B. ETCE 1ST YR 2ND SEM. EXAM.-2016

Time: 3 Hours **Subject: ENGINEERING MECHANICS** ***Full Marks: 100***

Answer any five questions.

1. (a) Three forces and a couple shown in **Fig. P1a** are applied to an angle bracket. *Find the resultant* of the force system (force & couple moment) reduced at the point ***B***. Also locate the points where the line of action of the single equivalent resultant force intersects the line ***AB*** and the line ***AC***. **[12]**

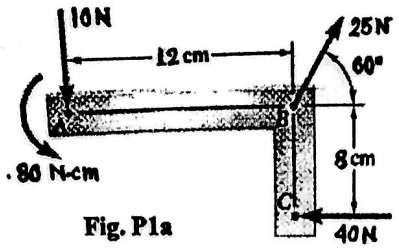

Fig. P1a

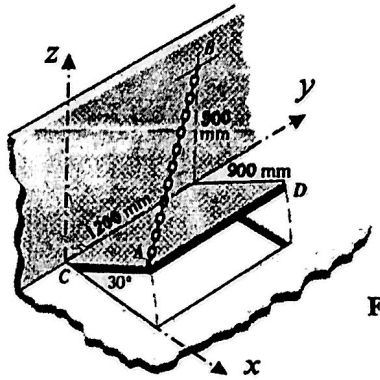

Fig. P1b

(b) The access door in **Fig. P1b** is held in the **30°** open position by the chain ***AB***. The tension in the chain is known to be **100 N**. Express this tension as a vector with the suitably defined axes system. Find the component of this force along the direction parallel to the line ***CD***. **[8]**

2. (a) Determine the reaction at the roller support at ***F*** for the frame as shown in **Fig. P2a**. Also determine the magnitude of the force in member ***BD***. **Draw the necessary free-body diagram(s).** **[8]**

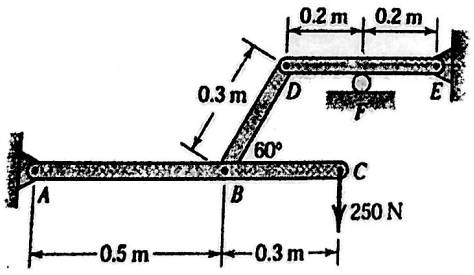

Fig. P2a

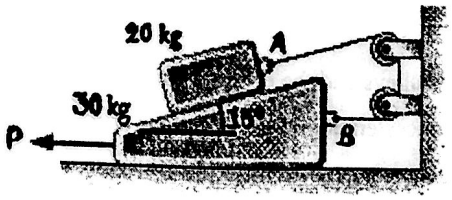

Fig. P2b

(b) The coefficients of friction are $\mu_S = 0.40$ and $\mu_k = 0.30$ between all surfaces of contact of the system shown in **Fig. P2b**. Determine the force **P** for which motion of the **30-kg** block is impending. **Draw the necessary free-body diagram(s).** **[12]**

[Turn over

3. A sign board of uniform density weighs **540 N** and is supported by a ball-and-socket joint at A and by two cables EC and BD. Determine the tension in each cable and the reaction at A. **Draw the necessary free-body diagram(s).** **[20]**

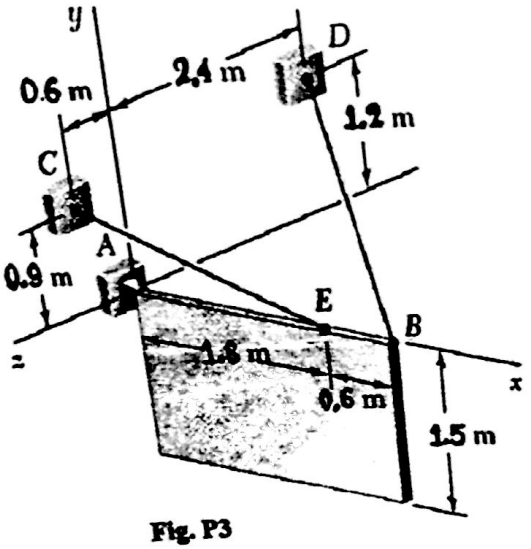

Fig. P3

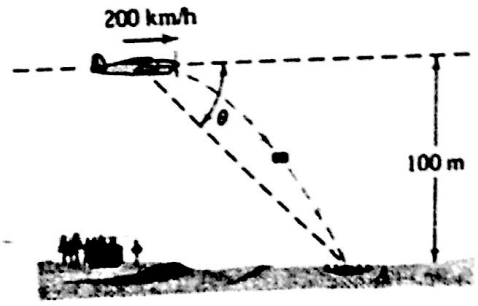

Fig. P4a

4. (a) **The pilot of an airplane as shown in Fig. P4a wishes to release the package of mail at the right moment to hit the recovery location A. What angle θ with the horizontal should the pilot's line of sight to the target make at the instant of release? The airplane is flying horizontally at an altitude of 100 m with a constant velocity 200 km/h.** **[10]**

