B.Sc.Engg. (ME)/2nd Sem.

10 September 2025
Group- A (Morning)

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

Semester Final Examination
Course No: ME 4203
Course Title: Dynamics

Summer Semester : A.Y. 2023-2024
Time : 2 Hour
Full Marks : 120

Answer all questions. Each question carries equal marks. The symbols have their usual meanings. Draw the free-body diagram if required. The right column also indicates the course objective (CO) and Program outcome (PO) and K, P, A addressed by each question

Q-01(a). When the **5-kg** box reaches point **A** it has a speed $\mathbf{V_A = 10\ m/s}$. Determine the normal force the box exerts on the surface when it reaches point **B**. Neglect friction and the size of the box. **15 (CO3) (PO2) K2**

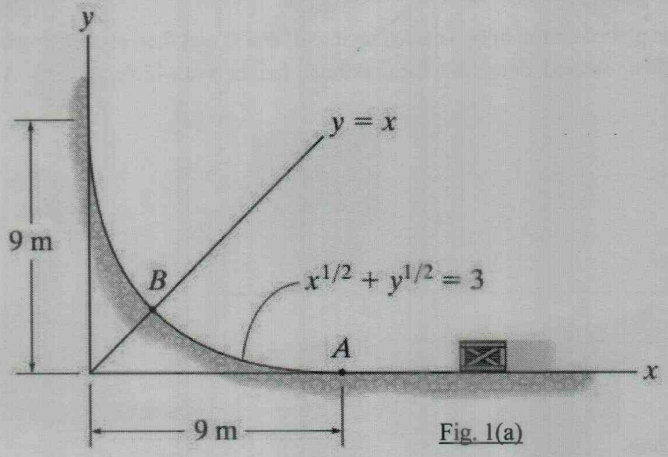

Fig. 1(a)

Q-01(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. **15 (CO3) (PO2) K2**

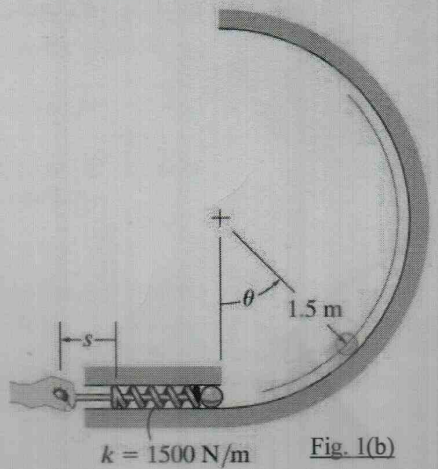

Fig. 1(b)

Q-02(a). The car C and its contents have a weight of **600 lb**, whereas block **B** has a weight of **200 lb**. If the car is released from rest, determine its speed when it travels **30 ft** down the **20°** incline. Suggestion: To measure the gravitational potential energy, establish separate datums at the initial elevations of B and C. **10 (CO3) (PO2) K2**

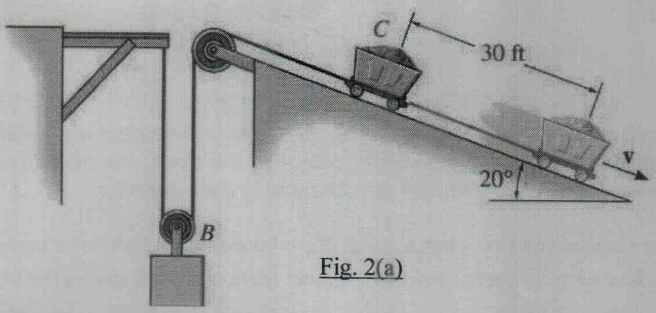

Fig. 2(a)

Q-02(b). 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 the block A will rise. **10 (CO3) (PO2) K2**

