INTI International University & Colleges

FINAL
ALTERNATIVE ASSESSMENT

(COVER PAGE)

Session	:	**April 2020**
Programme	:	Diploma in Mechanical Engineering (DMEN)
Course	:	**EGM2160: Mechanics of Machines**
Date of Examination	:	5 August 2020 (Wednesday)
Time	:	8.00am – 10.15am Reading Time : Nil
Duration	:	2 Hours 15 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)	:	**Mr Phua Chin Lai**
Chief Moderator	:	Mr Soo Swee Yoong

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

DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)
EGM2160: MECHANICS OF MACHINES
FINAL ALTERNATIVE ASSESSMENT: APRIL 2020 SESSION

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

Question 1

(a) A leather belt, 125 mm wide and 6 mm thick, transmits power from a pulley 750 mm diameter which runs at 500 rpm. The angle of lap is 150º and $\mu = 0.3$. If the mass of 1 m^3 of leather is 1 Mg and the stress in the belt is not to exceed 2.75 MN/m^2, find the maximum power which can be transmitted.

(15 marks)

(b) A rod PR is constrained by a guides to move horizontally as shown in Figure Q1(b). Which is driven by a crank OA and a sliding block P. For a given configuration find the velocity of the link PR, when OA has an angular velocity of 10 rad/s.

(10 marks)

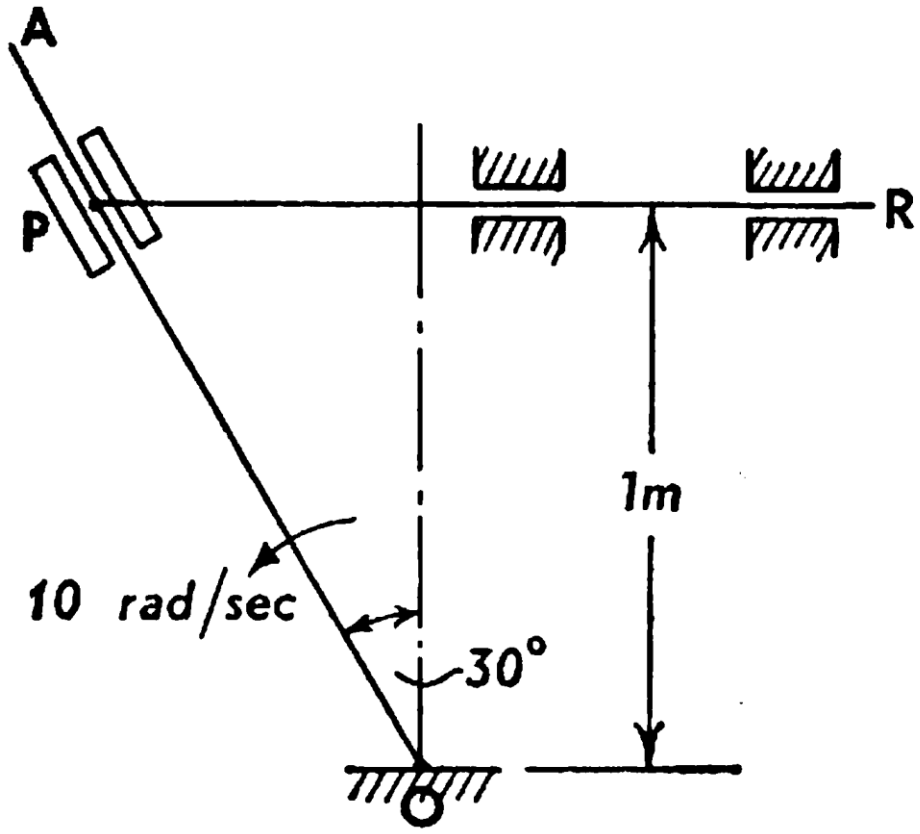

Figure Q1(b)

Question 2

(a) Figure Q2(a) shows an epicyclic gear has a fixed annular wheel C concentric with a sun wheel A. A planet wheel B gears with A and C and can rotate freely on a pin carried by an arm D which rotates about an axis co-axial with that A and C. If T_A and T_C are the numbers of teeth on A and C respectively.

(i) Show that the ratio of the speeds of D to A is $T_A /(T_A + T_C)$.

(ii) If the least number of teeth on any wheel of A or B is 18, and $T_A + T_C = 120$, find the greatest and least speeds of D when the wheel A rotates at 500 rpm.

(17 marks)

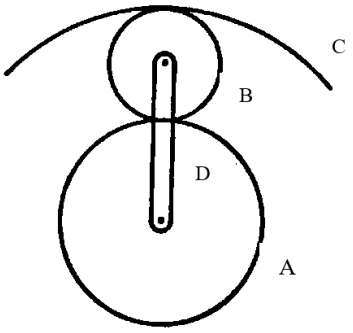

Figure Q2(a)

(b) In a Porter governor the upper and lower arms are each 250 mm long, and are each inclined at 30º to the vertical when the sleeve is in its lowest position. The points of suspension are each 25 mm from the axis of the spindle. The mass of each rotating ball is 3 kg, and that of the central load on the sleeve 20 kg. Determine the speed in rpm of the governor at the current position.

