Program: B. Sc. in ME **Date: 3 May, 2023**
Semester: 2nd **Time: 10:00 am – 01:00 pm**

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

Semester Final Examination **Summer Semester: 2021 - 2022**
Course Code: ME 4203 **Full Marks: 150**
Course Title: Dynamics **Time: 3 Hours**

There are **06 (Six)** questions. Answer **all** questions. Marks in the Margin indicate full marks. Don't write on this question paper. Symbols carry their usual meanings. **Assume reasonable values for any missing data**. Programmable calculators are not allowed.

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1. (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 0.10. Use work energy principle to solve this problem. **(10) (CO3) (PO2/PO3)**

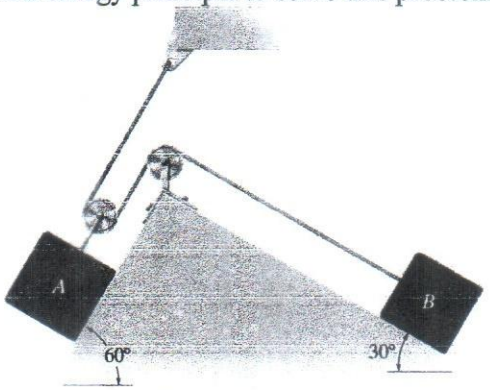

Figure: 1(a)

(b) The motor M of the hoist shown in Fig. 1(b) lifts the 75-lb crate C so that the acceleration of point P is 4 ft/s^2. Determine the power that must be supplied to the motor at the instant P has a velocity of 2 ft/s^2. Neglect the mass of the pulley and cable and take efficiency $\in$= 0.85. **(8) (CO3) (PO2/PO3)**

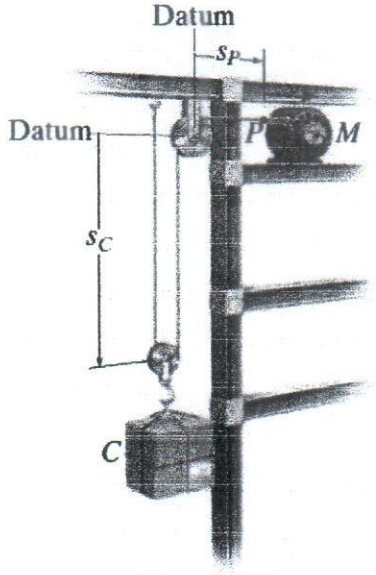

Figure: 1(b)

(c) The 30-lb block A is placed on top of two nested springs B and C and then pushed down to the position shown. If it is then released, determine the maximum height h to which it will rise. Use conservation of energy principle to solve this problem. **(7) (CO3) (PO2/PO3)**

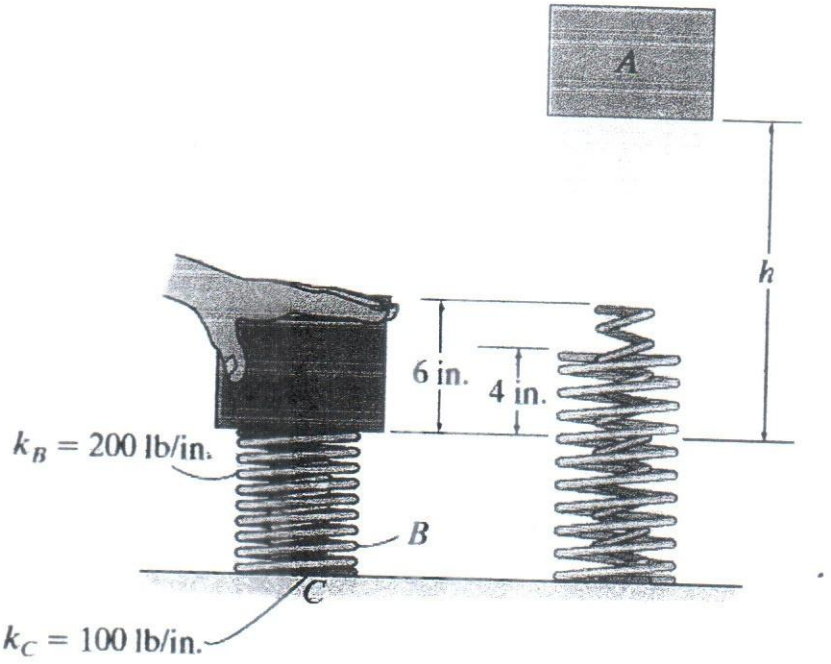

Figure 1(c)

