INTI International University & Colleges

**FINAL**
Examination Paper

(COVER PAGE)

| | | |
|---|---|---|
| Session | : | **April 2019** |
| Programme | : | Diploma In Mechanical Engineering (DMEN) |
| Course | : | **EGM2169 : Machine Components Design** |
| Date of Examination | : | July 31, 2019 (Wednesday) |
| Time | : | 8:00 am – 10:00 am     Reading Time: Nil |
| Duration | : | 2 Hours |
| Special Instructions | : | |

This paper consists of **SIX (6)** questions. Answer any **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks.

Materials permitted :

Calculator

Materials provided :

Formula Sheet


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Moderator : Associate Professor Dr Seyed Amirmostafa Jourabchi


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

DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)
EGM2169: MACHINE COMPONENTS DESIGN
FINAL EXAMINATION: APRIL 2019 SESSION

**Instructions:** This paper consists of **SIX (6)** questions. Answer any **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks.

## Question 1

An eccentrically loaded lap riveted joint is to be designed for a steel bracket as shown in Figure Q1. The bracket plate is 25 mm thick. All rivets are to be of the same size. Load on the bracket, P = 50 kN; rivet spacing, C = 100 mm; load arm, e = 400 mm. Permissible shear stress is 65 MPa and crushing stress is 120 MPa. Determine the minimum size of the rivets to be used for the joint.

(25 marks)

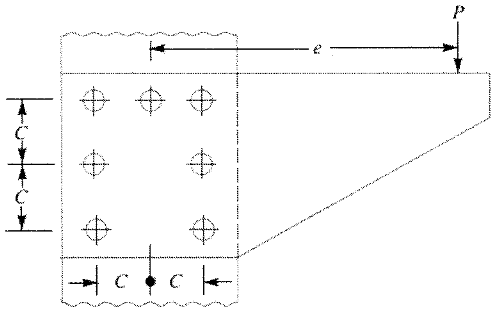



**Figure Q1**

## Question 2

(a) A 50 mm diameter solid shaft is welded to a flat plate as shown in Figure Q2(d). If the size of the weld is **s** = 15 mm, find the maximum normal and shear stress in weld.

(18 marks)

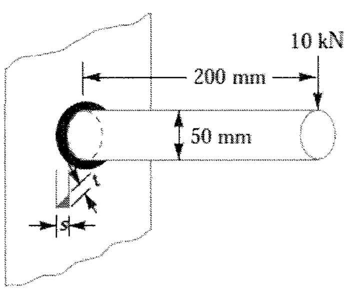



**Figure Q2 (a)**

(b) A plate 100 mm wide and 10 mm thick is to be welded to another plate by means of double parallel fillets. The plates are subjected to a static load of 80kN. Find the length of weld if the permissible shear stress in the weld does not exceed 55 MPa.

(7 marks)

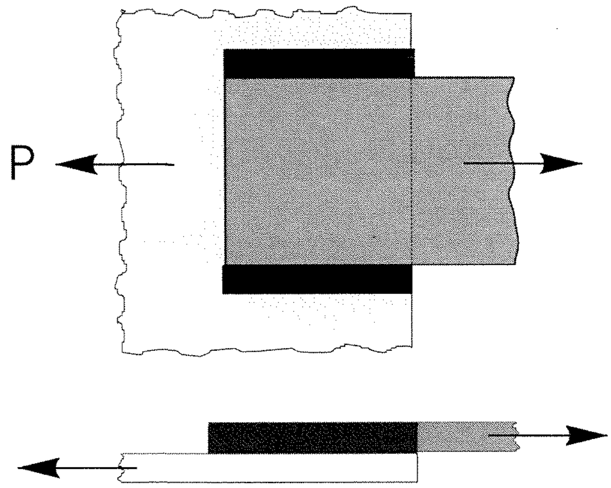



**Figure Q2 (b)**

**Question 3**

(a) A compression coil spring made of an alloy steel is having the following specifications Mean diameter of coil = 50 mm; Wire diameter = 5 mm; Number of active coils = 20. If this spring is subjected to an axial load of 500 N; calculate the maximum shear stress (neglect the curvature effect) to which the spring material is subjected.

(6 marks)

(b) A full journal bearing of 50 mm diameter and 100 mm long has a bearing pressure of 1.4 N/mm2. The speed of the journal is 900 r.p.m. and the ratio of journal diameter to the diametral clearance is 1000. The bearing is lubricated with oil whose absolute viscosity at the operating temperature of 75°C may be taken as 0.011 kg/m-s. The room temperature is 35°C. Find:

(i) The amount of artificial cooling required

(14 marks)

(ii) The mass of the lubricating oil required, if the difference between the outlet and inlet temperature of the oil is 10°C.

Take specific heat of the oil as1850 J / kg / °C.

