Second Semester Examination
2022/2023 Academic Session

July 2023

EMM 252 – Engineering Dynamics
(Dinamik Kejuruteraan)

Duration: 3 hours
(Masa: 3 Jam)

Please check that this examination paper consists of SIX (6) pages of printed material before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi ENAM (6) muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

Instructions: Answer ALL **FIVE (5)** questions.

*[**Arahan**: Jawab SEMUA **LIMA (5)** soalan]*

...2/-

1. (a) Figure 1 (a) shows a particle released with a velocity of 50 m/s at 30 degrees from the horizontal and landed on a bunker with a 45 degrees slope. The bunker is located 40m from the point of launch of the particle. Calculate the distance s.

(40 marks)

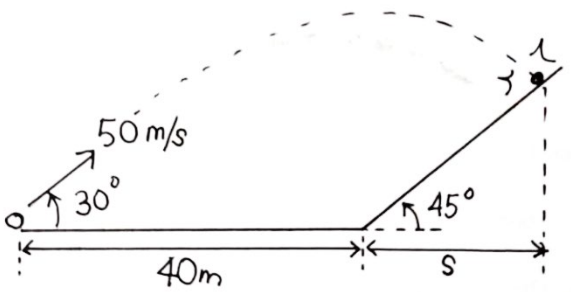

Figure 1 (a)

(b) Figure 1(b) below shows a slider A moving in a slot on a disc rotating at an angular velocity ω of 4 rad/s counter clock wise and angular acceleration $\dot{\omega}$ of 4 rad/s^2 clock wise. At the instance shown the slider A is moving in the slot at a velocity of 5m/s in the increasing radius direction and accelerating at 2 m/s^2 in the direction of increasing radius at a distance r of 0.8 m. Calculate the velocity and acceleration of the slider A in the r - θ coordinate.

(60 marks)

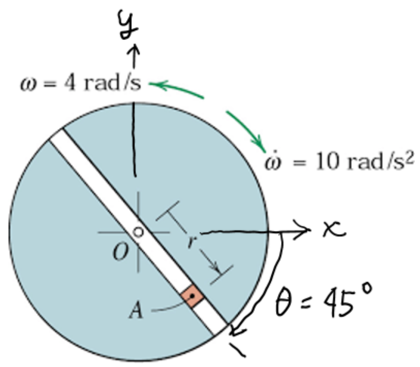

Figure 1 (b)

...3/-

2. Figure 2 shows a crank slider mechanism where the crank OA with a length r of 200 mm is rotating a constant angular speed ω of 1200 rpm counter clock wise and driving the connecting rod AB with a length L of 400 mm. At the instance shown, θ is 45 degrees, calculate the following:

   (i) angular velocity of the connecting rod AB **(30 marks)**

   (ii) velocity of the piston B **(30 marks)**

   (iii) angular acceleration of the connecting rod AB **(20 marks)**

   (iv) acceleration of the piston B **(20 marks)**

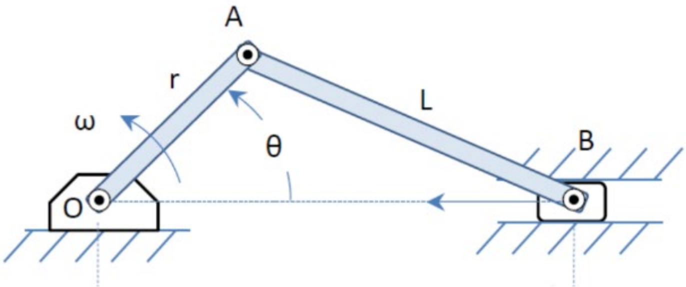

Figure 2

3. Figure 3 shows an arm AB with a slot with a slider C moving inside it. At the same time the slider C is pinned to the 40 cm long arm CD which is at 45 degrees from the horizon. Distance between the support points of A and D is 60 cm. At the instance shown, the arm CD is rotating with angular velocity of 2 rad/s and angular acceleration 0.4 rad/s^2, both in the counter clock wise direction. Using the rotating axes *x*-*y*, determine the following

