Program: B. Sc. in ME
Semester: 2nd

Date: 15 May, 2024
Time: 10:00 am – 01:00 pm
(Group B - Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Semester Final Examination — **Summer Semester: A.Y. 2022 - 2023**
Course Code: ME 4203 — **Time : 03 Hours**
Course Title: Dynamics — **Full Marks : 150**

There are 06 (Six) Questions. Answer all of them.

Each question carries equal marks. Symbols have their usual meanings. Draw the free body diagram if required. The right column also indicates the course objective (CO) and Program Outcomes (PO) addressed by each question. Assume reasonable values for missing data.

1 **(a)** Car B is traveling a distance **d** ahead of car A. Both cars are traveling at **60 ft/s** when the driver of B suddenly applies the brakes, causing his car to decelerate at **12 ft/s²**. It takes the driver of car A **0.75 s** to react (this is the normal reaction time for drivers). When he applies his brakes, he decelerates at **12 ft/s²**. Determine the minimum distance d between the cars so as to avoid a collision. **12.5** **(CO1)** **(PO2)**

Figure 1(a)

(b) The motion of a jet plane just after landing on a runway is described by the **a–t** graph. Determine the time **t′** when the jet plane stops. Construct the **v–t** and **s–t** graphs for the motion. Here **s = 0**, and **v = 300 ft/s** when **t = 0**. **12.5** **(CO1)** **(PO2)**

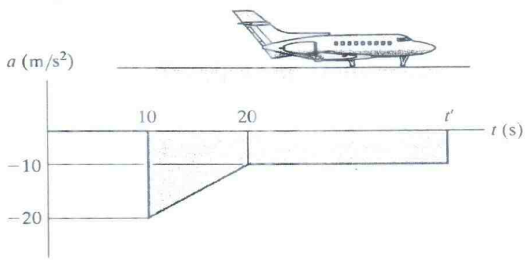

Figure 1(b)

2 **(a)** The sports car is traveling along a **30°** banked road having a radius of curvature of **ρ = 500 ft**. If the coefficient of friction between the tires and the road is **μ = 0.2**, determine the maximum safe speed so no slipping occurs. Neglect the size of the car. **7** **(CO2)** **(PO2)**

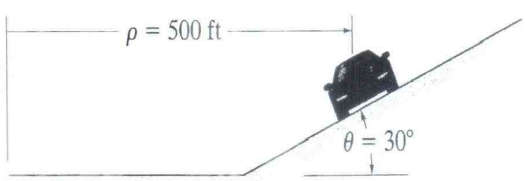

Figure 2(a)

(b) The **10-kg block** *A* rests on the **50-kg plate** *B* in the position shown. Neglecting the mass of the rope and pulley, and using the coefficients of kinetic friction indicated, determine: **18**

i) The acceleration of object A and B. **(CO2)**

ii) Tension acting on the cord **(PO2)**

iii) The time needed for block A to slide 0.5 m on the plate when the system is released from rest

When P=15 N is acting on B at 40°.

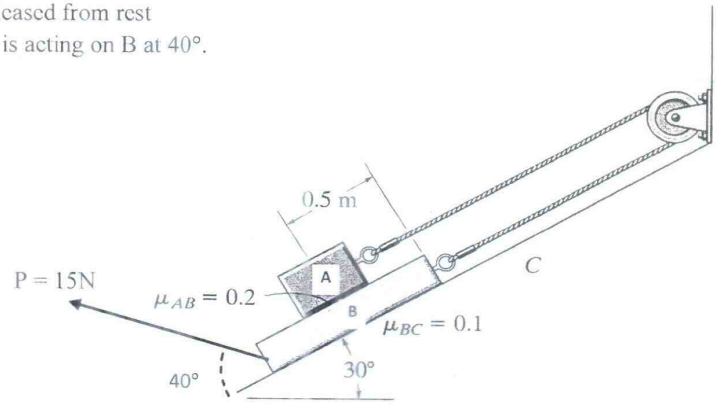

Figure 2(b)