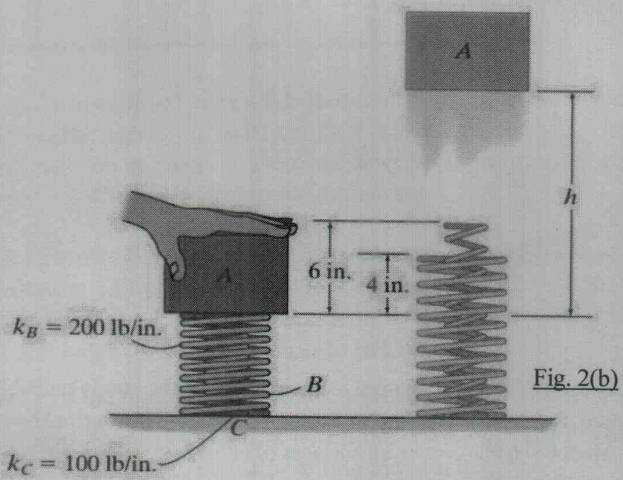

Fig. 2(b)

Q-02(c). The force of **F = 50 N** is applied to the cord when **s = 2 m**. If the **6-kg** collar is originally at rest, determine its velocity at **s = 0**. Neglect friction. **10 (CO3) (PO2) K2**

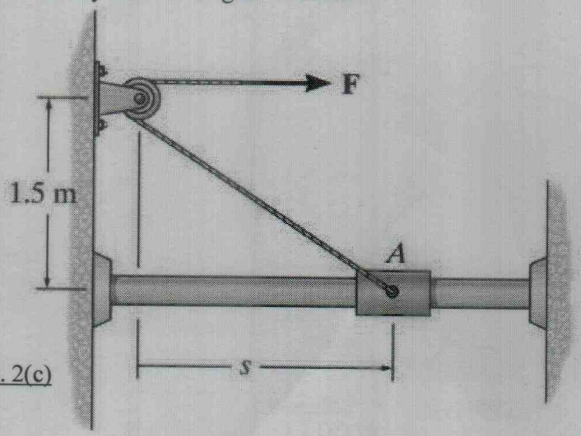

Fig. 2(c)

Q-03(a). The motor **M** pulls on the cable with a **variable force F** (Different equations in 3-time ranges), as shown in the fig 3(a), where t is in seconds. If the **5-kg** crate is initially at rest at $t = 0$, determine: **12 (CO4) (PO2) K2**

(i) The time required for the crate to begin lifting. *(Hint: It occurs within **0 to 4** seconds; find it using the equation of F in this time range.)*

(ii) At $t = 8$ **s,** Find total $\int \boldsymbol{Fdt}$, **total impulse** on the crate and the **speed** of the crate.

Neglect the mass of the cable and pulleys.

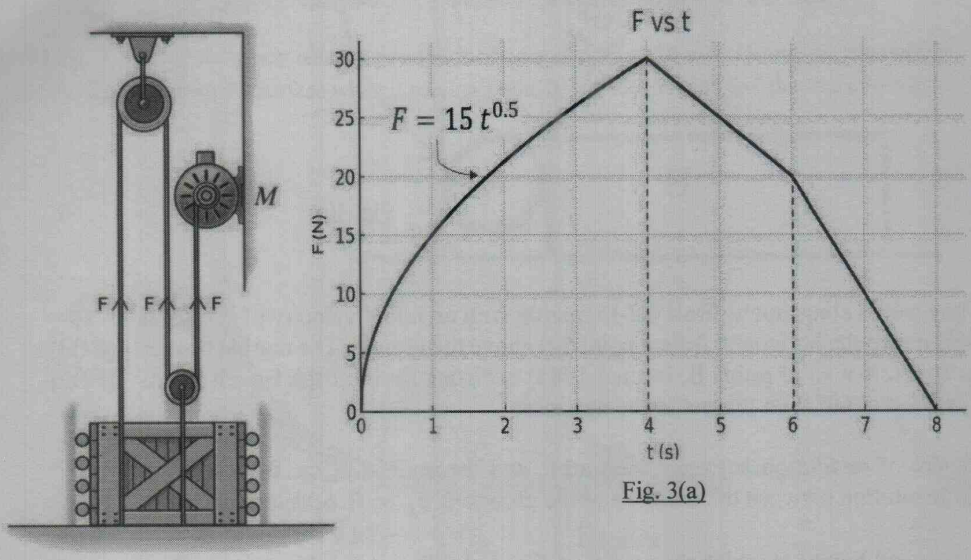

Fig. 3(a)

