Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER I
SESSION 2020/2021

COURSE NAME	:	MECHANICS OF MACHINE
COURSE CODE	:	DAM 21703 / DAM 31703
PROGRAM CODE	:	DAM
EXAMINATION DATE	:	JANUARY / FEBRUARY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	1) ANSWER **FIVE (5)** QUESTIONS ONLY 2) THE ANSWER BOOKLET NEED TO BE SUBMITTED 15 MINUTES AFTER THE EXAMINATION END. (SUBMIT ALL THE DOCUMENTS IN PDF)

THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

Q1 (a) A reverted gear train is shown in **Figure Q1(a)**. Discuss whether the following value can be different or must be the same.

(i) Module of gear A and B.
(ii) Module of gear B and C.
(iii) Distance 'a' and 'b'.

(6 marks)

(b) A simple gear train comprises of two gears. The radius of driver gear and pinion gear are 12 cm and 25 cm respectively. The driver gear rotates at 13000 revolutions per minute clockwise with torque of 14 Nm. If the efficiency of the gear is 82%, determine:

(i) output speed.
(ii) output power value.

(6 marks)

(c) A compound gear train comprises of six gears. The radius of each of the gears are as follows.

Gear	A	B	C	D	E	F
Radius (cm)	20	22	40	25	40	20

Gear B and C are on one shaft while gear D and E are on one shaft to another. Gear A drives gear B, gear C drives gear D and gear E drives gear F. When the gear rotates at 4000 revolutions per minute, the input power is 40 kW and the efficiency of the compound gear us 82%. Determine output torque of the compound gear.

(8 marks)

Q2 (a) Kamal participated in a hammer throwing sport carnival in UTHM. Three forces appear while he was rotating the hammer as illustrated in **Figure Q2(a)**.

(i) State the three forces 'a', 'b' and 'c'.
(ii) Explain the reason for force 'a' is the reaction of force 'b' while force 'c' does not have any reaction.

(5 marks)

(b) An open belt drive system consists of a flat belt connecting driver and driven pulley with 120 cm and 60 cm diameter on a parallel shaft 1.8 m apart with the value of tight tension equal to 800N. The driver pulley is connected to a power source with a speed of 1000 revolutions per minute. Given the mass of the belt is 0.2 kg and the coefficient of friction is 0.4,

(i) calculate the total length of the belt.
(ii) determine the centrifugal tension.
(iii) determine the power transmitted by the belt.

(15 marks)

Q3 (a) A disc is out of balance as illustrated in **Figure Q3(a)** because there are three balls A, B and C attached to it. The three balls are said to be coplanar and they rotate about a common center. A fourth ball D is added to balance the disc. If the mass and the position of each three balls are known, discuss how to justify the location of the fourth ball either should be at quadrant 1, 2, 3 or 4 using:

(i) mathematical calculation.
(ii) vector diagram.

(4 marks)

(b) The properties value of ball A, B and C as shown in **Figure Q3(a)** are given as below. For ball D, only the mass is known.

	Ball A	Ball B	Ball C	Ball D
Mass (kg)	5	3	2	4
Radius (m) Angle	0.2 $\theta = 30°$	0.35 $\varnothing = 45°$	0.15 $\alpha = 30°$	

Determine the value of radius and angle of ball D using:

(i) mathematical calculation.
(ii) vector diagram.

(16 marks)

Q4 (a) The equation diagram of square threaded screw moving up a plane as in **Figure Q4(a)** given by $P = W \tan(\alpha + \varnothing)$, where P is horizontal force, W is the load and α is the pitch angle.

(i) Describe $\varnothing$ and how the value of $\varnothing$ is determined.
(ii) Show that even though the screw is moving up a plane, the resultant force of the system is zero.

(7 marks)

(b) The mean diameter of a 'Vee' threaded screw jack as shown in **Figure Q4(b)** is 50 mm. The pitch of the thread is 12 mm and the angle of thread β is 15°. The coefficient of friction is 0.16. Calculate the efficiency and force that must be applied at the end of a 0.6 m long lever, which is perpendicular to the longitudinal axis of screw to raise a load of 25 kN.