2. (a) Determine the distance the load W is lifted in using the hoist. The shaft of the motor M turns with an angular velocity $\omega = 100\,(4 + t)$ rad/s, where t is in seconds. **(15) (CO1) (PO1/PO2)**

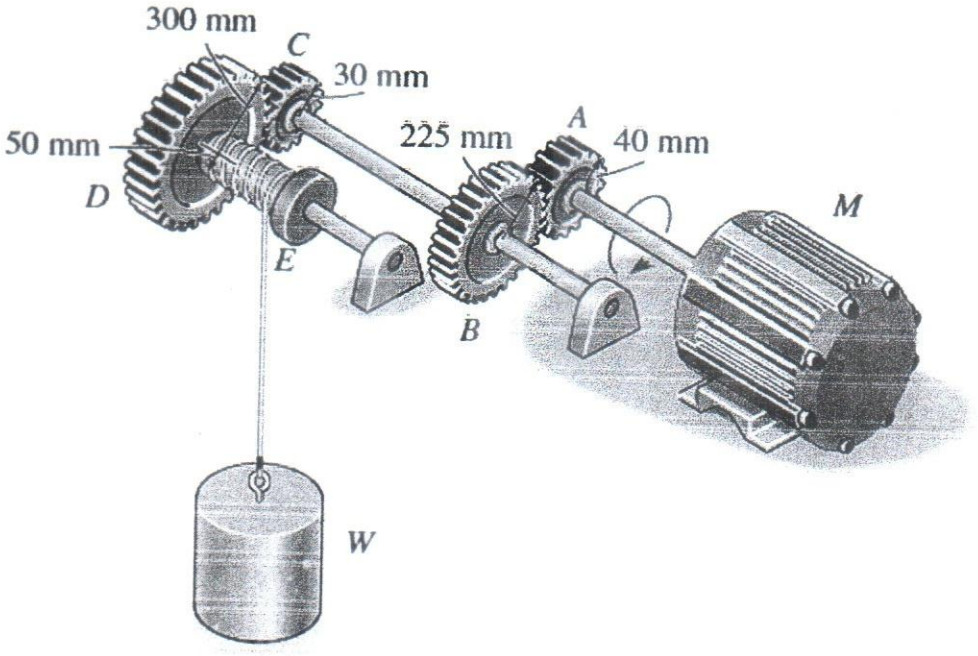

Figure: 2(a)

(b) Bar AB rotates uniformly about the fixed pin A with a constant angular velocity. Determine the velocity and acceleration of block C, at the instant $\theta = 60°$. **(10) (CO1) (PO1/PO2)**

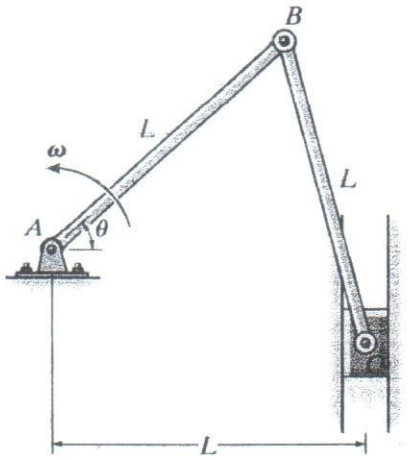

Figure 2(b)

3 (a) The motor lifts the 50-kg crate with an acceleration of 6 m/s^2. Determine the components of force reaction and the couple moment at the fixed support A. **(15) (CO2) (PO1/PO2)**

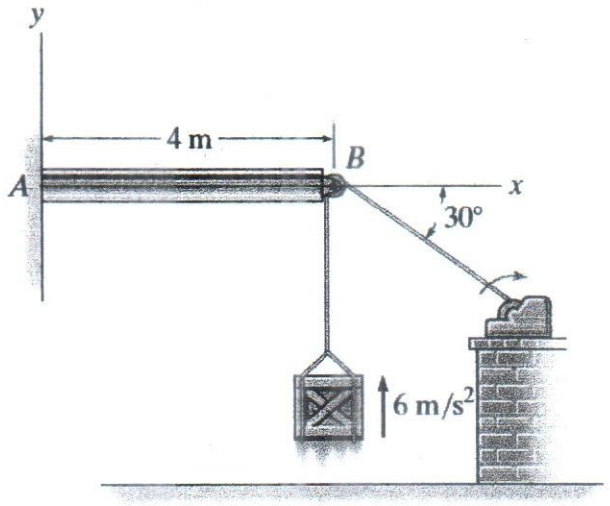

Figure 3(a)