(5 marks)

**Question 4**

The following particulars of a single reduction spur gear are given :

Gear ratio = 10 : 1; Distance between centres = 660 mm; Pinion transmits 500 kW at 1800 r.p.m.; Involute teeth of standard proportions (addendum = m) with pressure angle of 22.5°; Permissible normal pressure between teeth = 175 N per mm of width. Find :

(a) The nearest standard module if no interference is to occur
(10 marks)

(b) The number of teeth on each wheel
(3 marks)

(c) The necessary width of the pinion
(3 marks)

(d) The load on the bearings of the wheels due to power transmitted.
(9 marks)

**Question 5**

The block brake, as shown in figure below, provides a braking torque of 360 N-m. The diameter of the brake drum is 300 mm. The coefficient of friction is 0.3. Find:

(a) The force (P) to be applied at the end of the lever for the clockwise and counter clockwise
(12 marks)

(b) rotation of the brake drum
(3 marks)

(c) The location of the pivot or fulcrum to make the brake self-locking for the clockwise rotation of the brake drum.
(10 marks)

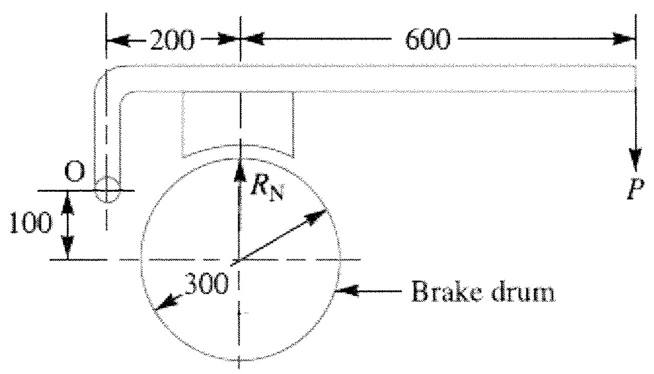



**Figure Q5**

**Question 6**

(a) Two pulleys, one 450 mm diameter and the other 200 mm diameter, on parallel shafts 1.95 m apart are connected by a crossed belt. Find the length of the belt required and the angle of contact between the belt and each pulley.

(7 marks)

(b) A solid circular shaft is subjected to a bending moment of 3000 N-m and a torque of 10 000 N-m. The shaft is made of 45 C 8 steel having ultimate tensile stress of 700 MPa and a ultimate shear stress of 500 MPa. Assuming a factor of safety as 6, determine the diameter of the shaft.

(18 marks)

**-THE END-**

Subject: Machines Components Design (EGM2169)

Formula Sheet

**For eccentrically loaded riveted joint**

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

**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**

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

Continue next page

Belt Tension Ratio

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

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

**For Journal Bearings**

**Coefficient of friction**

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

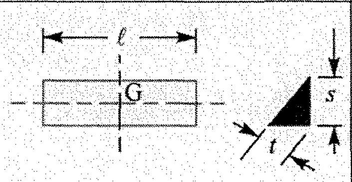
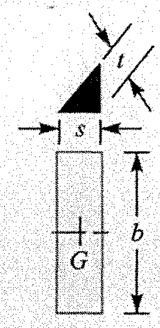
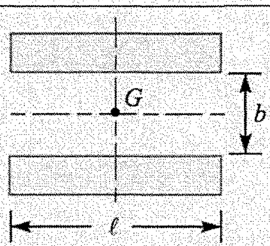
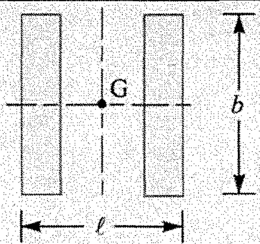
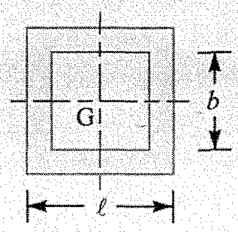
**Heat Generated**

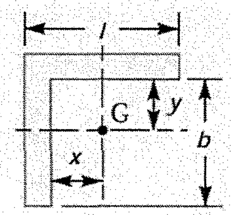
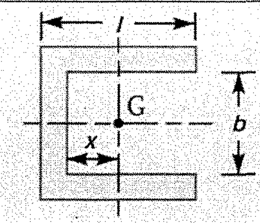
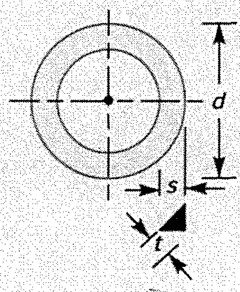
$$H_g = \mu WV$$

**Heat dissipated**

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

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. |  | $\frac{t(b+l)^3}{6}$ | $t\left(b.l+\frac{b^2}{3}\right)$ |

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

## Values 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 |

## Values of surface endurance limit

| Material of pinion and gear | Brinell hardness number (B.H.N.) | Surface endurance limit ($\sigma_{es}$) in N/mm² |
|---|---|---|
| Grey cast iron | 160 | 630 |
| Semi-steel | 200 | 630 |
| Phosphor bronze | 100 | 630 |
| Steel | 150 | 350 |
| | 200 | 490 |
| | 240 | 616 |
| | 280 | 721 |
| | 300 | 770 |
| | 320 | 826 |
| | 350 | 910 |
| | 400 | 1050 |

## values of the velocity factor ($C_v$)

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

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

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

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

**Formulas**

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

$W_T$ = 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 in metres,

circular pitch,

$p_c = \pi D / T = \pi m$

$D = m.T$

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, and

$T$ = Number of teeth.

$N$ = Speed in r.p.m., and

$C_S$ = Service factor.

## Lewis equation

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

$$= (\sigma_o . C_v)\, b . \pi\, m . y$$

## Buckingham equation

$$W_D = W_T + W_I$$

$W_D$ = Dynamic Load

$$\bar{x} = \frac{x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7}{n}$$

$$\bar{y} = \frac{y_1 + y_2 + y_3 + y_4 + y_5 + y_6 + y_7}{n}$$

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

$$P.e = F_1.l_1 + F_2.l_2 + F_3.l_3 + \ldots$$

$$= F_1.l_1 + F_1 \times \frac{l_2}{l_1} \times l_2 + F_1 \times \frac{l_3}{l_1} \times l_3 + \ldots$$

$$= \frac{F_1}{l_1} \left[ (l_1)^2 + (l_2)^2 + (l_3)^2 + \ldots \right]$$

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