Second Semester Examination
2021/2022 Academic Session

July/August 2022

EMM 252 – Engineering Dynamics
(Dinamik Kejuruteraan)

Duration: 2 hours
(Masa : 2 jam)

Please check that this examination paper consists of FIVE (5) pages of printed material before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi LIMA (5) muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

Instructions : Answer **FOUR (4)** questions.

*[**Arahan**: Jawab **EMPAT (4)** soalan.]*

1. Figure 1 below shows a four bar linkage. For the position shown the following data are given;

   OA = 100mm, AB=150mm and the angle θ_2 = 75 degree; θ_3 = 30 degree and θ_4 = 103 degree. At the position shown the arm OA is rotating at constant speed of 40 rpm clockwise. Using the kinematics of rigid bodies determine the following

   (a) length of the arm BC

   (b) the velocity of points A and B and the angular velocity of link AB and BC

   (c) the acceleration of points A and B and the angular acceleration of link AB and BC

(100 marks)

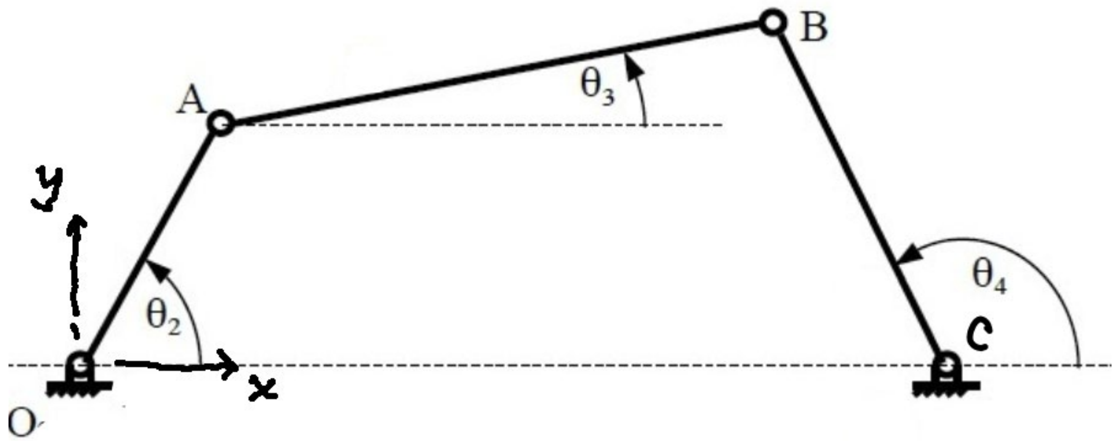


Figure 1

2. (a) A device is designed to test the wear of a slider in a slot with the mechanism shown in figure 2 below. Arm *CD* is rotating at 4 rad/sec in the counter clockwise direction with the block C pinned to the arm CD and slides in the slot of bar *AB*. By using the rotating axes approach where the x-y axes are rotating together with the arm CD where the y-axis is in the DC direction, determine the angular velocity of bar *AB* for the instant shown.

(70 marks)

   (b) State THREE changes that can be carried out on the device shown in figure 2 to reduce the energy consumption and explain the reasons why these changes can be effective

(30 marks)

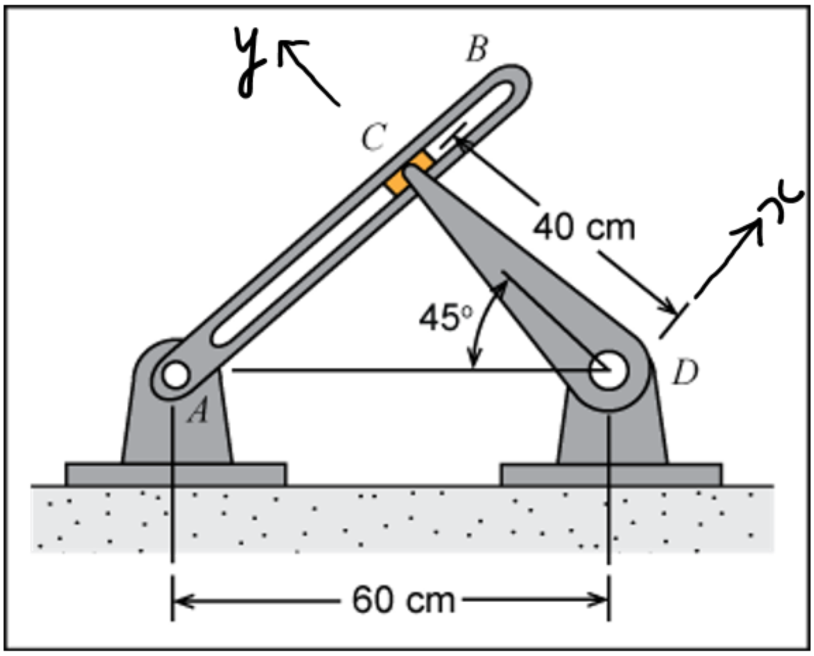


Figure 2

3. The assembly shown in Figure 3 consists of a homogeneous slender rod 1 that is rigidly coupled to a homogeneous sphere 2. The assembly is rotating in the vertical plane about the pin at O. Neglect the friction at O. When the assembly is in the position where θ= 30°, its angular velocity, ω is 1.2 rad/s clockwise. Given, L= 800 mm, m_1= 30 kg, m_2= 80 kg, and R= 200 mm. At this instant:

(i) Sketch the free body diagram and kinetic diagram of the assembly.

