left(l.b + \frac{b^2}{6}\right)$
8.		$\frac{\pi t d^3}{4}$	$\frac{\pi t d^2}{4}$

Power Screw

Torque to overcome between screw and nut

$$T_1 = W\tan(\alpha + \emptyset) \times \frac{d}{2}$$

Torque to overcome friction at the collar

$$T_2 = \mu W R, \quad \text{where } R = \frac{R_1 + R_2}{2} \qquad \text{(for uniform wear)}$$

Squared Threaded Screw Efficiency

$$\eta = \frac{\tan\alpha}{\tan(\alpha + \emptyset)}, \qquad \text{Note: } \tan(A+B) = \frac{\tan A + \tan B}{1 - \tan A \tan B}$$

Gear

Values of the velocity factor (C_v)

$$C_v = \frac{3}{3+v}, \text{ for ordinary cut gears operating at velocities upto 12.5 m / s.}$$

$$= \frac{4.5}{4.5+v}, \text{ for carefully cut gears operating at velocities upto 12.5 m/s.}$$

$$= \frac{6}{6+v}, \text{ for very accurately cut and ground metallic gears operating at velocities upto 20 m / s.}$$

$$= \frac{0.75}{0.75+\sqrt{v}}, \text{ for precision gears cut with high accuracy and operating at velocities upto 20 m / s.}$$

Spur Gear design

$$W_T = \frac{P}{v} \times C_s$$

W_T = Permissible tangential tooth load in newtons

P = Power transmitted in watts

$* \; v$ = Pitch line velocity in m/s = $\frac{\pi DN}{60}$

D = pitch circle diameter

* circular pitch,

$$p_c = \frac{\pi D}{T} = \pi m, \qquad D = m.T$$

Pitch line velocity

$$v = \frac{\pi.D.N}{60} = \frac{\pi m.T.N}{60} = \frac{p_c.T.N}{60}$$

m = Module in metres

T = Number of teeth

N = Speed in r.p.m

C_s = Service factor

Value of service factor

Type of load	*Type of service*		
	Intermittent or 3 hours per day	*8-10 hours per day*	*Continuous 24 hours per day*
Steady	0.8	1.00	1.25
Light shock	1.00	1.25	1.54
Medium shock	1.25	1.54	1.80
Heavy shock	1.54	1.80	2.00

Lewis equation

$$W_T = \sigma_w . b . p_c . y = \sigma_w . b . \pi m . y$$

Buckingham equation

$$W_D = W_T + W_I$$

W_D =Dynamic load