(b) The conveyor belt delivers each 12-kg crate to the ramp at A such that the crate's speed is $v_A = 2.5$ m/s, directed down along the ramp. If the coefficient of kinetic friction between each crate and the ramp is 0.3, determine the smallest incline θ of the ramp so that the crates will slide off and fall into the cart. **(10) (CO2) (PO1/PO2)**

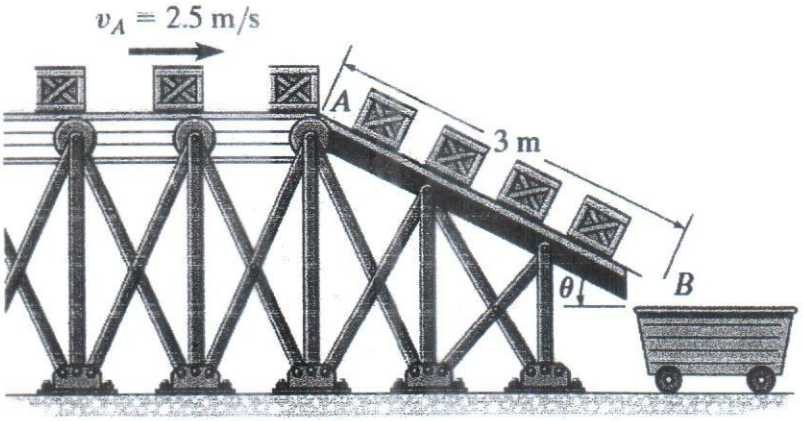

Figure 3(b)

4 (a) The power of a bus engine is transmitted using the belt-and pulley arrangement shown. If the engine turns pulley A at $\omega_A = 60$ rad/s, determine the angular velocities of the generator pulley B and the air-conditioning pulley C. The hub at D is rigidly connected to B and turns with it. **(7) (CO1) (PO1/PO2)**

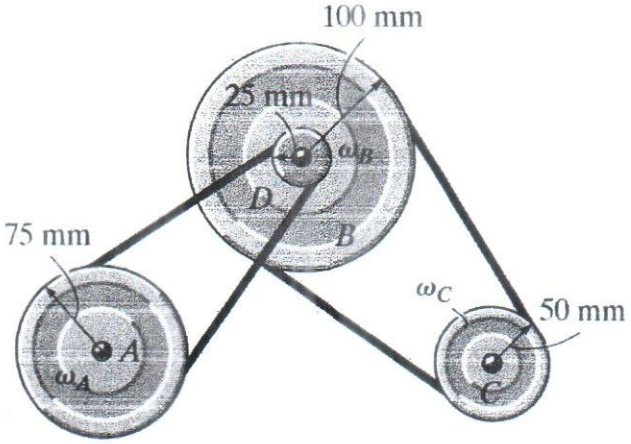

Figure 4(a)

(b) The 0.5-kg ball is fired from the tube at A with a velocity of v = 7 m/s. If the coefficient of restitution between the ball and the surface is e = 0.75, determine the height h after it bounces off the surface. **(8) (CO4) (PO2/PO3)**

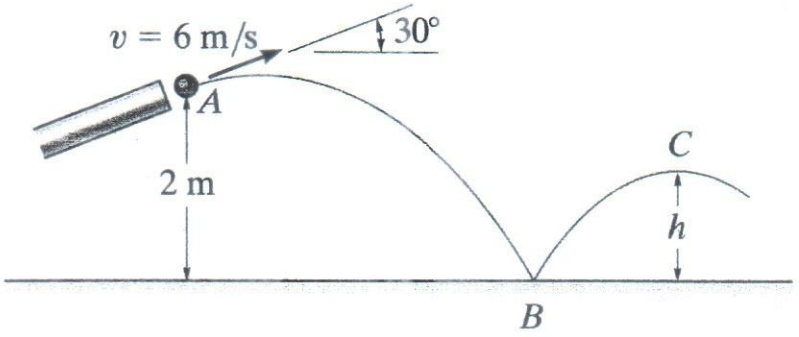

Figure 4(b)

