Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	DYNAMICS
COURSE CODE	:	DAM 13903
PROGRAMME CODE	:	DAM
EXAMINATION DATE	:	JULY / AUGUST 2023
DURATION	:	3 HOURS
INSTRUCTIONS	:	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 **SEVEN (7)** PAGES

Q1 (a) Ali is standing at the top of a cliff of height, h. He throws a ball with initial velocity v_0 and hits the ground with velocity v_1. By referring to the kinematic equation :

(i) determine the value of initial displacement s_0, final displacement s_1, initial velocity u, final velocity v, and acceleration a if the positive direction and datum are as in **Figure Q1(a)(i).**

(2.5 marks)

(ii) Determine the value of initial displacement s_0, final displacement s_1, initial velocity u, final velocity v, and acceleration a if the positive direction and datum are as in **Figure Q1(a)(ii).**

(2.5 marks)

(b) A golfer is standing on an elevated hill of 10°. He hits the golf ball with a velocity of 25 m/s at inclined angle of 45° to the elevated hill. Determine the distance d, the ball will land:

(i) using the direction as indicated in **Figure Q1(b)(i)**

(8 marks)

(ii) using the direction as indicated in **Figure Q1(b)(ii)**

(7 marks)

Q2 (a) Draw a circle of radius r indicating:

(i) tangential velocity v, angular velocity ω and angular acceleration α.

(3 marks)

(ii) tangential acceleration a_t, centripetal acceleration a_n and resultant acceleration a.

(3 marks)

(b) A car of mass 1.4 tons is traveling at a curve of radius 185 m. At that instant, the car is traveling at a speed of 80 km/h, which is increasing at a rate of 2 m/s^2. Determine the resultant force experienced by the car at that instant.

(9 marks)

(c) On your holiday in Switzerland, you rode a Bernina Express train as in **Figure Q2(c)**. Determine the radius of curvature, ρ when the train passes point B.

(5 marks)

Q3 (a) A driver of a 2 tons car is resting on an inclined road of 20°. Upon starting the engine of the car, he then increases the speed uniformly to 25 m/s in 30 seconds. If the efficiency of the car is 80%, determine the maximum power that must be supplied by the engine.

(7 marks)

(b) Explain with the aid of a sketch, the reason(s) for work done to extend or compress a spring is $-\frac{1}{2}kx^2$ while the energy to extend or compress a spring is $\frac{1}{2}kx^2$. Given k is the stiffness coefficient of the spring and x is the value of extension or compression.

(6 marks)

(c) **Figure Q3(c)** shows two springs AB and CD with spring stiffness of 400 N/m and 300 N/m respectively. Both springs have an unstretched length of 600 mm and a smooth collar of mass 3 kg in between. A force, F is then applied to the smooth collar. If the smooth collar is only able to move sideways, determine the speed of the collar when it has moved 100 mm.

(7 marks)

Q4 (a) **Figure Q4(a)** shows a gantry structure to test the response of an airplane during a crash. The airplane, having a mass of 6 Mg is hoisted back until θ is 60° and then the cable AC is released while the airplane is at rest. The airplane hits the ground at $\theta = 20°$. Neglecting the size of the airplane and the effect of lift caused by the wings during the motion.

(i) By applying the conservation of energy, explain the value of h_1 and h_2.

(4 marks)

(ii) Determine the velocity of the airplane when it hits the ground.

(5 marks)

(iii) Determine the tension of the cable AC at that instant.

(4 marks)

(b) A crate of 90 kg is tightened using a rope. The rope is then pulled upward on an inclined plane of 45°. At the instant the speed of the crate is 5 m/s, the rope is released. The coefficient of kinetic friction between the crate and the plane, μ_k is 0.2. Using the principle of impulse and momentum, determine the speed of the crate after 2 seconds.

(7 marks)

Q5 (a) Derive tangential acceleration a_t from arc length s.

(4 marks)

(b) A square box is attached to a cord that is wound around a frictionless pulley as in **Figure Q5(b).** If the square box moves from rest with an acceleration of 6 m/s^2, determine the angular acceleration and angular velocity of the pulley after 10 revolutions.

(6 marks)

(c) A circular cam is rotating anticlockwise at point O as illustrated in **Figure Q5(c)**. In its rotation, it causes plate C to move sideways. At an instant $\theta = 30°$, the cam is rotating at an angular velocity of 5 rad/s and angular acceleration of 3 rad/s^2.

