Universiti Tun Hussein Onn Malaysia

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER I
## SESSION 2022/2023

| | | |
|---|---|---|
| COURSE NAME | : | MECHANICS OF MACHINES |
| COURSE CODE | : | DAM 23803/ DAM 31703 |
| PROGRAMME CODE | : | DAM |
| EXAMINATION DATE | : | FEBRUARY 2023 |
| DURATION | : | 3 HOURS |
| INSTRUCTION | : | 1. ANSWER **FIVE (5)** QUESTIONS ONLY<br>2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK**<br>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 **TEN (10)** PAGES

**Q1** (a) In gear terminology, circular pitch, diametral pitch and module of the gear are important parameters. Explain how those 3 parameters related to each other.

(6 Marks)

(b) State the four types of gears and their meaning.

(4 Marks)

(c) A motor is accelerating a 250 kg load with acceleration of 1.2 $m/s^2$ through a gear system as shown in **Figure Q1(c)**. The rope that carries the load are encircled on a hoist with diameter 1.2 m. Gear for the hoist's shaft has 200 teeth, gear for motor shaft has 20 teeth. Gear efficiency is 90%. Mass of motor shaft is 250 kg with radius of gyration of 100 mm while hoist shaft has 1100 kg of mass with radius of gyration of 500 mm. Calculate the torque of the motor needed to bring up the load with acceleration 1.2 $m/s^2$. Neglect friction effect.

(10 Marks)

**Q2** (a) Explain **three (3)** advantages of flat belt and **three (3)** advantages of V-belt.

(6 Marks)

(b) In power transmission, belt-drive system depends on friction. However, slippage of the belt contributes to the inefficiency of the drive.

(i) Describe the phenomena of belt slip.

(2 Marks)

(ii) Belt slip condition considered as one of the factors that contribute to the inefficiency of the drive. Justify the consequences of that condition.

(2 Marks)

(c) As shown in **Figure Q2(c)**, a multiple V-belt drive with a groove angle of 40° is required to transmit 30 kW from a pulley 180 mm in diameter to another pulley 300 mm in diameter rotating at 210 rev/min. The coefficient of friction between the belt and the pulley is 0.30 and the maximum permissible belt tension is 1000 N for each of the ten belts used.

(i) Calculate the torque on the smaller pulley.

(3 Marks)

(ii) Determine the angle of contact.

(4 Marks)

(iii) Suggest the ideal center distance.

(3 Marks)

**Q3** (a) Explain the static and dynamic balancing and provide **two (2)** examples of each.
(6 Marks)

(b) State the principle of D'Alembert.
(2 Marks)

(c) **Figure Q3(c)** shows four masses A, B, C and D are to be completely balanced at radius 120 mm, 150 mm and 180 mm and 210 mm respectively. Mass B, C and D are 20 kg, 15 kg and 5 kg. The planes which the mass revolve are spaced 100 cm apart. Find the required mass A and the angular settings relative to a plane so that the shaft is in complete balance.
(12 Marks)

**Q4** (a) Describe the differences between static friction and dynamic friction with examples.
(6 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 15 mm and the angle of thread $\beta$ is 18°. The coefficient of friction is 0.19. Calculate the efficiency and force that must be applied at the end of a 0.85 m long lever, which is perpendicular to the longitudinal axis of screw to raise a load of 35 kN.
(14 Marks)

**Q5** (a) Indicate the velocity of pin joint as illustrated in **Figure Q5(a)**. The radius of the pin joint is given as *r*.
(4 Marks)

(b) ABCD is a four bar chain with the link AD is fixed as **Figure Q5(b)**. The length the links are AB = 6.25 cm, BC = 17.5 cm, CD = 11.25 cm, DA = 20 cm. The crank AB makes 100 rpm in the clockwise direction. Find the following when the angle BAD is 60°.