(c) A ski jumper starts with a horizontal take-off velocity of 25 m/s and lands on a straight landing hill inclined at 30°. Determine (*a*) the time between take-off and landing, (*b*) the length *d* of the jump, (*c*) the maximum vertical distance between the jumper and the landing hill. **(10) (CO1) (PO1/PO2)**

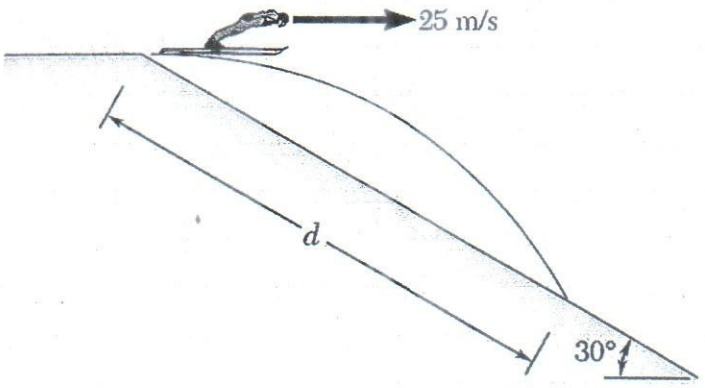

Figure 4(c)

5 (a) For the Scotch yoke mechanism shown, the acceleration of point A is defined by the relation: **(8) (CO1) (PO1/PO2)**

$$a = -1.08\sin(kt) - 1.44\cos(kt),$$

where a and t are expressed in m/s^2 and seconds, respectively, and k= 3 rad/s. Knowing that x = 0.16 m and v = 0.36 m/s when t = 0, determine the velocity and position of point A when t =0.5 s.

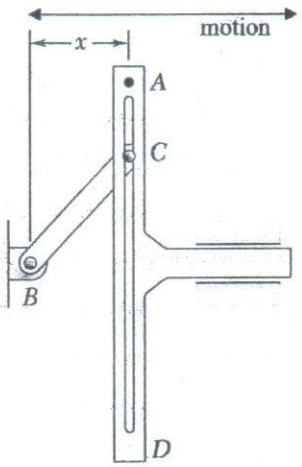

Figure 5(a)

(b) The v–s graph of a cyclist traveling along a straight road is shown. **(10)**
(i) Construct the a–s graphs. **(CO2)**
(iii) Also, determine the velocity, acceleration and time required for the cyclist to travel a distance s = 200 m (if s=0 when t=0). **(PO1/PO2)**

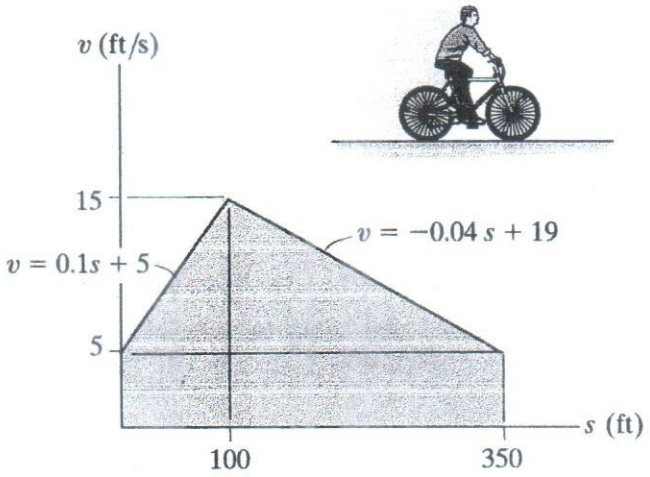

Figure 5(b)

(c) The 15-kg block A slides on the surface for which μ_k = 0.5. The block has a velocity v = 10 m/s at a distance s = 4 m from the 10-kg block B. If the unstretched spring has a stiffness k = 1000 N/m, determine the maximum compression of the spring due to the collision. Take e = 0.55 **(7) (CO4) (PO2/PO3)**

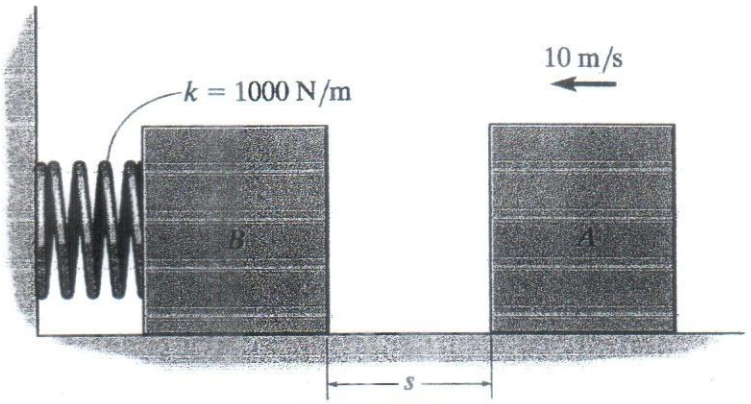

Figure 5(c)