(i) Show that at any value θ, the movement of plate C in x direction is $x = 0.15 + 0.12 \sin\theta$.

(2 marks)

(ii) Determine the velocity and the acceleration of plate C in the x - direction at $\theta = 30°$.

(8 marks)

Q6 (a) Explain the following terms:

(i) relative displacement $r_B = r_A + r_{B/A}$

(2 marks)

(ii) relative velocity $v_B = v_A + \omega \times r_{B/A}$

(2 marks)

(iii) relative acceleration $a_B = a_A + \alpha \times r_{B/A} - \omega^2 r_{B/A}$

(3 marks)

(iv) relative velocity $v_B = v_A + \omega \times r_{B/IC}$

(3 marks)

(b) **Figure Q6(b)** shows a crank system that consists of slider block C, bar BC and bar AB. At the instant, bar AB has an angular velocity, ω_{AB} of 6 rad/s rotating about point A. Determine the velocity of slider block C at that instant.

(10 marks)

Q7 A uniform hollow cylinder of mass, $m = 8$ kg has an outer radius, $R = 0.8$ m and an inner radius, $r = 0.4$ m. The cylinder is released from rest at the top of a plane that is declined at 30° to the horizontal surface. The coefficient of static and dynamic friction between the cylinder and the declined plane are $\mu_s = 0.3$ and $\mu_k = 0.15$ respectively. The moment of inertia of the cylinder is $\frac{1}{2}m(R^2 - r^2)$.

(a) Explain the coefficient of static friction μ_s and coefficient of dynamics friction μ_k.

(2 marks)

(b) Sketch the uniform hollow cylinder indicating the line of the moment of inertia and explain the reason for the line to be as stated.

(3 marks)

(c) Determine whether the cylinder rotates or slips when it is released.

(12 marks)

(d) Determine the linear and angular acceleration of the cylinder.

(3 marks)

- END OF QUESTIONS –

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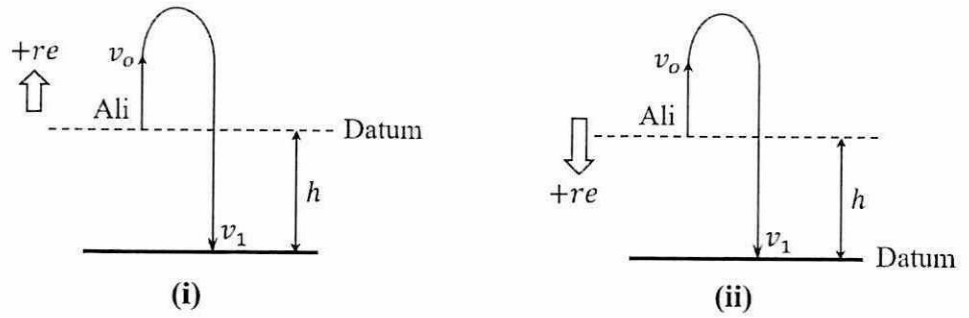

Figure Q1(a)

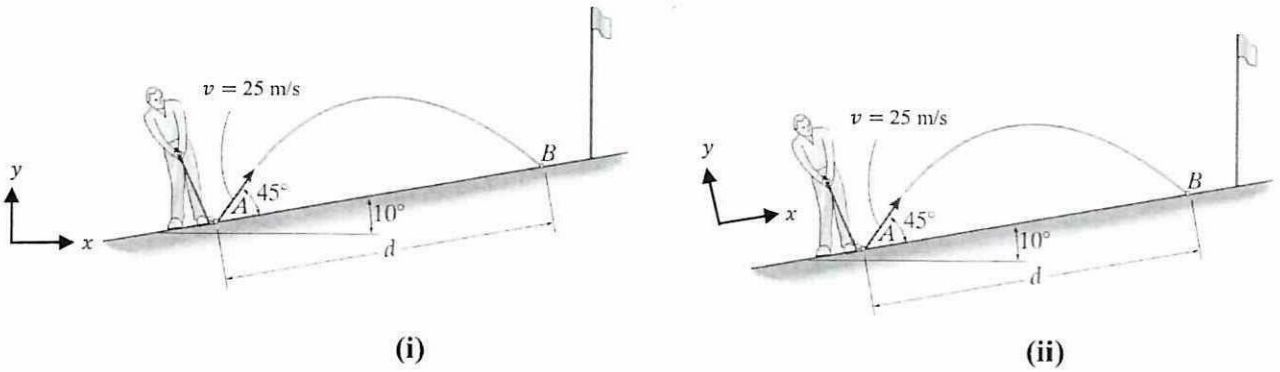

Figure Q1(b)

