Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	DYNAMICS
COURSE CODE	:	DAM 13903
PROGRAMME CODE	:	DAM
EXAMINATION DATE	:	JULY 2024
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER **FIVE (5)** QUESTION ONLY 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ 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) A ball is thrown upward at an angle of 45° above the horizontal with an initial speed of 30 m/s. Assume $g = 9.81$ m/s².

(i) Compute the horizontal and vertical components of the initial velocity.

(4 marks)

(ii) Determine the total time of flight and the horizontal range of the projectile.

(4 marks)

(ii) Compute the maximum height reached by the projectile.

(4 marks)

(b) A motorcycle is navigating a circular turn with a radius of curvature of 40 m. The motorcycle has a mass of 250 kg and is moving at a constant speed of 15 m/s.

(i) Calculate the centripetal acceleration and the centripetal force exerted on the motorcycle.

(4 marks)

(ii) Explain the concept of a banked curve in road design and relate three (3) factors that influence the banking angle of a road.

(4 marks)

Q2 (a) Define dependent motion in engineering mechanics and provide an example to explain it.

(5 marks)

(b) A 600 kg roller coaster starts from rest at a height of 40 m. It travels down the track and encounters a loop with a radius of 20 m. Neglecting friction, calculate the speed of the roller coaster at the bottom of the loop.

(5 marks)

(c) Two cars collided at an intersection. Car *A* has a mass of 1200 kg and is moving with a velocity of 20 m/s to the right. Car *B* has a mass of 1000 kg and is stationary. After the collision, the two cars move together. Calculate the final velocity of the combined system.

(5 marks)

(d) Two ice skaters, initially at rest on a frictionless surface, push off each other. If one skater has a mass of 80 kg and moves away with a velocity of 3 m/s, calculate the velocity of the other skater which has a mass of 120 kg, assuming conservation of momentum.

(5 marks)

Q3 (a) Explain the practical applications of the impulse-momentum theorem in physics, engineering, and sports, providing examples of its impact.

(6 marks)

(b) The 4.5 kg cannon is horizontally fired by a 227 kg cannon, as depicted in **Figure Q3.1**. If the muzzle velocity of the bullet measures 610 m/s relative to the ground. Additionally, if the cannon is resting on a smooth support and needs to be stopped after recoiling a distance of 15.24 cm.

Figure Q3.1

(i) Using the principle of Conservation of Linear Momentum, determine the recoil velocity of the cannon just after firing.

(6 marks)

(ii) Determine the required stiffness k of the three identical springs-one on the right, one on the left, and one below-each of which is originally unstretched.

(8 marks)

Q4 (a) Angular Acceleration is defined as the time rate of change of angular velocity.

(i) Define angular acceleration in the context of planar kinematics.

(3 marks)

(ii) Based on answer Q4(a)(i), explain how it relates to the rate of change of angular velocity.

(3 marks)

(b) The angular acceleration of the disk as shown in **Figure Q4.1** is defined by the $\alpha = 3t^2 + 12$ rad/s^2, where t is in seconds. If the disk is originally rotating at $\omega_0 = 12$ rad/s, determine the magnitude of the velocity and the tangential and normal components of the acceleration of point A on the disk when $t = 2$ s.

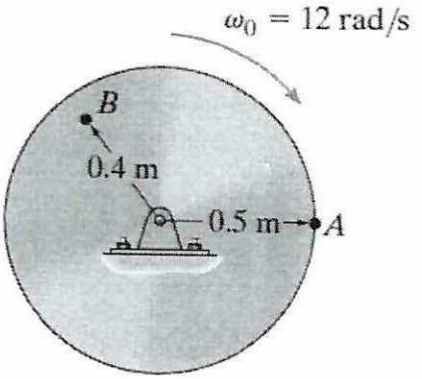

Figure Q4.1

(6 marks)

(c) As illustrated in **Figure Q4.2**, at the instant $\omega_A = 5$ rad/s, pulley A is given an angular acceleration $\alpha = (0.8\theta)$ rad/s^2, where θ is in radians. Determine the magnitude of acceleration of point B on pulley C when A rotates 3 revolutions. Pulley C has an inner hub that is fixed to its outer one and turns with it.

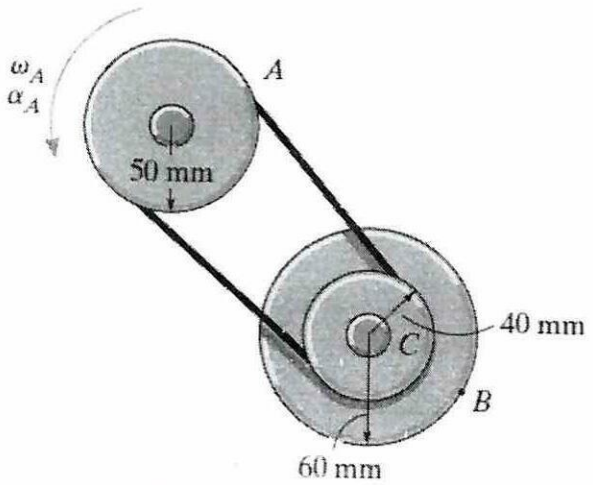

Figure Q4.2

(8 marks)

Q5 (a) Describe reaction forces, and how do they relate to Newton's law of motion.