6 (a) The thrust on the 4-Mg rocket sled is shown in the graph. **(13)**
(i) Construct the *v–t, a-t and s-t* graphs. ($s = 0$, $v=0$ when $t = 0$) **(CO4)**
(ii) Determine the sled's velocity, acceleration, and travel distance when $t = 30$ s. Neglect friction. **(PO2/PO3)**
($s = 0$, $v=0$ when $t = 0$)

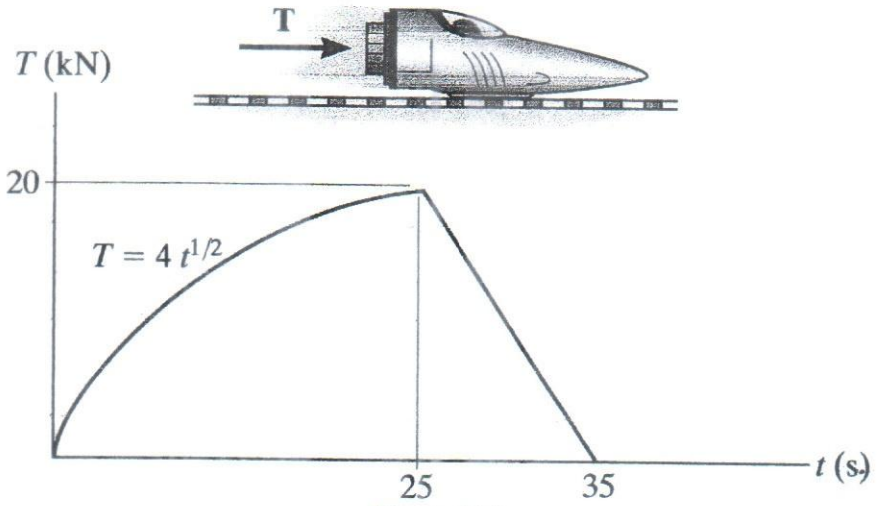

Figure 6(a)

(b) The elastic cord has an unstretched length $l_0 = 5$ 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 5 lb. [g =32.2 ft/s^2] **(12)**
If the block is released from rest from the position shown, **(CO3)**
(i) Determine its speed when it reaches point *C* after it slides along the smooth guide. **(PO2/PO3)**
(ii) Also, calculate the angular momentum of the block about point *A*, at any instant after it passes point *C*.
(ii) After leaving the guide, it is launched onto the smooth *horizontal* plane. Determine if the cord becomes unstretched.

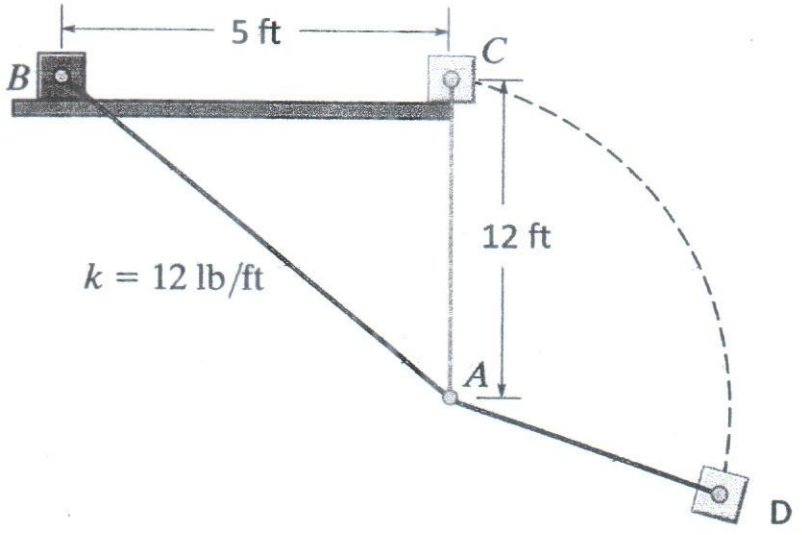

Figure 6(b)