   (i) Velocity of slider C **(20 marks)**

   (ii) Angular velocity of arm AB **(40 marks)**

   (iii) Angular acceleration of arm AB **(40 marks)**

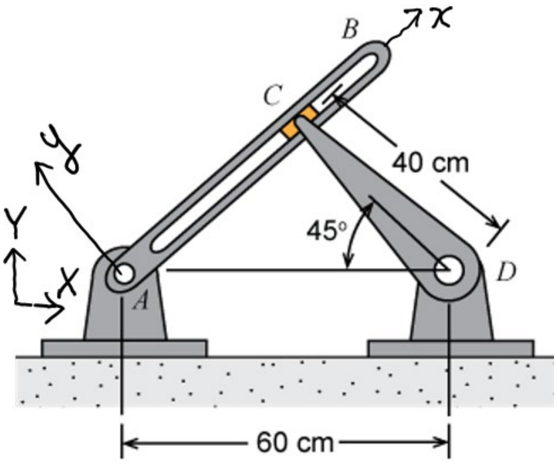

Figure 3

4. The 20 kg slender rod shown in Figure 4 is rotating counter clockwise in a vertical plane about a smooth pin at *A*. At the position shown, the angular velocity, ω of the rod is 8 rad/s. At this instant:

   (i) Draw the free body diagram and kinetic diagram of the rod.

   (ii) Determine the angular acceleration, α of the rod.

   (iii) Determine the magnitude of the normal and tangential reactive forces exerted on pin at *A.*

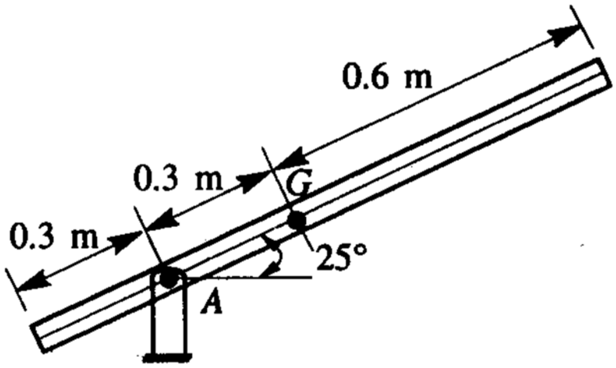

Figure 4

(100 marks)

5. (a) Figure 5 (a) portrays a woodpecker in the process of drilling a hole in a tree, which involves a series of rapid and repetitive strikes on a tree trunk with its powerful beak. Based on the principle of linear impulse and momentum, and with the help of a sketch, describe how the woodpecker can avoid brain injury while pecking for its survival.

Figure 5 (a)

(40 marks)

...5/-

(b) Figure 5 (b) represents a slender 5 kg rod that can rotate in a vertical plane about a pivot at B. A spring of a constant k of 500 N/m and unstretched length of 150 mm is attached to the rod. Knowing that the rod is released from rest in the position shown, determine its angular velocity after it has rotated through 90 degrees.

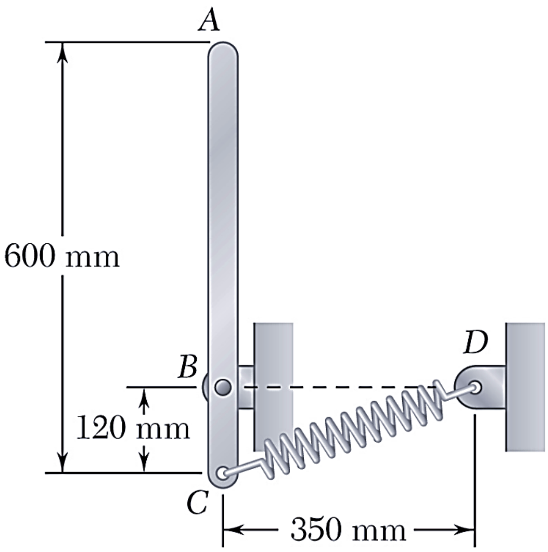

Figure 5 (b)

