Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	ENGINEERING MECHANICS
COURSE CODE	:	BDX 10603
PROGRAMME CODE	:	BDX
EXAMINATION DATE	:	JULY 2024
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER ALL QUESTIONS 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 **FIVE (5)** PAGES

Q1 (a) A ball of mass 0.2 kg is dropped from a height of 3.0 m above the horizontal ground and bouncing at a height of 2.0 m. by stating assumptions you made, find:

i. The coefficient of restitution between the ball and the ground

(5 marks)

ii. Calculate the loss in mechanical energy caused by the impact with the ground and suggest a possible explanation for this loss.

(5 marks)

(b) A sphere of mass 3.0 kg at the time of collision has a velocity 3 m/s and collides head on with identical sphere of mass 1.5 kg which travelled at a speed of 2 m/s which results in the direction of lighter sphere being reversed in direction and its speed become 3.5 m/s. Calculate;

i. The speed of the heavier sphere after collision

(1 mark)

ii. The coefficient of restitution between the spheres

(1 mark)

iii. The loss in kinetic energy after the impact

(2 marks)

iv. What can you deduce from the answer in (ii) and (iii)

(3 marks)

v. State the assumption that has been made

(3 marks)

Q2 (a) James is preparing his horse to perform in a ring. During the training James is holding at one end of the extensible rope and the other end on his horse's bridle. The rope has unstretched length of 9 m and a modulus of elasticity of 700 N.

i. If the horse trotting at a steady speed of 3 m/s in a circle of the radius 12 m, find the tension in the rope and the horse's mass

(4 marks)

ii. The rope obey the Hooke's Law if the extension is not exceeded 3.5 m, find the greatest speed of the horse that can be achieved if the Law should not be broken.

(6 marks)

(b) On a level section of a race track, a car can just go round a bend of radius 100 m at a speed of 30 m/s without skidding.

i. Find the coefficient of friction between the car and the race track. Taking g as 10 m/s^2

(2 marks)

On a section of the track that is banked at an angle θ to the horizontal a speed of 40 m/s can just be reached without skidding, from the calculated coefficient of friction above,

ii. Show that $\frac{90\cos\theta+100\sin\theta}{10\cos\theta-9\sin\theta} = 16$

(6 marks)

iii. Find θ to the nearest degree

(2 marks)

Q3 (a) The **figure Q3.1** shows two objects A and B of mass 3m and 2m respectively connected by light inextensible string which passes over a smooth fixed pulley at the edge of a horizontal table. Object B is hanging freely at the height ***h*** above the floor. The A is then released from rest and experienced a retarding force due to friction of magnitude 1/3 mg. Object A doesn't reach the edge of the table at the time B reach the floor. Prove that at the instant when B reaches the floor, the speed of A is:

$$\sqrt{\left(\frac{2gh}{3}\right)}$$

Demonstrate that the length of the string must exceed 4h, given that after B impacts the floor, A continues its motion along the table but eventually comes to a halt before reaching the edge.

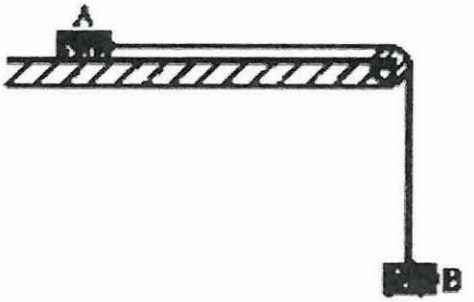

Figure Q3.1

(10 marks)

(b) A light elastic spring of length 2m and modulus of elasticity 7 N has one end fixed to a point A and the other end is attached to a ball weight 1 kg and was freely hanged at point C below point A.

i. Calculate distance AC

(1 mark)

The ball is then raised to a distance 2m below A and released form the rest, calculate

ii. The velocity of the ball as it passes the point C

(2 marks)

iii. The distance of the ball below A when it comes first to rest.

(3 marks)

iv. How does changing the length of the spring affect its elastic properties and behaviour?

(4 marks)

Q4 (a) A particle travelling between point P and Q with simple harmonic motion. If the distance PQ is 6m and the maximum acceleration is 16m/s2. Find the time taken to travel

i. A distance 1.5m from P

(2 marks)

ii. From P to the midpoint PQ

(2 marks)

iii. From the midpoint PO to OQ

(2 marks)

(b) A particle move with simple harmonic motion between two points A and B. the period of one oscillation is 12 seconds. The particles start from A and after 2 second has reached a point distant 0.5m from A. Find

i. the amplitude of the motion

(2 marks)

ii. the maximum acceleration

(2 marks)

iii. the velocity 4 seconds after leaving A

(2 marks)

(c) An object performing simple harmonic motion (SHM) with amplitude 0.8 m about fixed point O. A and B are two points on the path of the object such that OA and OB are 0.6 m and 0.4 m respectively. If the object takes 2 second to travel from A to B, the periodic time of the SHM if

i. A and B are on the same side of O

(2 marks)

ii. A and B are on the opposite side of O

(2 marks)

(d)

The prongs of the tuning fork which sound middle C, are vibrating at a rate of 256 oscillations per second. Assuming that the motion of the prongs is simple harmonic and that the amplitude of the end of a prong is 0.1mm, find

i. The maximum velocity and the maximum acceleration of the end of the prong

(2 marks)

ii. The velocity and the acceleration of the end of a prong when its displacement from the centre of its path is 0.05mm

(2 marks)

Q5 (a) The **figure Q5.1** shows the shape of sliding playground. The section DE is straight, and BCD is a circular arc of radius 5 m. C is the highest point of the arc and CD subtends an angle of 30° at the centre. By neglecting any resistance to motion, calculate

i. The child's speed as it passes through C, given that it is on the point of losing contact at C

(2 marks)

ii. The child's speed as it passes through D, given that it is on the point of losing contact at D

(2 marks)

iii. The greatest possible height of the A above the level D if the child start from rest and not losing contact at any point on the sliding playground.

(2 marks)

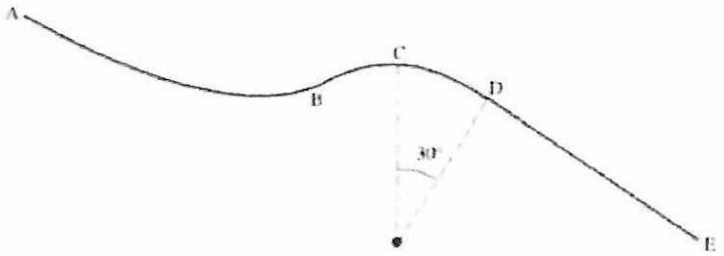

Figure Q5.1

(b) A launch is travelling with velocity 20i + 15j and the velocity of a pleasure boat is 10i – 4j. Calculate

(i) The velocity of the launch relative to the pleasure boat

(2 marks)

(ii) The velocity of the pleasure boat relative to the launch.

(2 marks)

(c) A particle P starts from rest at the origin when t=0, and moves along the positive x-axis with an acceleration of ½ ti after t seconds. A second particle Q starts to move form point (3,0) with constant velocity of 3i + 4j. Calculate

i. The velocity vector and the position vector of P after t seconds.

(2 marks)

ii. The velocity vector and the displacement vector Q after t seconds

(2 marks)

iii. What is the velocity of Q relative to P when t=4?

(3 marks)

iv. What is the displacement of Q relative to P when t=4?

(3 marks)

- END OF QUESTIONS -