(13 mark)

Q5 (a) Describe **four (4)** types of inversion in slider crank mechanism and example for each for each inversion.

(4 marks)

(b) The four bars chain in **Figure Q5(b)** comprises of link AB = 1.0 m, link BC = 1.2 m and link CD = 0.4 m. The distance between point A and D is 1.7 m. Crank AB is rotating anticlockwise with an angular velocity of 2.6 rad/s which is decreasing at 4.5 rad/s^2.

(i) Redraw the **Figure Q5(b)** to appropriate scale.
(ii) Draw the velocity and acceleration diagram of the bar chain.
(ii) Determine the velocity and acceleration of each link.

(16 marks)

Q6 (a) Define free vibration and discuss the similarities between undamped and damped vibration.

(4 marks)

(b) A uniform thin rod AB as shown in **Figure Q6(b)** is in a free vibration state. The moment of inertia of the rod at point A is 120 kgm^2 and carries a concentrated mass of 5 kg at B. The rod is hinged at A and is balanced horizontally by two springs positioned at point C and D. If the spring stiffness of spring C and D are 5.0 kN and 2.0 kN respectively;

(i) determine the moment of inertia at point A for the system.
(ii) determine the force experienced by both spring in term of θ where θ is the angle of deflection.
(iii) by using the principle of moment about point A, calculate the natural frequency of the system.

(16 marks)

- END OF QUESTIONS -

FINAL EXAMINATION

SEMESTER / SESSION : SEMESTER 1 / 2020/2021
COURSE NAME : MECHANICS OF MACHINE
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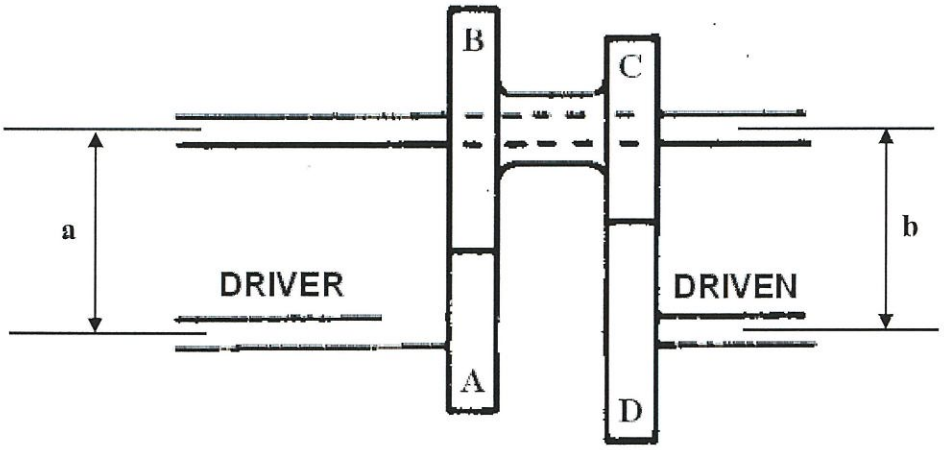

Figure 1(a)

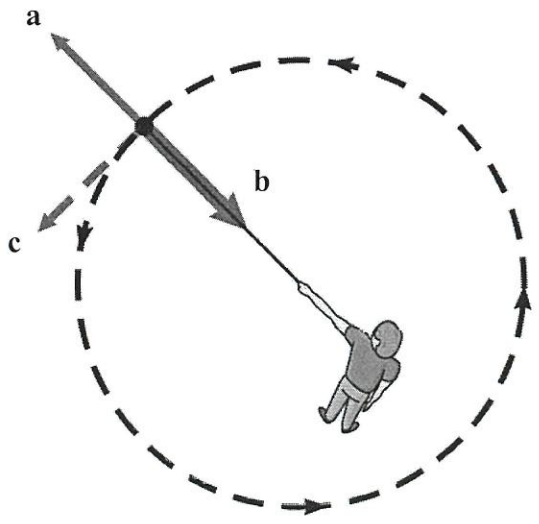

Figure 2(a)

