REF. NO.: AM/ME/T/IA/115/2017(S)

B. ELE. ENGG. 1ST. YEAR 1ST. SEM. SUPPLE. EXAM.-2017

ENGINEERING MECHANICS

FULL MARKS 100 DURATION 3 HRS.

Answer any five questions with no more than three from each group. Marks are equally distributed (if not mentioned otherwise) among the parts (if any) of a given question. Assume reasonable values for any missing data.

Group A

1. Answer the following questions-
   a. For the given force moment system acting on the plate, determine the position at which the line of action intersects with the y axis.
   b. The cable exerts a tension of $T = 2\text{kN}$ on the fixed bracket A. Determine-
      i. The vector expression for the tension $\boldsymbol{T}$.
      ii. The moment developed at the support O due to the tension.

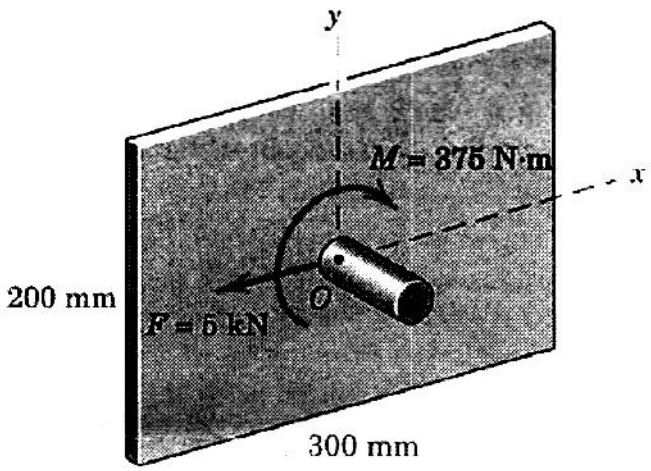

Figure (1a)

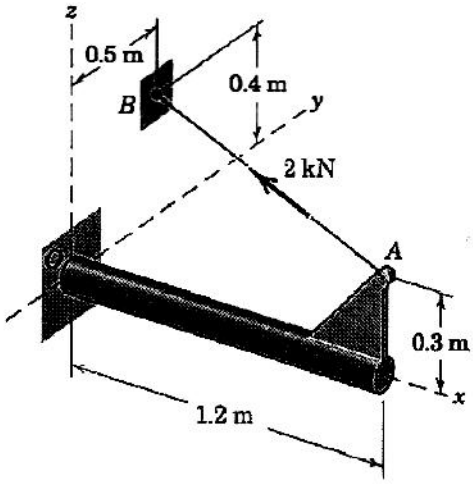

Figure (1b)

[Turn over

2. Each of the three uniform 1200-mm bars has a mass of 20 kg. The bars are welded together into the configuration shown and suspended by three vertical wires. Bars AB and BC lie in the horizontal $x - y$ plane, and the third bar lies in a plane parallel to the $x - z$ plane. Compute the tension in each wire.

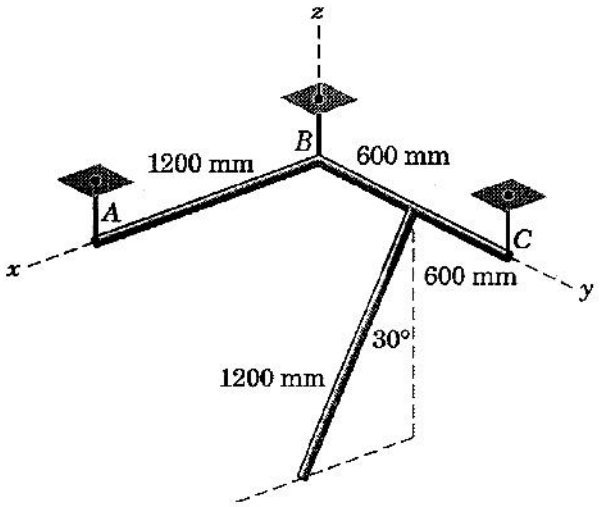

Figure (2)

3. Answer the following questions-
   a. **The top of the folding workbench has a mass of 50 kg with mass center at G. Calculate the $x -$ and y-components of the force supported by the pin at E.**
   b. For the shaded area-
      i. Determine the *volume of revolution* about x axis using the concept of a compound geometry.
      ii. Apply Pappus theorem on the above result to determine the centroid of the shaded area.