(i) The angular velocity of links CD and BC.
(12 Marks)

(ii) Velocity of point E, 10cm from C on the link BC.
(2 Marks)

(iii) The velocity of point F, which is 10.5cm from B and C and lying outside ABCD.
(2 Marks)

**Q6** (a) Define natural frequency for undamped free vibration and list **two (2)** ways for determining it.

(4 Marks)

(b) A uniform thin rod AB as shown in **Figure Q6(b)** is hinged at point A. The moment of inertia of the thin rod at point A is 75 $kgm^2$. A concentrated mass of 2.5 kg is then fixed at the point C and balanced horizontally by two springs positioned at point D and E. Given the spring stiffness of spring D and E are 3.0 kN and 1.0 kN respectively;

(i) determine the moment of inertia of the complete assembly at point A,

(2 Marks)

(ii) determine the force experienced by both spring in term of $\theta$ where $\theta$ is the angle of deflection.

(6 Marks)

(iii) calculate the natural frequency of the complete assembly

(8 Marks)

**-END OF QUESTIONS –**

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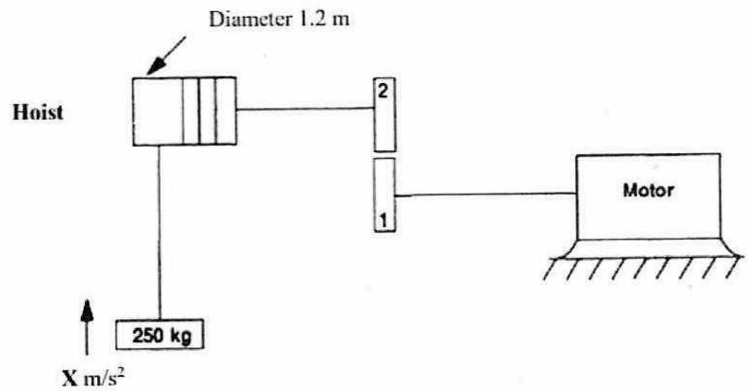


**Figure Q1(c)**

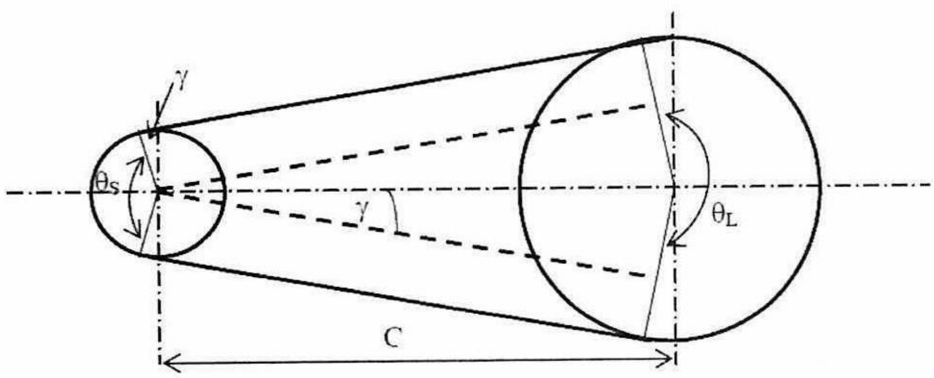


**Figure Q2(c)**

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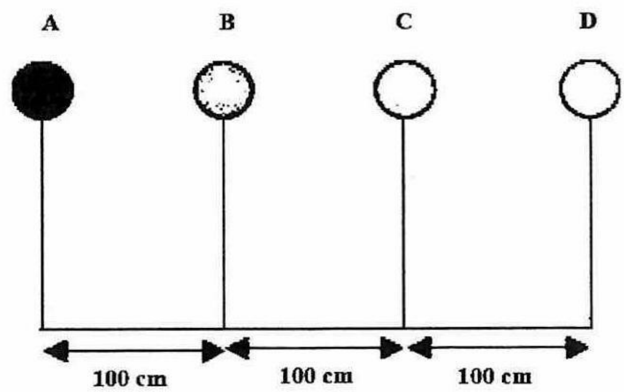


Figure Q3(c)