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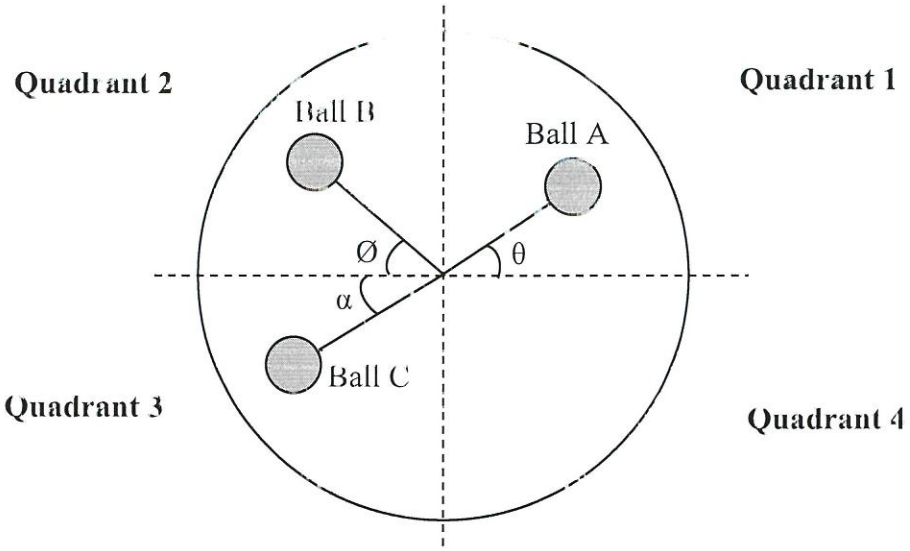

Figure 3(a)

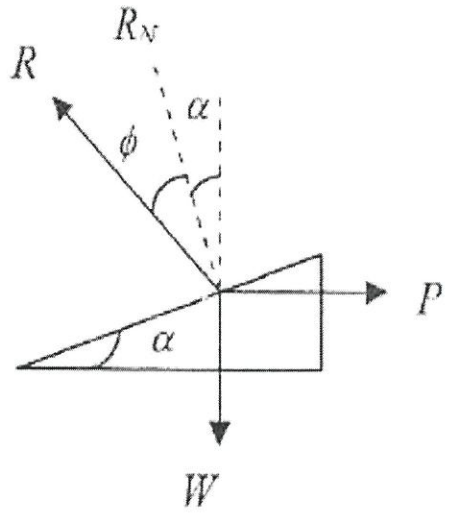

Figure 4(a)

FINAL EXAMINATION

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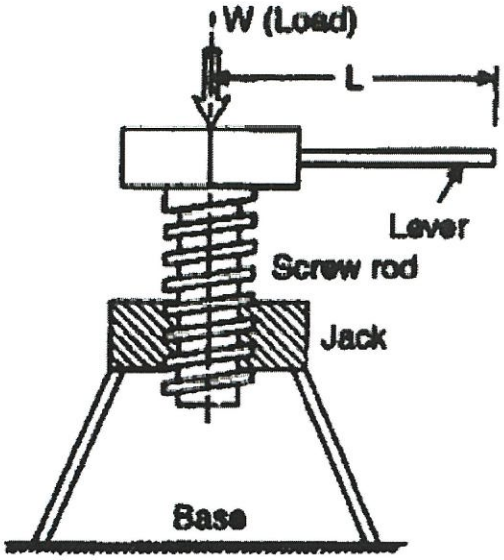

Figure 4(b)