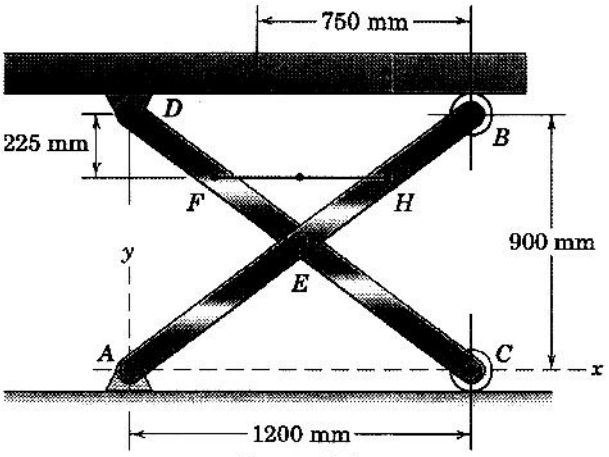

Figure (3a)

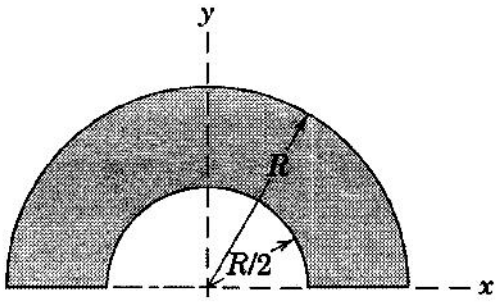

Figure (3b)

4. Answer the following questions-
   a. Determine the range of weights W of the uniform slender bar for which the system will be in equilibrium. Neglect friction at all bearings. Given, $L = 1\text{m}$.
   b. The moments of inertia of the area A about the parallel p- and p'-axes differ by $15 \times 10^6\text{mm}^4$. Compute the area A, which has its centroid at C.

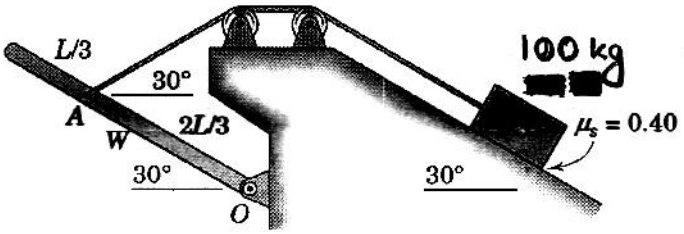

Figure (4a)

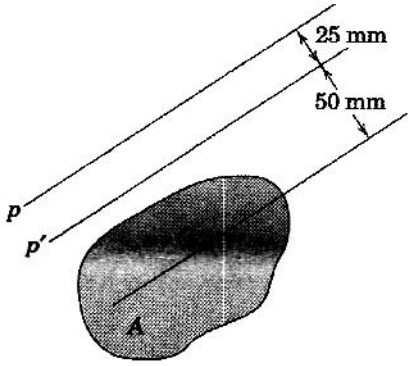

Figure (4b)

Group B

5. Answer the following questions-
   a. The acceleration of a point A is defined by the relation $a = 600x(1 + kx^2)$, where a and x are expressed in **m/s²** and **m**, respectively, and k is a constant. Knowing that the velocity of A is **7.5 m/s** when $x = 0$ and **15 m/s** when $x = 0.45$ **m**, determine the value of k. [8]
   b. The pilot of an airplane pulls into a steep **45°** climb at **300 km/h** and releases a package at position A as shown in **Fig. 5b**. Calculate the horizontal distance s and the corresponding time t from the point of release to the point at which the package strikes the ground. [12]

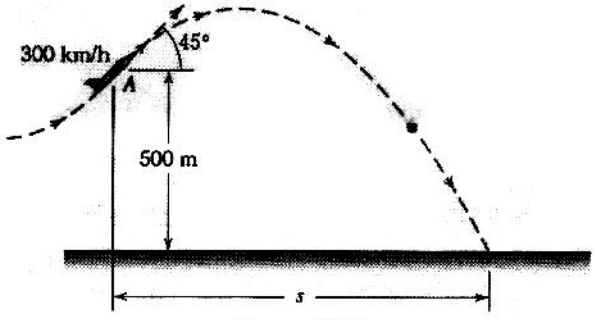

Figure (5b)

