INTI International University & Colleges

FINAL
Examination Paper

(COVER PAGE)

Session	:	**August 2019**
Programme	:	Diploma In Mechanical Engineering (DMEN)
Course	:	**EGM2169 : Machine Components Design**
Date of Examination	:	December 10, 2019 (Tuesday)
Time	:	2:00 pm – 4:00 pm 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

Examiner (s)	:	**Soo Swee Yoong** and Lim Kah Hei
Moderator	:	Associate Professor Dr Seyed Amirmostafa Jourabchi

*This paper consists of **6** printed pages, including the cover page.*

DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)
EGM2169: MACHINE COMPONENT DESIGN
FINAL EXAMINATION: AUGUST 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

A bracket is attached to a column by 6 rivets of equal size as shown in Figure. Q1. It carries a load of 60 kN at a distance of 200 mm from the centre of the column. If the maximum shear stress in the rivet is limited to 150 MPa, determine,

(a) the direct and secondary shear loads,
(10 marks)

(b) the radial lengths,
(2 marks)

(c) the resultant shear loads and
(7 marks)

(d) the diameter of the rivet.
(3 marks)

(e) and sketch the Free-Body-Diagram and label clearly all the important forces and radial lengths.
(3 marks)

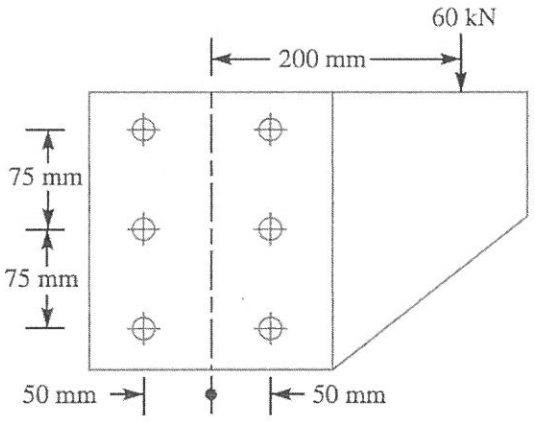
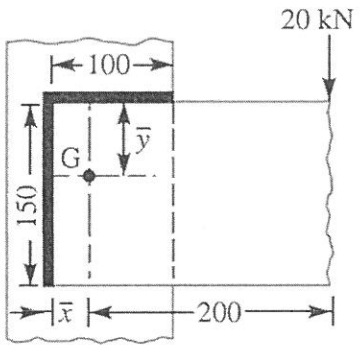


Figure Q1

Question 2

Figure Q2 shows a welded joint. At the end of the structure is subjected to an eccentric load of 30 kN. Referring to the figure, the welding is only on one side.
Given the permissible shear stress for the weld material is 80 MPa. Draw FBD and indicate clearly all the forces, and determine the angle and length for moment. Determine the uniform size of the weld on the entire length of two legs.



All dimensions in mm.

Figure Q2 Welded joint that subjected to force.

(25 marks)

Question 3

(a) In a carburetor, a tension spring is used to perform its function. The spring is assembled with a preload of 30 N. Given the wire diameter of the spring is 2 mm with a spring index of 6. The spring has 18 active coils. Material properties of the spring wire are shown in the Table Q3 (a) below.

Properties	Value
Design shear stress	680 MPa
Modulus of rigidity	80 kN/mm^2

Table Q3 (a)

(i) Determine the initial torsional shear stress in the wire.

(ii) Determine the spring rate

(iii) Determine the force required to cause the body of the spring to its yield strength.

(10 marks)

(b) A 150 mm diameter shaft supporting a load of 10 kN has a speed of 1500 rev/min. The shaft runs in a bearing whose length is 1.5 times the shaft diameter. If the diameter clearance of the bearing is 0.15 mm and the absolute viscosity of the oil at the operating temperature is 0.011 kg/m-s, find the power wasted by friction.

(15 marks)

Question 4

A pair of straight teeth spur gears transmit 20 kW at 300 r.p.m. of the pinion. The speed ratio is 1:3. The allowable static stresses for gear of cast iron and pinion of steel are 120 MPa and 100 MPa respectively. Given:

Information	Value
Number of teeth of pinion	15
Face width	14 times module
Velocity factor, C_v	$\frac{3}{3+v}$
Factor, y	$0.154 - \frac{0.912}{\text{No. of teeth}}$
Service factor, C_s	1

(a) Determine the module,

(19 marks)

(b) and Face width.

(2 marks)

(c) and pitch diameter of the gear and pinion.

(4 marks)

Question 5

(a) Two parallel shafts whose centre lines are 4.8 m apart, are connected by an open belt drive. The diameter of the larger pulley is 1.5 m and that of smaller pulley is 1 m. The initial tension in the belt when stationary is 3 kN. The mass of the belt is 1.5 kg / m length. The coefficient of friction between the belt and the pulley is 0.3. Taking centrifugal tension into account, calculate the power transmitted, when the smaller pulley rotates at 400 r.p.m.