3 (a) Determine the velocity of the **60 lb block A** if the two blocks are released from rest and the **40 lb block B** moves **2 ft** up the incline. The coefficient of kinetic friction between both blocks and the inclined planes is μ_k**=0.10**. **12.5** **(CO3)** **(PO2)**

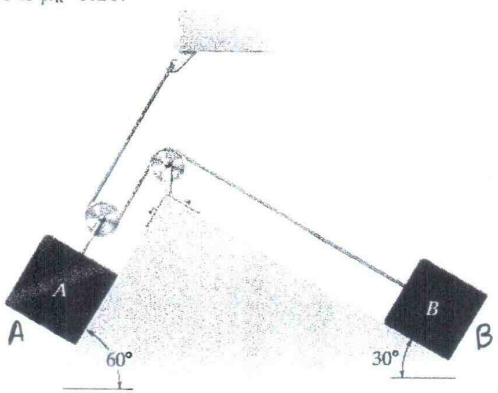

Figure 3(a)

(b) The **25-lb** block has an initial speed of $\mathbf{v_o}$**= 10 ft/s** when it is midway between springs A and B. After striking spring B, it rebounds and slides across the horizontal plane toward spring A. If the coefficient of kinetic friction between the plane and the block is μ_k**=0.4**, determine the total distance travelled by the block before it comes to rest. **12.5** **(CO3)** **(PO2)**

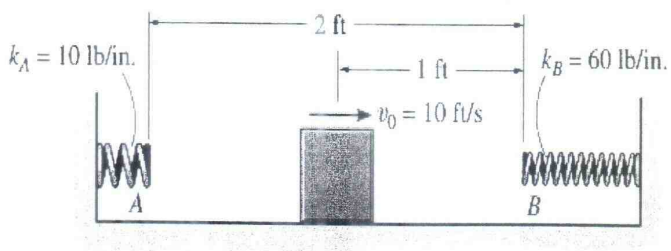

Figure 3(b)

4 (a) The **5 kg** collar has a velocity of **5 m/s** to the right when it is at A. It then travels down along the smooth guide. Determine the speed of the collar when it reaches point B, which is located just before the end of the curved portion of the rod. The spring has an unstretched length of **100 mm** and B is located just before the end of the curved portion of the rod. **12.5 (CO3) (PO2)**

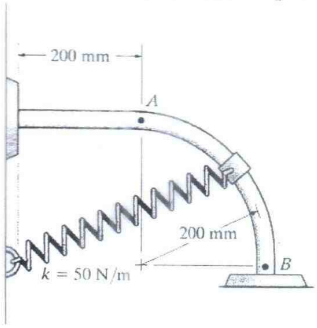

Figure 4(a)

(b) When **s = 0**, the spring on the firing mechanism is unstretched. If the arm is pulled back such that **s = 100** mm and released, determine the speed of the **0.3 kg** ball and the normal reaction of the circular track on the ball when **θ = 60°**. Assume all surfaces of contact to be smooth. Neglect the mass of the spring and the size of the ball. **12.5 (CO3) (PO2)**

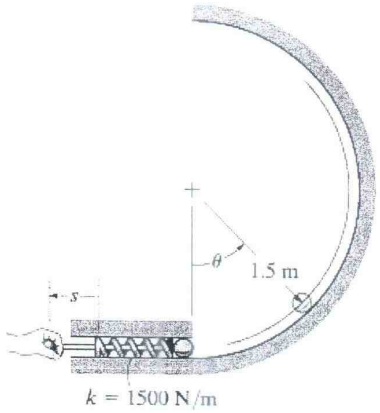

Figure 4(b)

5 (a) The **30-kg** slider block is moving to the left with a speed of **5 ms^{-1}** when it is acted upon by the forces $\mathbf{F}_1$ and $\mathbf{F}_2$. If these loadings vary in the manner shown on the graph, determine the speed of the block at $t = 6$ **s**. Neglect friction and the mass of the pulleys and cords. **12 (CO4) (PO2)**

