Ref. No.: Ex/CSE/EM/ME/T/122A/82/2016

B. CSE. 1^{ST} YR 2^{ND} SEM. EXM. 2016

ENGINEERING MECHANICS

DURATION 3hrs. FULL MARKS 100

Answer any 5 questions. Questions carry equal marks. Marks are equally distributed within the parts (if any) of the questions. Any missing data can be suitably assumed.

1. Solve the following problems:
   a. Two integral pulleys are acted on by belt tensions as shown. The resultant $\boldsymbol{R}$ of these forces passes through the centre O. Determine the magnitude of T and the angle θ the resultant makes with the x axis.
   b. Tension in the cable BC is T=750 N. Determine the moment due to that force about point O. The elbow at A makes a right angle and AB is inclined 30° below $x - z$ plane.

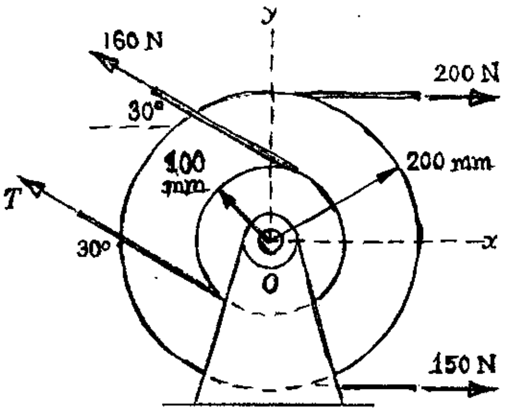

Figure (1a)

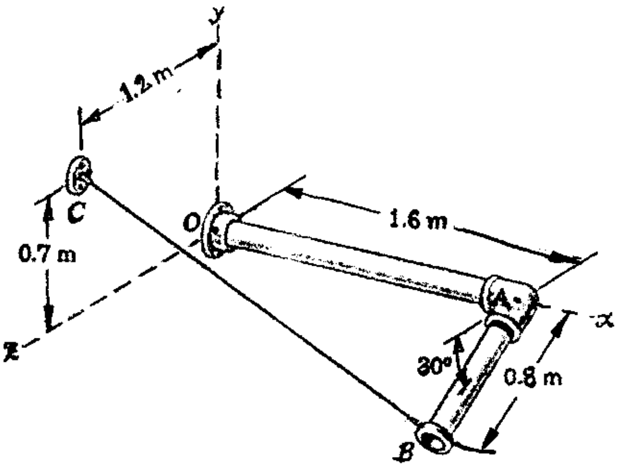

Figure (1b)

2. Determine the tensions in the cables AB and CD and the reactions at the ball-socket joint O as functions of tha location along x axis of the constant downward force L.

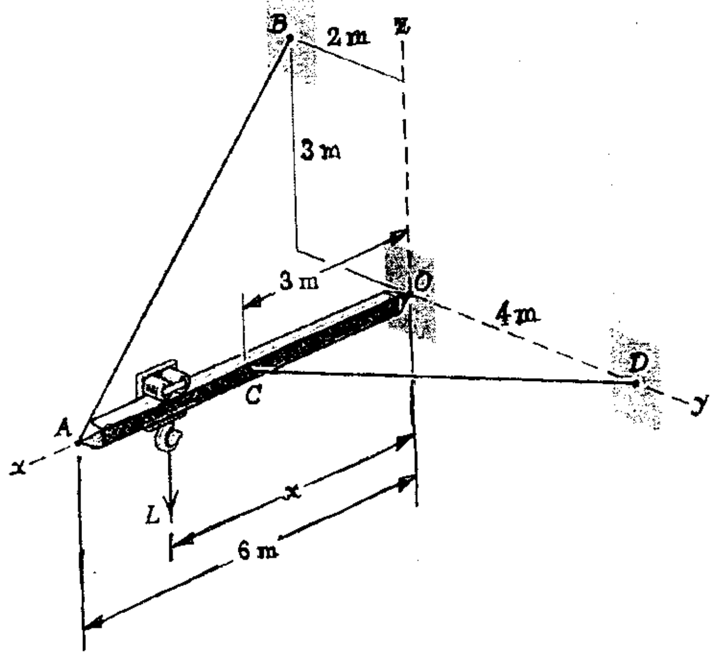

Figure (2)

3. Determine the compression force C on the can exerted by the member BE in the downward direction when an external force P=50 N is applied on the member AOD at D. The member BE through a square shaped protrusion at E is constrained to move along a vertical channel.