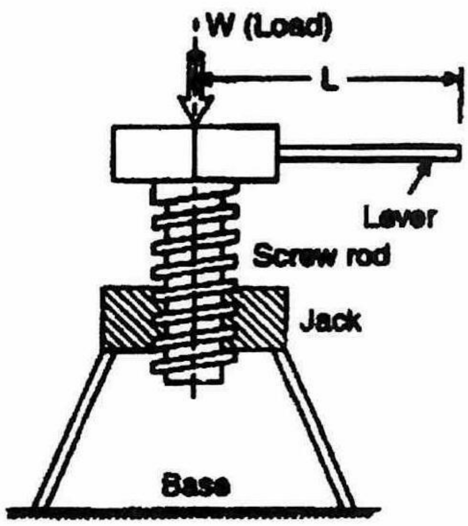


Figure Q4(b)

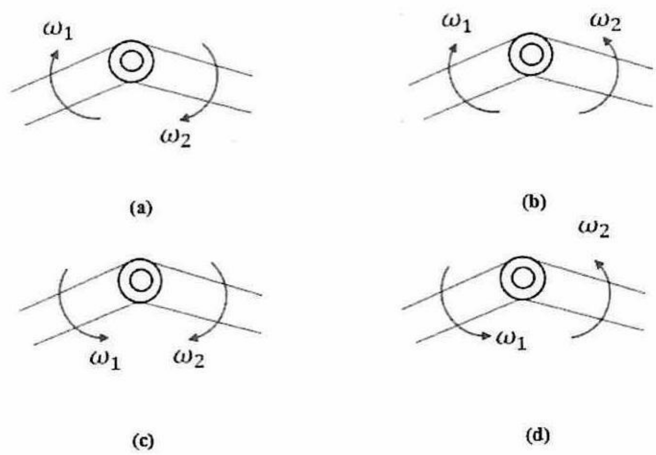


**Figure Q5(a)**

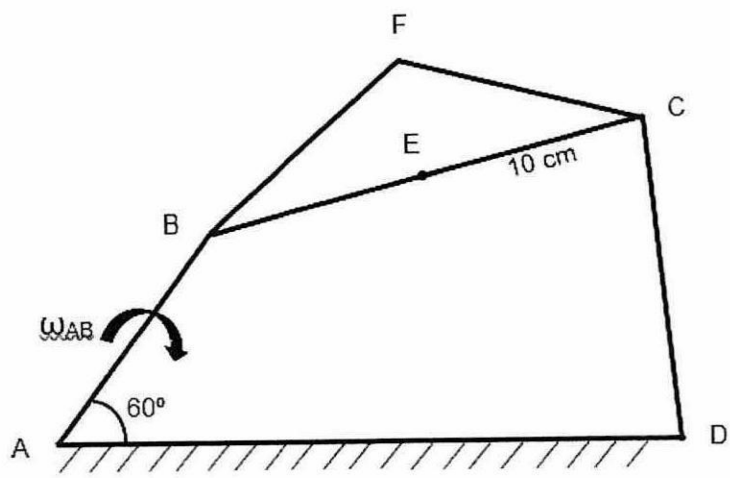


**Figure Q5(b)**

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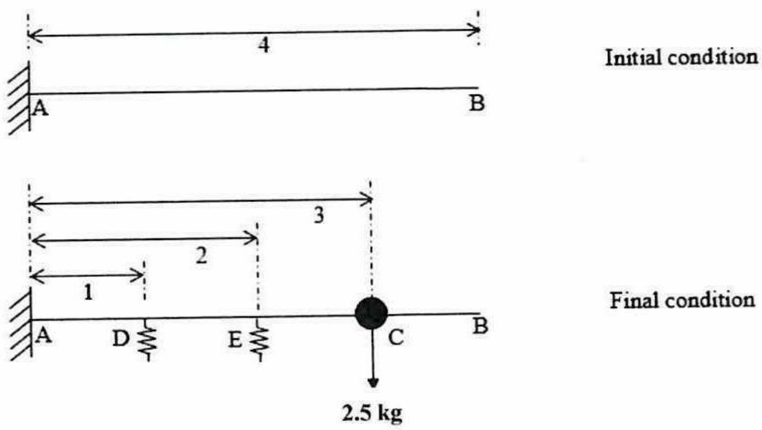


Figure Q6(b)

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