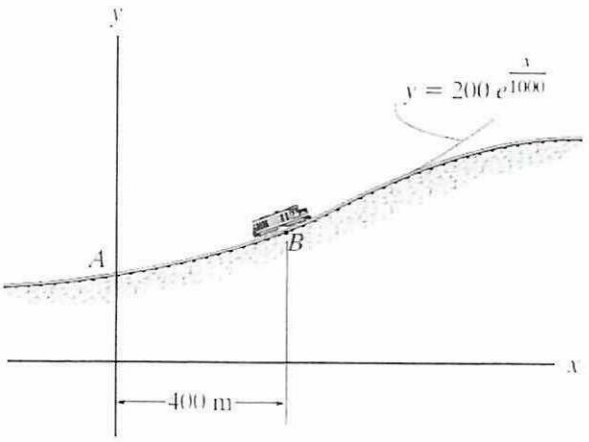

Figure Q2(c)

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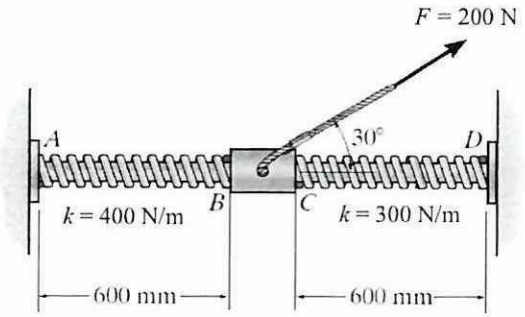

Figure Q3(c)

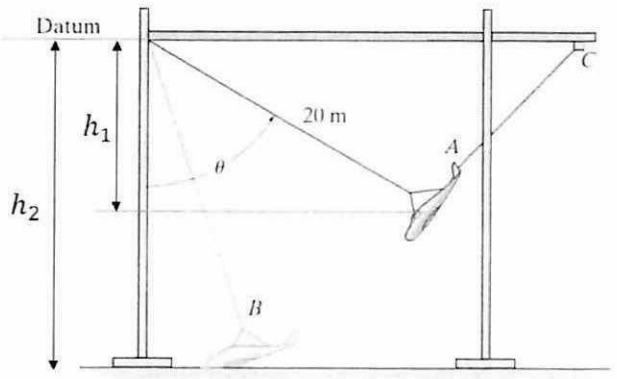

Figure Q4(a)

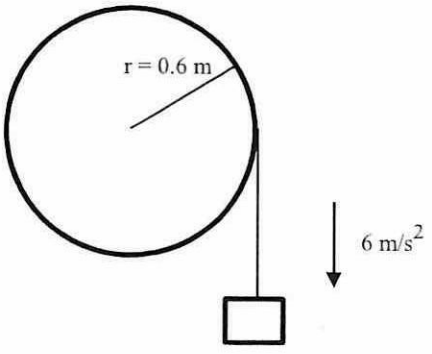

Figure Q5(b)

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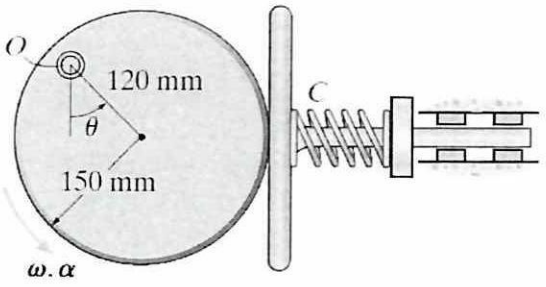

Figure Q5(c)

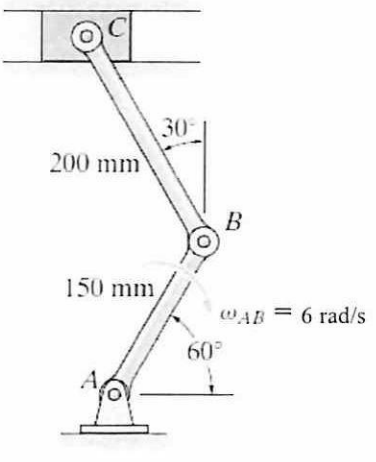

Figure Q6(b)