Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	MECHANICS OF MACHINES
COURSE CODE	:	DAM 23803
PROGRAMME CODE	:	DAM
EXAMINATION DATE	:	JULY / AUGUST 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **FIVE (5)** QUESTIONS **ONLY** 2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK** 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) Explain **two (2)** differences between simple gear train and reverted gear train.

(4 Marks)

(b) A gear box has an input speed of 2000 rev/min clockwise and an output speed of 500 rev/min anticlockwise. The input power is 50 kW, and the efficiency is 60%. Determine:

(i) the input torque,

(2 Marks)

(ii) the output power,

(2 Marks)

(iii) the output torque, and

(2 Marks)

(iv) the holding torque.

(2 Marks)

(c) A gear train system is used to hoist a load of 10 kg as shown in **Figure Q1(c)**. The radius of the hoist is 1.0 m. Neglect the moment of inertia of the shaft, gear, and friction effect. The efficiency of the gear train is $\eta_{G,1/2} = 92\%$. Find the torque of the motor needed to bring the load up with an acceleration of 1.2 m/s^2.

(8 Marks)

Q2 (a) State **five (5)** advantages of belt drive system.

(5 Marks)

(b) Two pulleys are connected with a 1.2 m length flat belt type. The driver pulley with diameter 40 cm is rotating with speed 350 rpm, while diameter of driven pulley is 100 cm. Coefficient of friction of the contact surface between belt and pulley is 0.3. The maximum allowable tension is 600 N. Find;

(i) the power transmitted by the belt,

(8 Marks)

(ii) the initial tension of the belt.

(2 Marks)

(iii) If the flat belt is now replaced by a V-belt with groove angle of 30°, find the power transmitted by this belt.

(5 Marks)

Q3 (a) Define **two (2)** types of balancing.

(4 Marks)

(b) State the principle of D'Alembert.

(2 Marks)

(c) A rotating shaft carries four masses A, B, C and D which are radially attached to it as shown in **Figure Q3(c)**. The mass centres are 30 mm, 40 mm, 35 mm, and 38 mm respectively from the axis of rotation. The masses A, C and D are 7.5 kg, 5 kg and 4 kg respectively. The axial distances between the planes of rotation of A and B is 400 mm and between B and C is 500 mm. The masses A and C are at right angles to each other. Find for a complete balance for the following.

(i) The angles between the masses B and D from mass A.

(8 Marks)

(ii) The axial distance between the planes of rotation of C and D.

(4 Marks)

(iii) The magnitude of mass B.

(2 Marks)

Q4 (a) Describe the differences between sliding friction and rolling friction. Give **two (2)** examples for each type of that friction.

(4 Marks)

(b) The table of a planer machine has a mass of 200 kg and is driven at 0.2 ms^{-1} by a single square thread screw of diameter 50 mm and pitch 12 mm. Using the coefficient of friction between the table and the screw is 0.15, calculate the parameters that are needed by the screw to drive the table against a cutting tool force of 250 N.

(i) The screw percentage efficiency, η.

(4 Marks)

(ii) The total force applied, W.

(4 Marks)

(iii) The torque required, τ.

(4 Marks)

(iv) The power to be applied.

(4 Marks)

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

(6Marks)

(b) The four bars chain in **Figure Q5(b)** comprises of link AB = 3.5 cm, link BC = 10 cm, and link CD = 9.0 mm. The distance between points A and D is 8.0 cm. Crank AB is rotating counterclockwise at a constant rotational speed of 350 rpm.

(i) Redraw the **Figure Q5(b)** using appropriate scale.

(4 Marks)

(ii) Draw the velocity and acceleration diagram of the bar chain.

(5 Marks)

(iii) Determine the velocity and acceleration of each link.

(5 Marks)

Q6 (a) Define the Simple Harmonic Motion (SHM) and list **two (2)** criteria of SHM.

(4 Marks)

(b) An undamped system vibrates with a frequency of 15 Hz and an amplitude of 1 mm. Calculate the maximum value of the system's velocity and acceleration.

(6 Marks)

(c) A uniform thin rod, AB with a mass of 1.5 kg and 3.5 kg of concentrated mass at B as shown in **Figure Q6(c)**. The rod is hinged at A and attached with a 2.8 kN/m stiffness spring at C to keep it in the horizontal position. By neglecting the effect of the spring's mass, determine the frequency of oscillation.