(15 marks)

(b) Figure Q5 (b) show a differential band brake. It has a drum diameter of 600 mm and the angle of contact is 240°. The brake band is 5 mm thick and 100 mm wide. The coefficient of friction between the band and the drum is 0.3. If the band is subjected to a stress of 50 MPa, find :

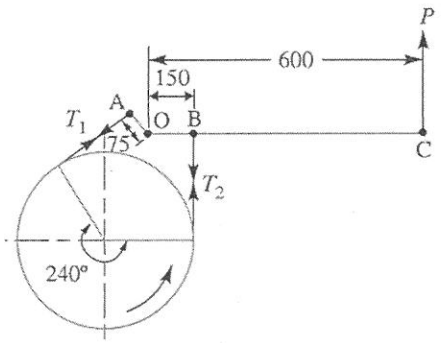


Figure Q5 (b)

(i) The least force required at the end of a 600 mm lever

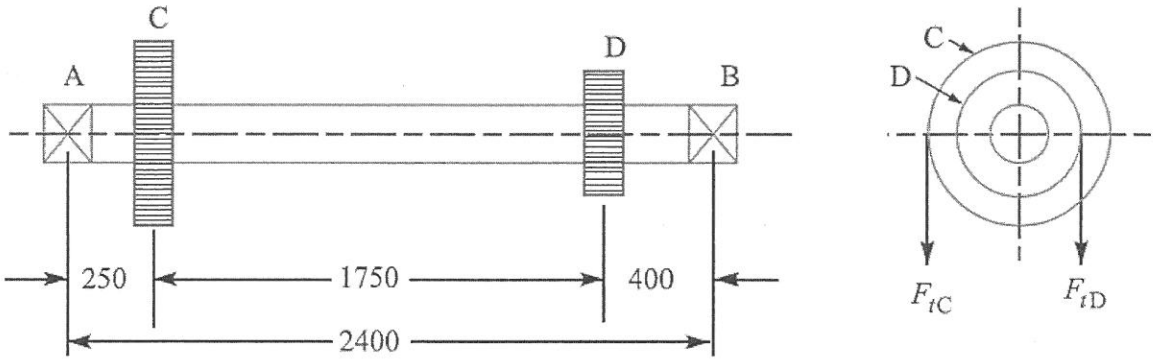
(8 marks)

(ii) The torque applied to the brake drum shaft.

(2 marks)

Question 6

A horizontal nickel steel shaft shown in Figure Q6 rests on two bearings of A at the left and B at the right end. The pitch diameter of the gear C is 600 mm and that of gear D is 200 mm. The shaft transmits 20 kW at 120 r.p.m. The power is delivered to the shaft at gear C and is taken out at gear D in such a manner that the tooth pressure F_{tD} of the gear C and F_{tD} of the gear D act vertically downwards. Find the diameter of the shaft, if the working stress is 100 MPa in tension and 56 MPa in shear. The gears C and D weighs 950 N and 350 N respectively. The combined shock and fatigue factors for bending and torsion may be taken as 1.5 and 1.2 respectively.



All dimensions in mm.

Figure Q6 Horizontal nickel steel shaft rests on two bearings with two gears

(25 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

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

Maximum Shear Stress

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

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

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

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 (σ_{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

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

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

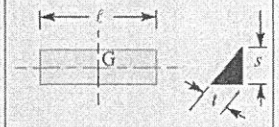
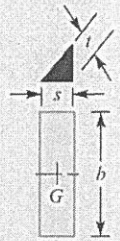
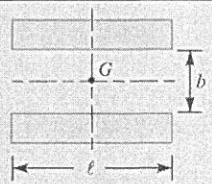
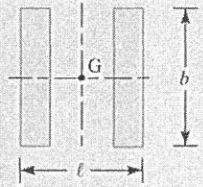
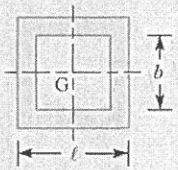
$P_s = \frac{P}{n}$, acting parallel to the load P.

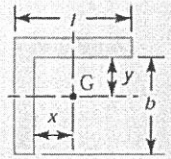
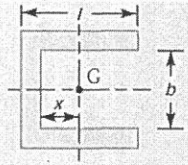
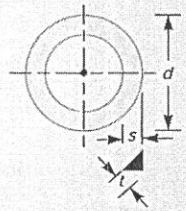
$$P.e = F_1.l_1 + F_2.l_2 + F_3.l_3 + \ ...$$

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

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

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

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.	 $x=\frac{l^2}{2(l+b)}, y=\frac{b^2}{2(l+b)}$	$t\left[\frac{(b+l)^4-6b^2l^2}{12(l+b)}\right]$	$t\left(\frac{4l.b+b^2}{6}\right)$ (Top) $t\left[\frac{b^2(4l+b)}{6(2l+b)}\right]$ (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.		$\frac{\pi t d^3}{4}$	$\frac{\pi t d^2}{4}$