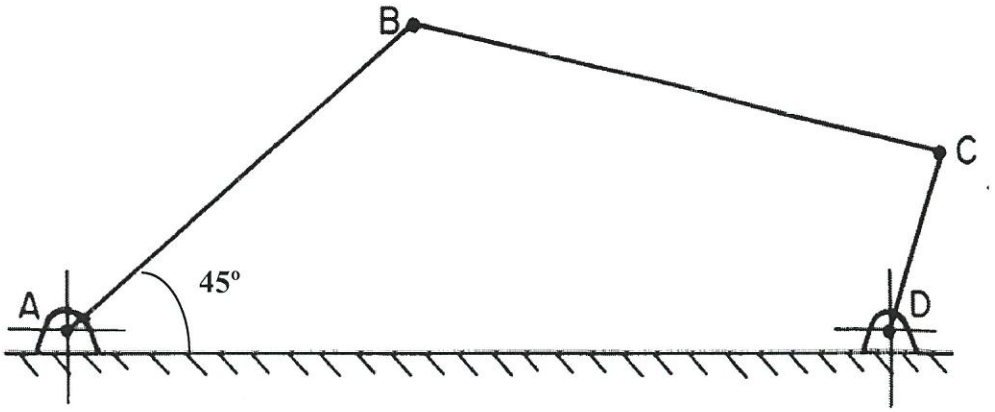

Figure 5(b)

FINAL EXAMINATION

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COURSE NAME : MECHANICS OF MACHINE
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COURSE CODE : DAM 21703 / DAM 31703

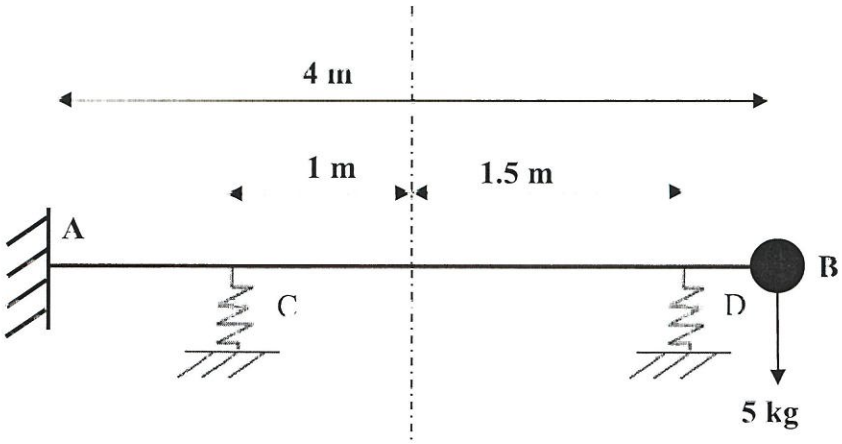

Figure 6(b)

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SEMESTER / SESSION : SEMESTER 1 / 2020/2021 PROGRAMME CODE : DAM
COURSE NAME : MECHANICS OF MACHINE COURSE CODE : DAM 21703 / DAM 31703

List of Formula

1. Linear velocity at the contact surface of gear, $\pi D_1 N_1 = \pi D_2 N_2$
2. Equivalent Moment of Inertia, $I_{equiv} = \left(I_A + \frac{I_B n^2}{\eta_G} \right)$
3. Velocity Ratio for belt drives, $n = \frac{N_2}{N_1} = \frac{d_1}{d_2}$
4. Belt tension ratio for flat belt, $\frac{T_1}{T_2} = e^{\mu\theta}$
5. Belt tension ratio for V-Belt, $\frac{T_1}{T_2} = e^{\left(\frac{\mu\theta}{\sin\beta}\right)} = e^{(\mu\theta)(\operatorname{cosec}\beta)}$
6. V-Belt type force balance, $R_N = \frac{R}{2\sin\beta}$
7. Maximum Power for Belt Drives, $P = (T_1 - T_2)v$
8. Centrifugal force term, $\rho A v^2 = T_C$
9. Limiting Angle of Friction, $\tan\phi = \frac{F}{R_N} = \mu$
10. Inclination of Square Threaded Screw, $\tan\alpha = \frac{p}{\pi d}$
11. Efficiency for Square Threaded Screw, $\eta = \frac{p}{\pi D \tan(\beta + \alpha)}$
12. Radial component of acceleration, $f_{BA}^r = \omega^2 (BA) = \frac{(V_{BA})^2}{BA}$

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List of Formula

13. Tangential component of acceleration, $f_{BA}^{t} = \alpha(BA)$

14. Newton's Second Law of Motion, $\sum M_O = I_O\ddot{\theta}$

15. Principle of conversion of energy, $\frac{d}{dt}[T.K + T.U]$