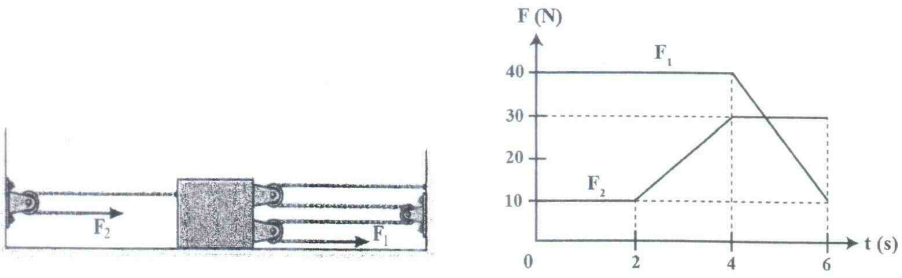

Figure 5(a)

(b) The elastic cord has an unstretched length $l_0 = 1.5$ **ft** and a stiffness $k = 12$ **lb/ft**. It is attached to a fixed point at A and a block at B, which has a weight of **2 lb**. If the block is released from rest from the position shown, **(CO4) (PO2)**

(i) determine its speed when it reaches point C after it slides along the smooth guide.

(ii) Also, calculate the angular momentum of the block about point A, at any instant after it passes point C.

(iii) After leaving the guide, it is launched onto the smooth *horizontal* plane. Determine if the cord becomes unstretched.

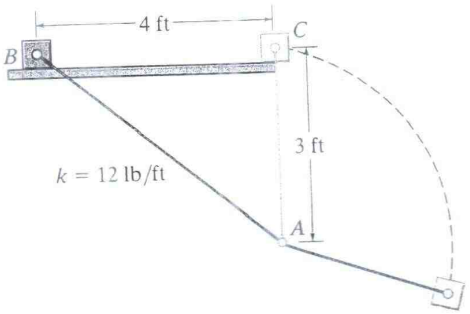

Figure 5(b)

6 (a) A pitching machine throws the **0.5-kg** ball toward the wall with an initial velocity $\mathbf{V}_A = 10$ **ms**$^{-1}$ as shown. **[15] (CO4) (PO2)**

Determine (i) the velocity at which it strikes the wall at B,

(ii) the velocity at which it rebounds from the wall if $e = 0.5$, and

(iii) the distance s from the wall to where it strikes the ground at C.

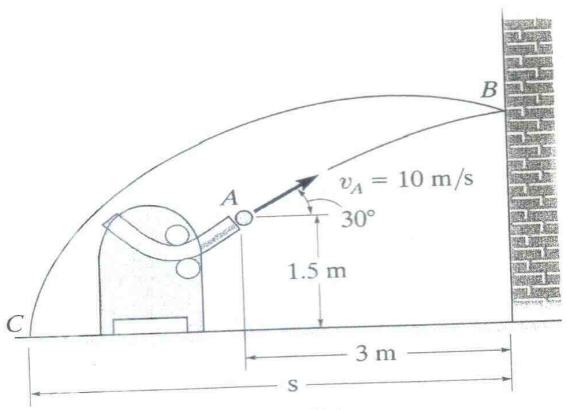

Figure 6(a)

(b) Two identical **10-kg** spheres are attached to the light rigid rod, which rotates in the horizontal plane centered at pin O. If the spheres are subjected to tangential forces of $P = 10$ **N**, and the rod is subjected to a couple moment $M = (8t)$ N.m, where t is in seconds, determine the speed of the spheres at the instant $t = 4$ **s**. The system starts from rest. Neglect the size of the spheres. **[10] (CO4) (PO2)**

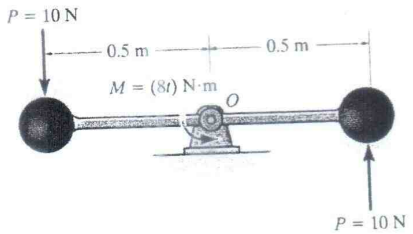

Figure 6(b)