(4 marks)

(b) The paraboloid is formed by revolving the shaded area around the x-axis as shown in **Figure Q5.1**. Determine the radius of gyration, k_x. The density of the material is $\rho = 5.5$ Mg/m^3.

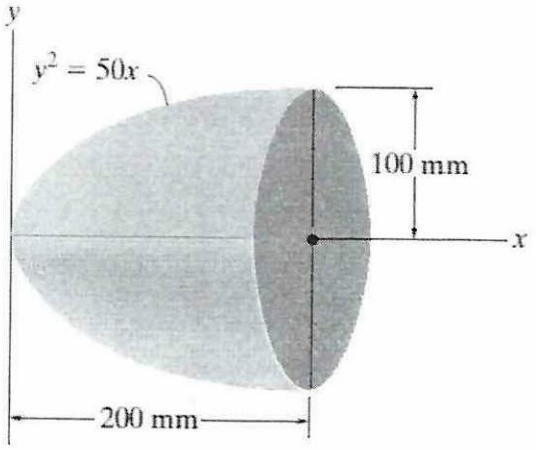

Figure Q5.1

(6 marks)

(c) A force of $P = 300$ N is applied to the 60 kg cart as depicted in **Figure Q5.2**. Determine the reactions at both the wheels at A and both the wheels at B. Also, what is the acceleration of the cart. The mass center of the cart is at G.

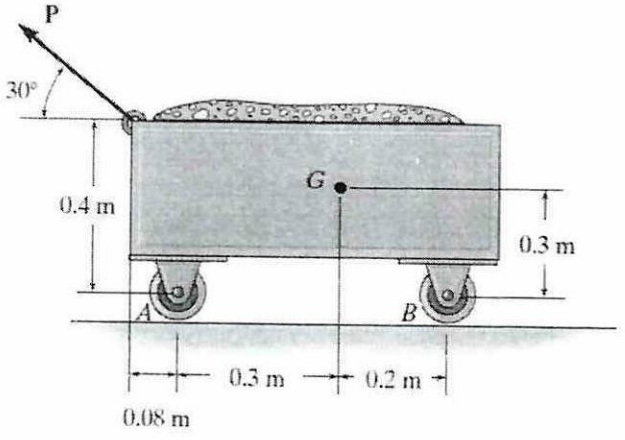

Figure Q5.2

(10 marks)

Q6 (a) Define and explain the concept of moment of inertia for a rigid body.

(4 marks)

(b) **Figure Q6.1** shows a pendulum comprised of the 2 kg slender rod and the 6 kg thin plate. It also provides information on the moment of inertia of the rod, I_r and the plate, I_p. The distance between the center of gravity of the pendulum, G to the point O is given by x.

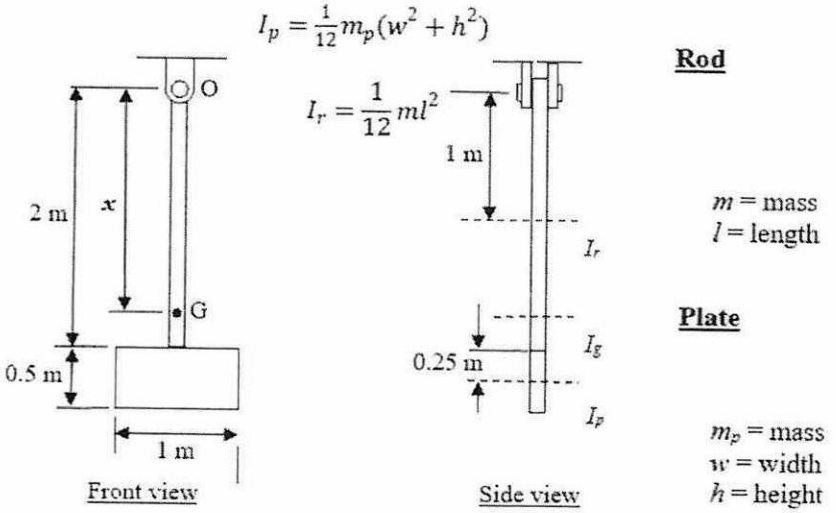

Figure Q6.1

(i) Determine the distance x by using the principle of centroid.

(3 marks)

(ii) Calculate the moment of inertia of the pendulum, I_g that passing through G.

(5 marks)

(c) The car shown in **Figure Q6.2** has a mass of 2 Mg and a center of mass at G. The rear "driving" wheels are always slipping, whereas the front wheels are free to rotate. Neglect the mass of the wheels. The coefficient of kinetic friction between the wheels and the road is 0.25.

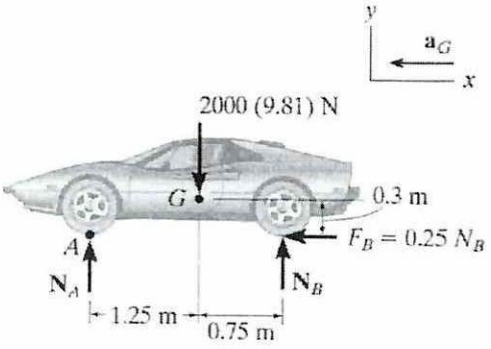

Figure Q6.2

(i) With a help of sketch, explain the reason for the friction F_B to have the same direction with the movement of the car.

(2 marks)

(ii) Compute the acceleration of the car.

(6 marks)

- END OF QUESTIONS -