(b) A particle moves in a two-dimensional curvilinear motion has coordinates in **mm** which vary with time t in **second** according to $x = 5t^2 + 4$ and $y = 2t^3 + 6$. For the time t = **3 second**, determine the radius of curvature of the particle, unit tangent vector, normal and tangential acceleration components at that instant. **[10]**

5. (a) **The two blocks are kept on the inclined plane as shown in Fig. P5a. Neglecting the masses of the pulleys and the effect of friction in the pulleys and between the blocks and the incline, determine the acceleration of each block and the tension in the cable. Draw the necessary free-body diagram(s).** **[10]**

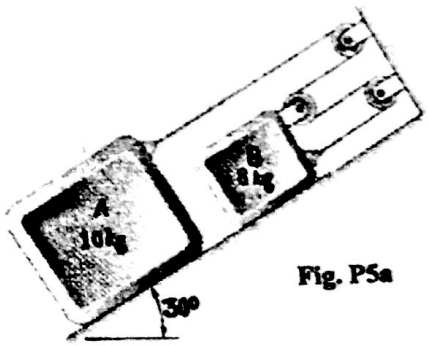

Fig. P5a

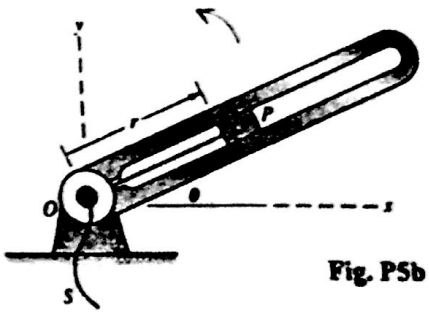

Fig. P5b

(b) The slotted arm as shown in **Fig. P5b** revolves **in the horizontal plane about the fixed vertical axis through point** O. The **2-kg** slider P is drawn towards O at the constant rate of **50 mm/s** by pulling the cord S. At the instant for which r = **225 mm**, the arm rotates at a rate **6 rad/s** in **counterclockwise** direction, which is slowing down at a rate **2 rad/s²**. For this instant of time determine the tension in the cord and the magnitude of the reaction force exerted on the slider by the smooth walls of the radial slot. **Draw the necessary free-body diagram(s).** **[10]**

6. (a) Determine the volume and the total surface area of the solid of revolution as shown in **Fig. P6a.** **[10]**

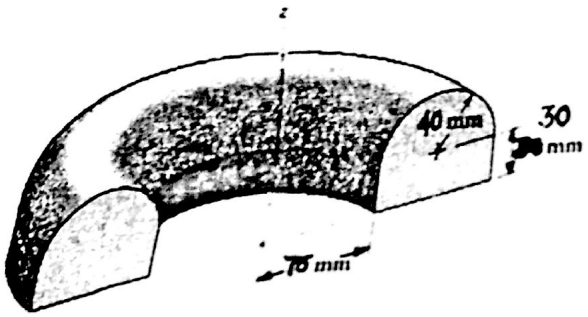

Fig. P6a

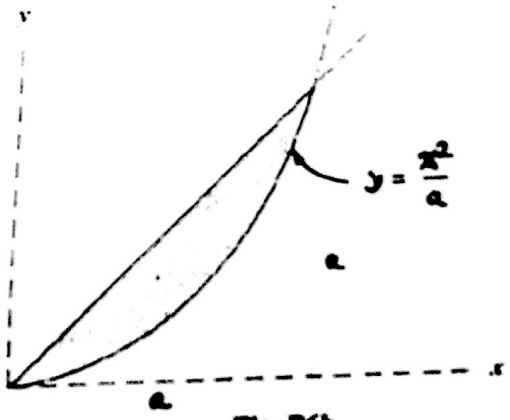

Fig. P6b

(b) Determine the moments of inertia of the shaded area about x- and y-axes as shown in **Fig. P6b.** **[10]**

7. Derive the expressions for velocity and acceleration components in polar $(r-\theta)$ coordinate system of a particle in two-dimensional motion. **[10]**

(b) Each of the sliders A and B has a mass of 2 kg and moves with negligible friction in its respective guide in a vertical plane as showing in **Fig. P7b** (with y being the vertical direction). A 20-N horizontal force is applied to the midpoint of the rigid connecting link with negligible mass and the assembly is released from rest at $\theta = 0°$. Calculate the velocity v_A with which the slider A will strike the horizontal guide when $\theta = 90°$. **[10]**

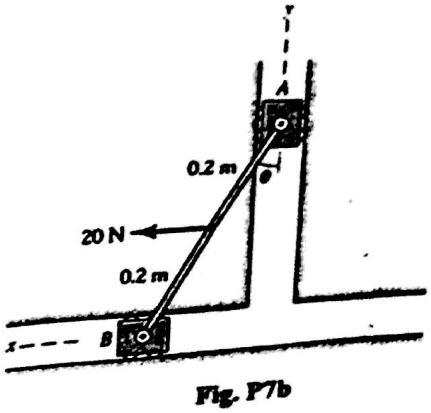

Fig. P7b