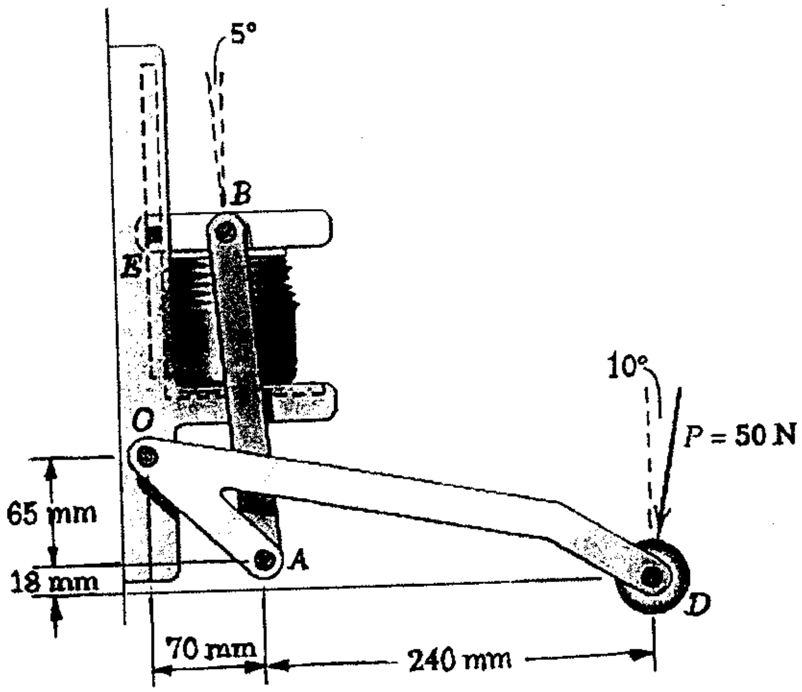

Figure (3)

4. Solve the following problems:
   a. State Pappus theorems of volume and surface of revolution.
      Determine the volume V and total surface area A of the geometry shown in the figure.
   b. The system is released from the rest with the cable taut. For the static and kinetic coefficients of friction $\mu_s = 0.25$ and $\mu_k = 0.20$ determine the accelerations of the 60 kg block and the 20 kg cylinder. Also determine the tension in the cable. Neglect the small mass and friction associated with the cable-pulley assembly.

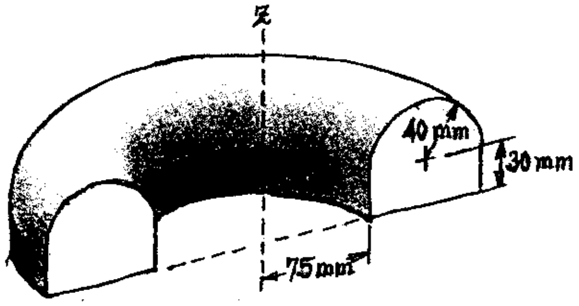

Figure (4a)

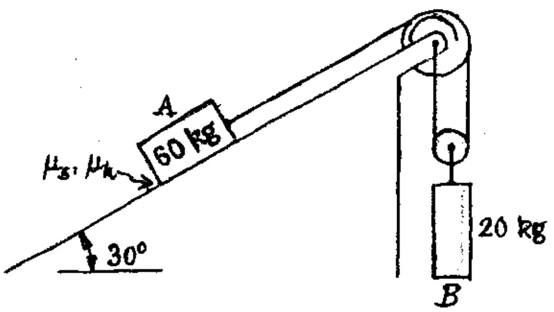

Figure (4b)

5. Solve the following problems-
   a. State the parallel axis theorem for Area Moment of Inertia.
      If $I_{xx} = 4.0 \times 10^6\ mm^4$ and $I_{x'x'} = 10.0 \times 10^6\ mm^4$, determine the bounded area whose centroid is C.
   b. The rocket moves in a vertical plane and is being propelled by a thrust T of 32 kN. It is also subjected to an atmospheric resistance R of 9.6 kN. If the rocket has a velocity of 3 km/s and if the gravitational acceleration is 6 m/s^2 at the altitude of the rocket, calculate the radius of curvature of its path for the position described and the time-rate-of change of the magnitude v of the velocity of the rocket. The mass of the rocket at the instant considered is 2000 kg.