(60 marks)

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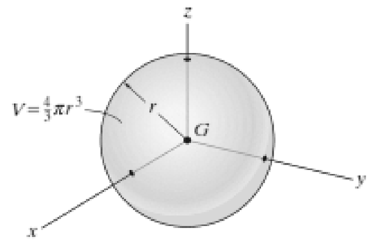
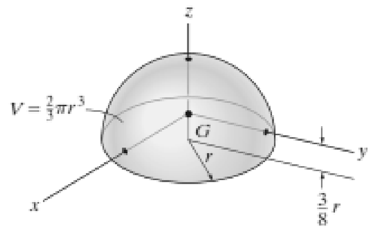
APPENDIX 1

Center of Gravity and Mass Moment of Inertia of Homogeneous Solids



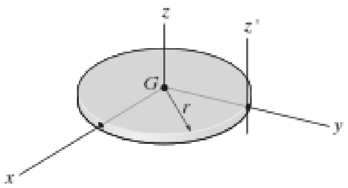
Sphere

$$I_{xx} = I_{yy} = I_{zz} = \frac{2}{5}mr^2$$



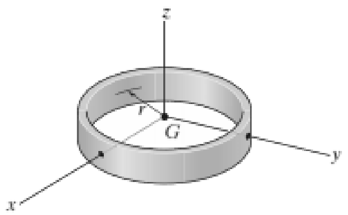
Hemisphere

$$I_{xx} = I_{yy} = 0.259\,mr^2 \quad I_{zz} = \frac{2}{5}mr^2$$



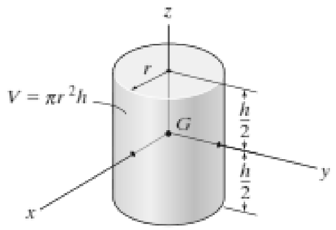
Thin Circular disk

$$I_{xx} = I_{yy} = \frac{1}{4}mr^2 \quad I_{zz} = \frac{1}{2}mr^2 \quad I_{z'z'} = \frac{3}{2}mr^2$$



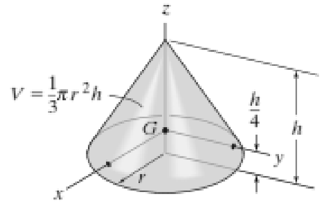
Thin ring

$$I_{xx} = I_{yy} = \frac{1}{2}mr^2 \quad I_{zz} = mr^2$$



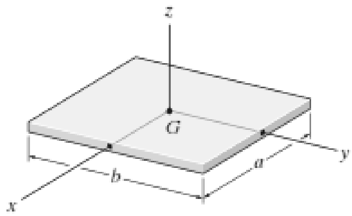
Cylinder

$$I_{xx} = I_{yy} = \frac{1}{12}m(3r^2 + h^2) \quad I_{zz} = \frac{1}{2}mr^2$$



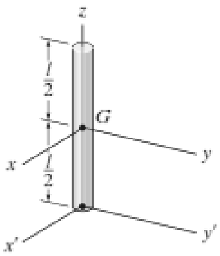
Cone

$$I_{xx} = I_{yy} = \frac{3}{80}m(4r^2 + h^2) \quad I_{zz} = \frac{3}{10}mr^2$$



Thin plate

$$I_{xx} = \frac{1}{12}mb^2 \quad I_{yy} = \frac{1}{12}ma^2 \quad I_{zz} = \frac{1}{12}m(a^2 + b^2)$$



Slender Rod

$$I_{xx} = I_{yy} = \frac{1}{12}ml^2 \quad I_{x'x'} = I_{y'y'} = \frac{1}{3}ml^2 \quad I_{z'z'} = 0$$