(10 Marks)

–END OF QUESTIONS–

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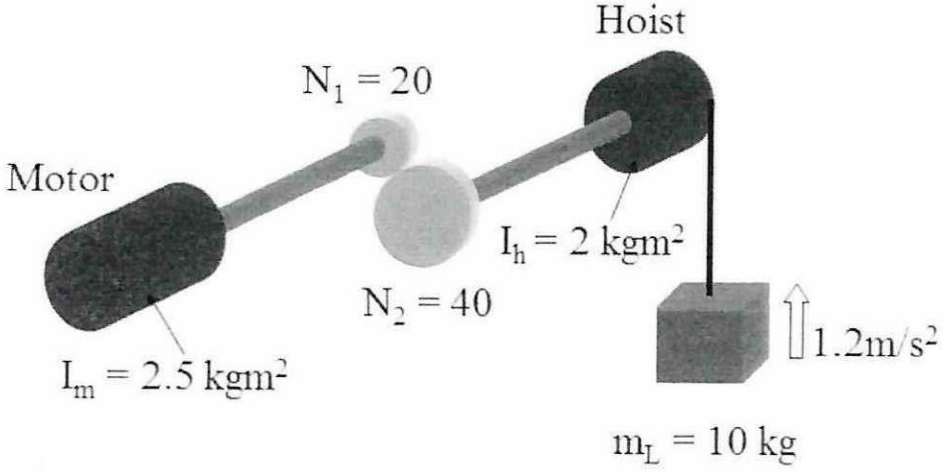

Figure Q1(c)

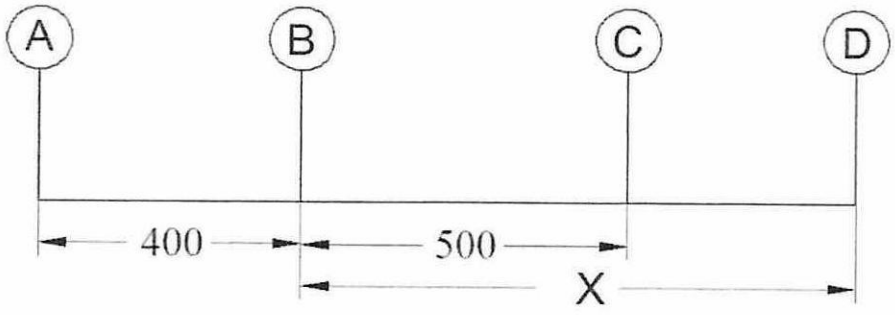

Figure Q3(c)

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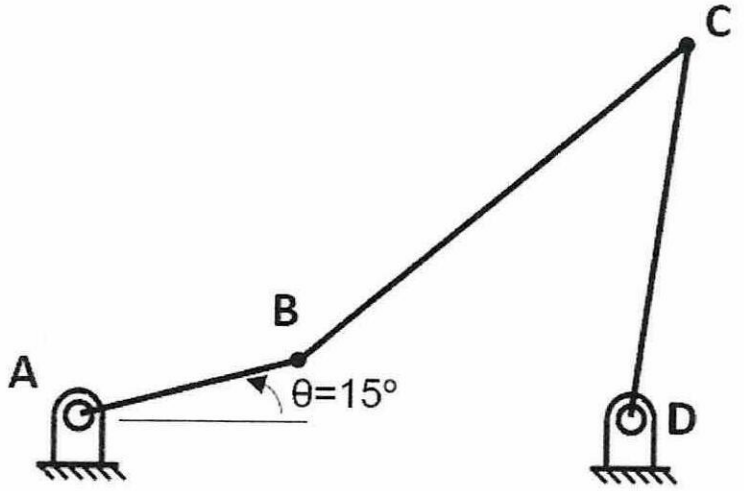

Figure Q5(b)

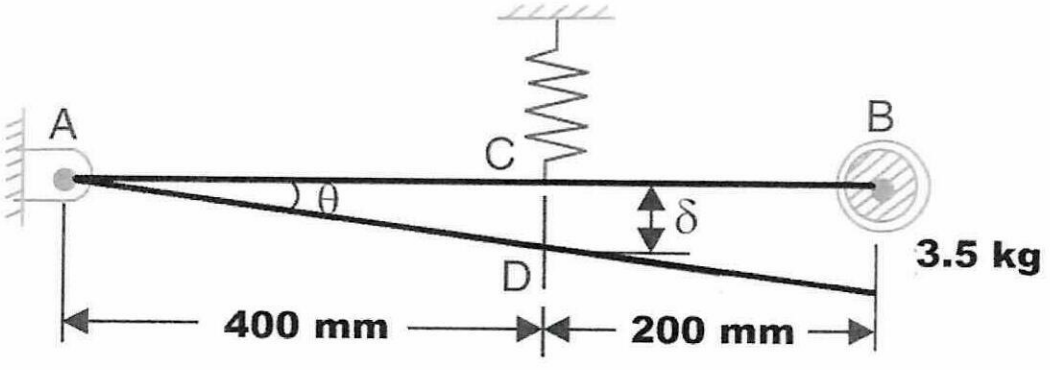

Figure Q6(c)

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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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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, $\frac{d}{dt}[T.K + T.U]$