6. Answer the following questions-

   a. The rotation of the **0.9 m** arm ***OA*** about ***O*** (as shown in **Fig. 6a**) is defined by $\theta = 0.15t^2$ where θ is in radian and t in second. Collar ***B*** slides along the arm such that $r = 0.9 - 0.12t^2$ where r is in meter. After the arm has been rotated through **30°**, determine radial and transverse $(r - \theta)$ components of velocity and acceleration of the collar. Also find out the angle made by the velocity vector and the acceleration vector of the collar with the arm ***OA*** at this instant of time. [10]

   b. **In Fig. 6b, the block *C* starts from rest and moves downward with a constant** acceleration. Knowing that after **12 s** the velocity of block A is **456 mm/s**, determine the accelerations of ***A***, ***B***, and ***C***. [10]

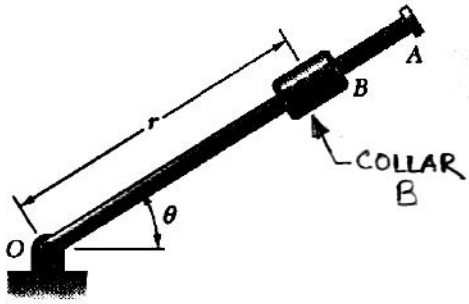

Figure (6a)

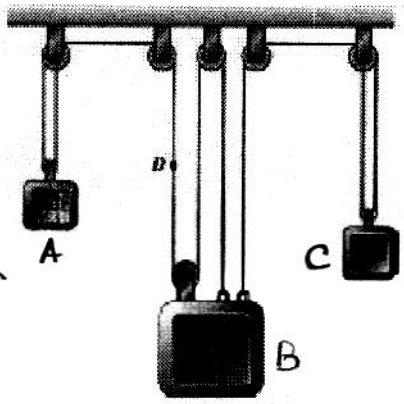

Figure (6b)

7. Answer the following questions-

   a. A **40-kg** package is at rest on an incline when a force P is applied to it (**Fig. 7a**). Determine the magnitude of P to initiate the motion in upward direction. Also determine the magnitude of P necessary if **4 s** is required for the package to travel **10 m** up the incline. The static and kinetic coefficients of friction between the package and the incline are **0.30** and **0.25**, respectively. Draw the necessary free-body diagram. [12]

   b. A **200-g (0.2-kg)** bullet initially travelling at **6 m/s** to the right strikes the still plate supported by a spring. The bullet remains in contact with the plate for **0.08 s**, during which a force of resistance ($\boldsymbol{F}$) has been applied on the bullet which varies with time according to a function approximated by the upper half of an ellipse as shown in **Fig. 7b**. Find out the speed v at which the bullet will return to the left just after the contact has been cease. [8]

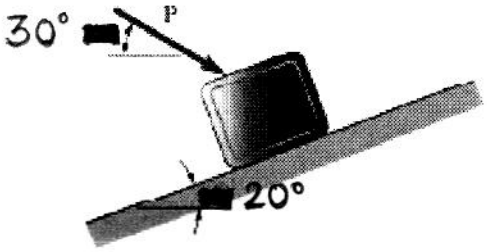

Figure (7a)

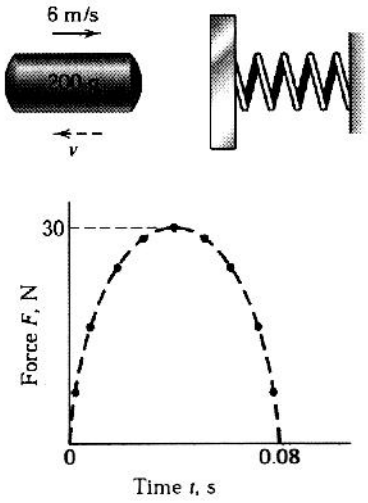

Figure (7b)

8. Write short notes on-
    a. Centroid of a 3D curvilinear segment.
    b. Moment of a couple.
    c. Expressions of velocity and acceleration in $r - \theta$ coordinate system.
    d. Work-energy principle for particle dynamics.