(8 marks)

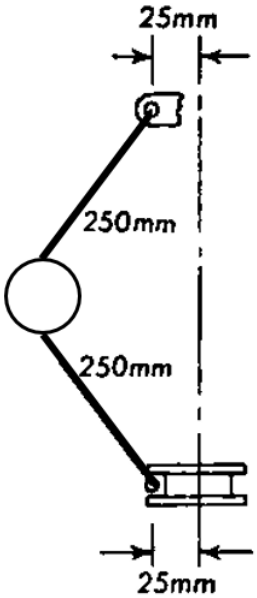

Figure Q2(b)

Question 3

(a) A multi plate clutch is to transmit 12 kW at 1500 rpm. The inner and outer radii for the plates are to be 50 mm and 100 mm respectively. The maximum axial spring force is restricted to 1 kN. Assuming constant wear. Determine,

(i) the necessary number of pairs of surfaces and

(ii) the necessary axial force, if $\mu = 0.35$.

(10 marks)

(b) A double-acting steam engine runs at 100 rev/min. A curve of the turning-moment, T plotted on a crank angle base, Θ showed in Figure Q3(b) with the following areas alternatively above and below the mean turning moment line: 780, 400, 520, 620, 260, 460, 340, 420 mm^2. The scales used on the axes were 1 mm = 400 Nm and 1 mm = 1º crank angle.

If the total fluctuation in speed is limited to 1.5% of the mean speed, determine the mass of the flywheel necessary if the radius of gyration is 1.05 m.

(15 marks)

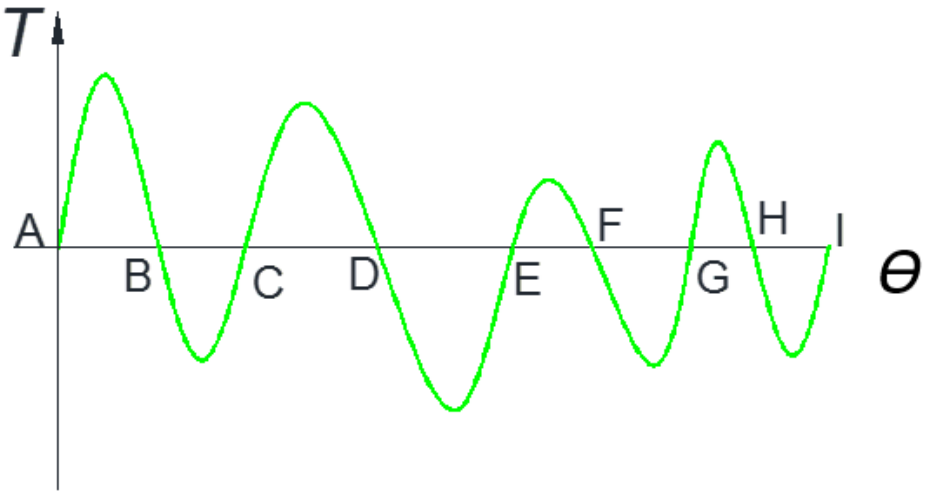

Figure Q3(b)

Question 4

(a) A mass of 25 kg is suspended from a spring which has a stiffness of 14 kN/m of extension. It vibrates freely with an amplitude of 12 mm. Determine,

(i) the periodic time, (2 marks)

(ii) the velocity and acceleration when displaced 8 mm from the equilibrium position, and (6 marks)

(iii) the time interval in passing from this position to the position of maximum displacement. (4 marks)

(b) On a packaging machine mechanism a crosshead moves in a straight guide with a simple harmonic motion. At distances of 125 mm and 200 mm from its mean position the crosshead has velocities of 6 m/s and 3 m/s respectively. Determine,

(i) the amplitude of the motion, (5 marks)

(ii) the maximum velocity, and (4 marks)

(iii) the periodic time. (2 marks)

(iv) If the crosshead has a mass of 0.2 kg, what is the maximum inertia force? (2 marks)

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Formula Sheet

Plate clutch

Uniform pressure	Uniform wear
$W = \pi P(r_1{}^2 - r_2{}^2)$	$W = 2\pi C(r_1 - r_2)$ where $C = Pr$
$R = \frac{2}{3}\left(\frac{r_1{}^3 - r_2{}^3}{r_1{}^2 - r_2{}^2}\right)$	$R = \frac{1}{2}(r_1 + r_2)$
$T = n\mu WR$	$T = n\mu WR$

Centrifugal clutch

$T = n\mu(P_c - P_s)r_D$, where $P_c = m\omega^2 r_G$, $P_s = m\omega_1{}^2 r_G$ *or* F_{spring}, $r_D =$ drum radius and $r_G =$ radius of center gravity of mass

Belt drive

$$\frac{T_1}{T_2} = e^{\mu\theta}$$

$$\text{Power} = (T_1 - T_2)v$$

$T_1 + T_2 = 2T_o$ where T_o is the tension at rest

Crank effort diagram

Maximum fluctuation energy = $\frac{1}{2}I(\omega_1^2 - \omega_2^2) = I\omega^2 C_s$

Coefficient of fluctuation of speed $C_s = \frac{N_1 - N_2}{N}$

Free Vibration

$$f = \frac{1}{2\pi}\sqrt{\frac{g}{\delta}} \quad \text{or} \quad f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}, \quad T = \frac{1}{f}$$

$$x = a\cos(\omega t)$$

$$\dot{x} = v = -a\omega\sin(\omega t) = \omega\sqrt{a^2 - x^2}$$

$$\ddot{x} = -a\omega^2\cos(\omega t) = \omega^2 x$$