Q-03(b). A **4-lb** ball B is traveling around in a circle of radius $\mathbf{r = 3\ ft}$ with a speed $(v_B)_1 = 6$ ft/s. The attached cord is pulled down through the hole with a constant speed $v_r = 2$ ft/s, so that the radius of the path decreases according to the relation **18 (CO4) (PO2) K2**

$$r(t) = 3 - 0.25t\ (ft)$$

If the kinematic coefficient of friction between the ball and the surface is $\mu_k = 0.02$, determine

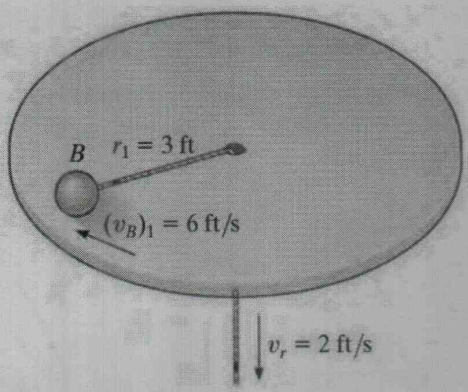

Fig. 3(b)

(i) After $\mathbf{t = 4\ s}$ find the **radius**, the **speed** of the ball, and the **cord force**.

(ii) The **time** required for the ball to reach a speed of **8.5 ft/s**. Also, find the **distance** of the ball from the hole at that instant and **cord force**.

Q-04(a). The bag A, having a weight of **6 lb**, is attached to a **3-ft** light cord and is released from rest at $\theta = 0°$ (horizontal). It swings down and **collides with the 18-lb box B when the bag is at $\theta = 60°$** .The line of impact is horizontal. If the coefficient of restitution between the bag and the box is **e = 0.5**, determine the velocities of the bag and the box immediately after impact. **10 (CO4) (PO2) K2**

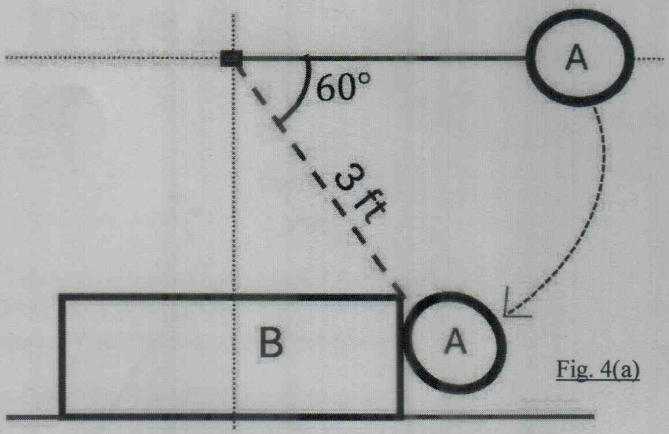

Fig. 4(a)

Q-04(b). A boy uses a slingshot to fire a **0.2-lb** marble with an initial velocity of **75 ft/s** at an angle of **45°** above the horizontal from a point **5 ft** above the ground. The marble travels and strikes a concrete wall at **point B**, located **100** ft horizontally from the launch point. The wall is inclined at **60°** with respect to the horizontal. **20 (CO4) (PO2) K2**

If the coefficient of restitution between the marble and the wall is $\mathbf{e_w = 0.5}$, and the coefficient of restitution between the marble and the ground is $\mathbf{e_g = 0.6}$, determine:

1. The **time** and **height** at which the marble strikes **point B**.
2. The **velocity** of the marble immediately after it rebounds from the wall.
3. The **horizontal distance** from B at which the marble hits the ground (point C) and **velocity** of the ball before and after hitting the ground.
4. The **maximum height** reached by the marble after rebounding from the ground.

Fig. 4(b)