(ii) Determine the angular acceleration, *α* of the assembly.

(iii) Determine the magnitude of resultant reaction force acting on pin at *O.*

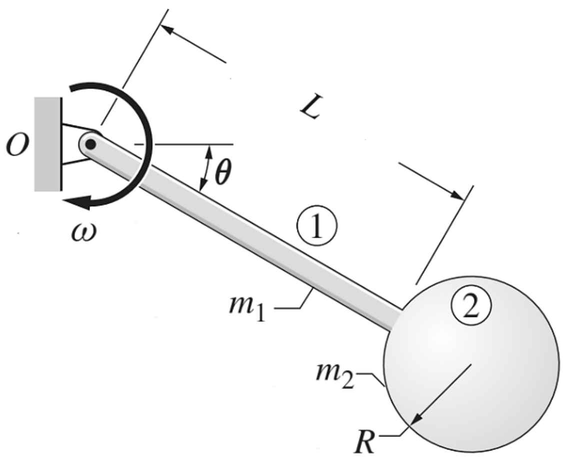


Figure 3

(100 marks)

4. (a) Figure Q4(a) shows American footballers using personal protective equipment (PPE) in action during a competitive match. Based on the principle of linear impulse and momentum, explains how PPE can reduce concussion or injury among American footballers.

Figure Q4 (a)

(35 marks)

(b) Figure Q4(b) represents a thin bar AB with a mass of 10 kg. It is horizontally positioned and the spring is not stretched. Determine the spring's stiffness k so that the bar's motion, due to its own weight, is temporarily stopped when it has rotated 45 degrees clockwise from rest.

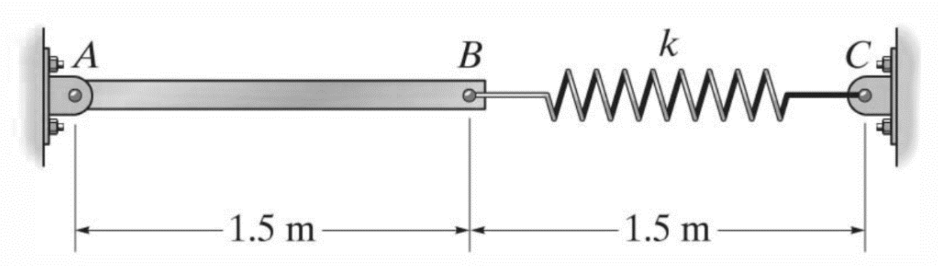


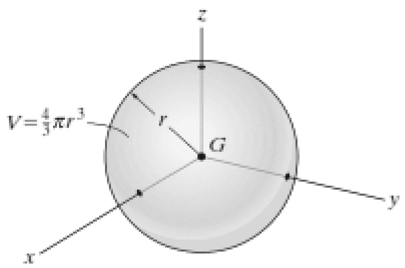
Figure Q4 (b)

(65 marks)

- oooOOOooo -

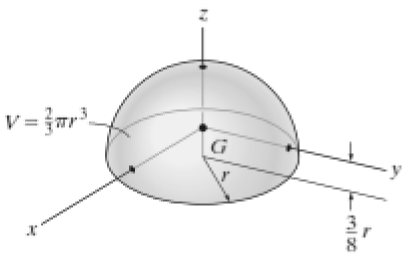
APPENDIX

Center of Gravity and Mass Moment of Inertia of Homogeneous Solids



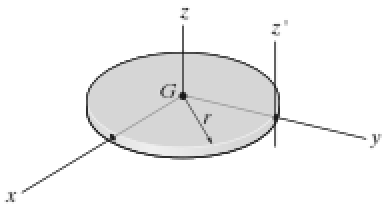
Sphere

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



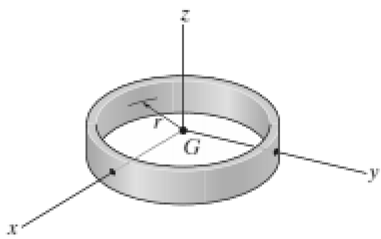
Hemisphere

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



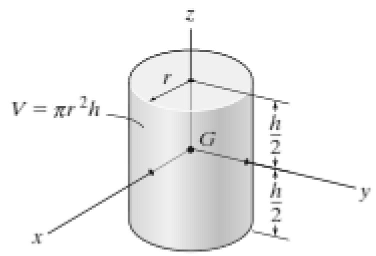
Thin Circular disk

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



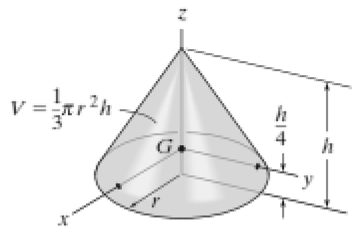
Thin ring

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



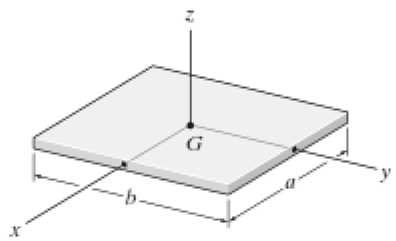
Cylinder

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



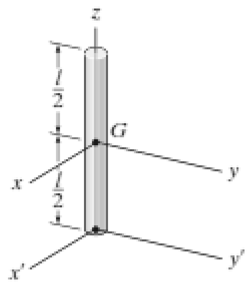
Cone

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



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

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