FINAL
ALTERNATIVE ASSESSMENT

(COVER PAGE)

Session	:	**January 2022**
Programme	:	Diploma in Mechanical Engineering (DMEN)
Course	:	**EGM2160: Mechanics of Machines**
Date of Examination	:	7 March 2022 (Monday)
Time	:	4.00pm – 6.30pm Reading Time : Nil
Duration	:	2 Hours 30 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 **6** printed pages, including the cover page*

DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)
EGM2160: MECHANICS OF MACHINES
FINAL ALTERNATIVE ASSESSMENT: JANUARY 2022 SESSION

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

Question 1

(a) A multi-plate clutch is used to connect two shafts in line. If the inner and outer diameters of the contact surfaces are 90 and 140 mm respectively and there are six contacts. Assume the coefficient of friction, μ = 0.3 and the contact pressure times radius is a constant over each surface. Compute

(i) the axial trust required to transmit 7.5 kW at 750 rev/min, (7 marks)

(ii) the contact pressures at the inner and outer radii. (5 marks)

(b) A multi-disc friction clutch has to be designed to transmit 75 kW from an engine running at 2000 rev/min. Assuming the pressure is uniform at 150 kN/m^2, and the inner and outer diameters of the lining are 100 mm and 150 mm respectively. Assume $\mu = 0.25$.

(i) Compute the necessary end trust and the necessary number of contact surfaces.
(7 marks)

(ii) If this clutch is used to transmit the power from a larger engine to a rotor, which has a mass of 1150 kg and a radius of gyration of 200 mm, compute the time required for this rotor to reach 1500 rev/min from rest. Assume that the clutch is transmitting the maximum possible torque.
(6 marks)

Question 2

Figure Q2 shows an epicyclic train has a sun-wheel with 40 teeth and two planet wheels (P) of 60 teeth, the latter meshing with the internal teeth of a fixed annulus (A). The input shaft, carrying the sun-wheel, transmitts 5 kW at 400 rev/min. The output shaft is connected to an arm which carries the planet wheels.

(i) Compute the speed of the output shaft and the torque transmitted if the overall efficiency is 95%.

(20 marks)

(ii) If the annulus is rotated independently, compute its speed in order to make the output shaft at 20 rev/min.

(5 marks)

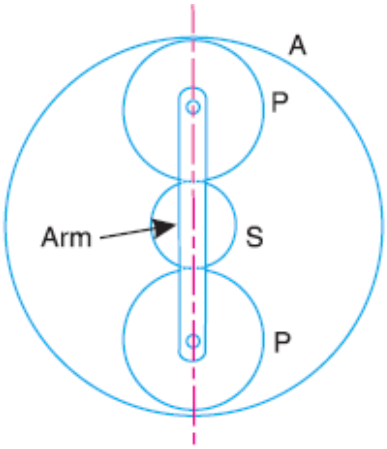

Figure Q2

Question 3

(a) A Proell governor shown in Figure Q3(a), its upper and lower arms are each 250 mm long, and are each inclined at 30° to the vertical when the sleeve is in its lowest position. The points of suspension are each 30 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 25 kg. If the movement of the sleeve is 40 mm, compute the range of speed of the governor.

(15 marks)

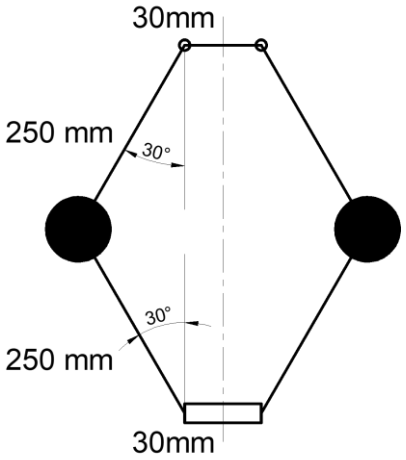

Figure Q3(a)

(b) Two parallel shafts are to be connected by spur gearing. The approximate distance between the shafts is 600 mm. If one shaft runs at 120 rev/min and the other at 360 rev/min, compute

(i) the number of teeth on each wheel, if the module is 8 mm.

(ii) the exact distance apart of the shafts.

(10 marks)

Question 4

(a) A Porter governor shown in Figure Q4(a), it has 300 mm arms and the rotating balls each have a mass of 1.8 kg. At the mean speed of 120 rev/min, the arms make 30º to the vertical. Compute

(i) the central dead load, (7 marks)

(ii) the lowest and highest speed if the sleeve movement is ± 25 mm. (5 marks)

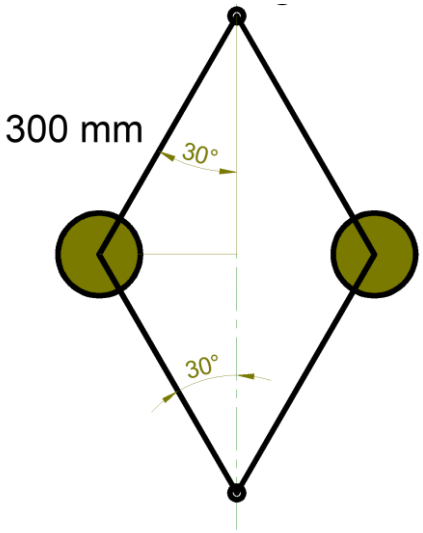

Figure Q4(a)

(b) A machine is driven by a friction disc clutch, both sides of the disc are being effective in producing driving friction. The external and internal diameter of the disc are 200 mm and 125 mm respectively. The axial pressure applied to the disc is 70 kN/m^2 and μ =0.25. Assuming the pressure is uniformly distributed,

(i) compute the torque transmitted, (6 marks)

(ii) if the machine is at rest, the clutch is suddenly engaged, how long does it take for the machine to attain a speed of 300 rev/min. Given the mass moment inertia of the rotating parts of the machine is 4.7 kgm^2.

(7 marks)

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

Gear Train

$m = \frac{D}{T}$

~THE END~

EGM2160 (F)/January 2022 Session/ formatted