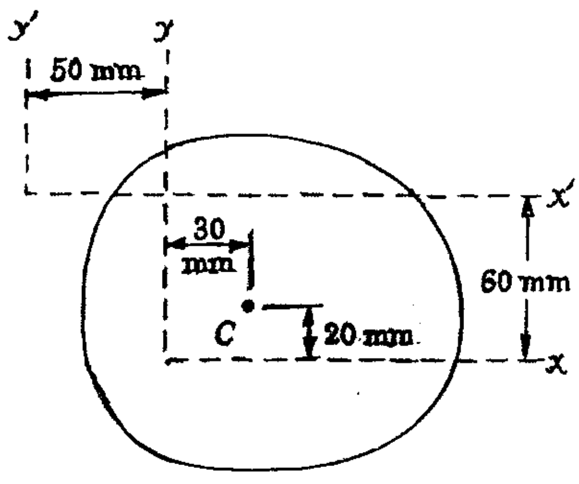

Figure (5a)

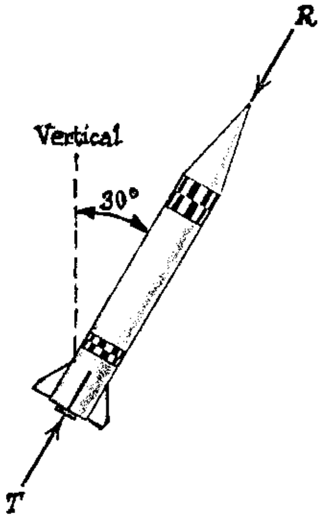

Figure (5b)

6. Solve the following problems:
   a. The uniform slender bar of length l is placed in the opening of width d at an angle of 30° as shown. For a coefficient of static friction $\mu_s =$ 0.4 determine the minimum and maximum values of d for which the bar would be in equilibrium.
   (Hint: Consider two cases, $0 < d < \frac{l}{2}$ and $l > d > \frac{l}{2}$).
   b. Write the expressions (derivation not required) for the velocity and the acceleration of a particle undergoing a curvilinear motion in $r - \theta$ coordinate system.
   Calculate the minimum possible magnitude u of the muzzle velocity which a projectile must have when fired from point A to reach a target B on the same horizontal plane 12 km away.

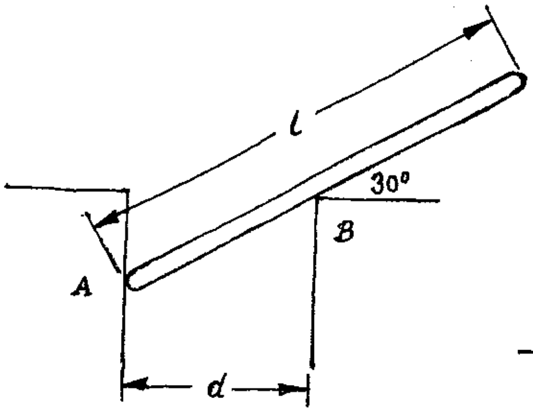

Figure (6a)

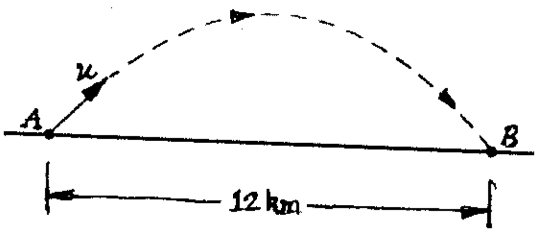

Figure (6b)

7. Solve the following problems:
   a. The flexible bicycle-type chain of length $\pi r/2$ and mass per unit length ρ is released from rest with $\theta = 0°$ in the *smooth* circular channel and falls through the hole in the supporting surface. Determine the velocity v of the chain as the last link leaves the slot. (Hint: Compare the potential energies due to gravity at $\theta = 0°$ and $\theta = 90°$).
   b. With $\mu_k = 0.02$, determine the time t in seconds taken by the ice racing vehicle to attain a velocity of 100 km/h.

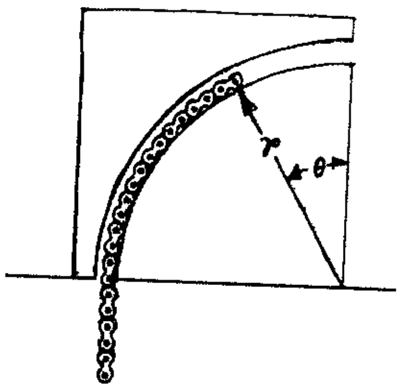

Figure (7a)

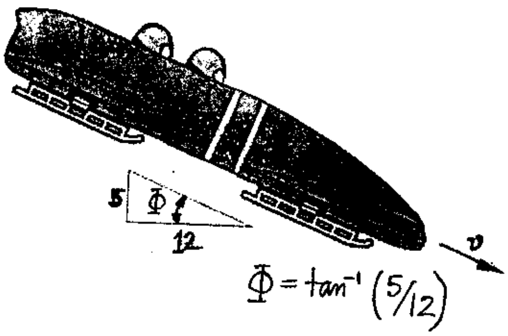

Figure (7b)