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GNG1105/1505 – Engineering Mechanics/Mécanique pour ingénieurs
Final Exam

December 10th, 2015.
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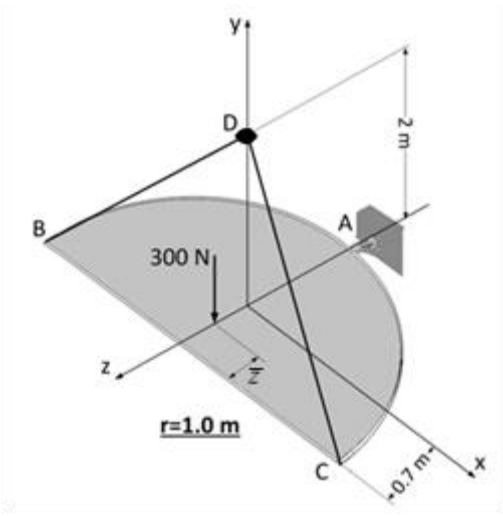
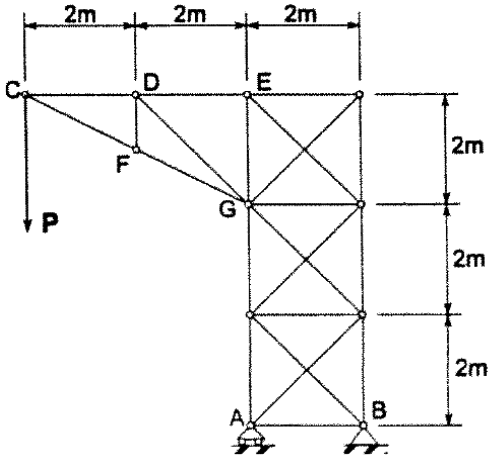
Closed book examination. Only non-programmable calculators are allowed. All other electronic devices are not allowed. All questions are of equal value. Draw free-body diagrams for each question.

1- A semi-circular plate of 1.0 m radius is being held in equilibrium by a ball and socket joint at point A and by two cables at points B and C. These two cables are attached to point D above the plate and lies on the y-axis, as shown in the diagram. The weight of the plate is 300N which is acting at its centroid G.



   a) Draw the free body diagram of the plate.
   b) Write, in vector form, the tension in cables BD, CD, and the 300N weight.
   c) Calculate the tensions in cables BD and CD and the components of the reaction at point A.

2- The sketch shows a truss loaded with a force P = 5 kN, as shown in the diagram. All joints are pinned.

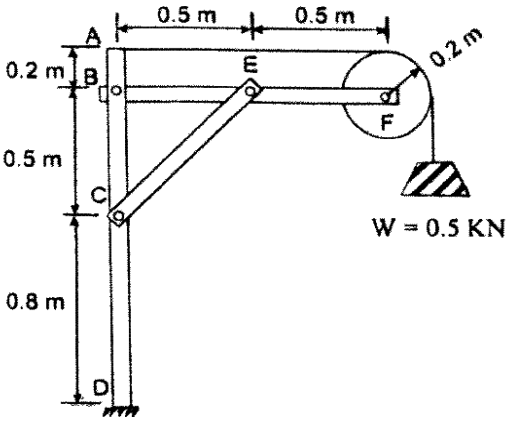


   a) Find the reactions at supports A and B.
   b) Using the **method of sections**, determine the forces in members DE, FG and DG and specify if they are in tension or compression.

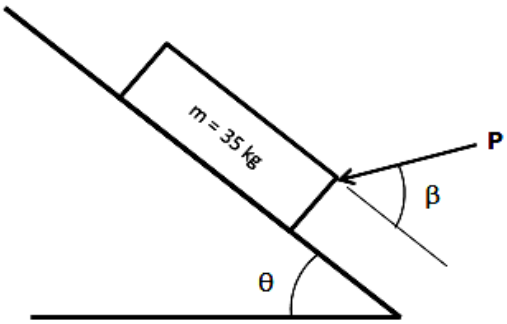
3- In the frame shown in the diagram, joints B, C and E are pinned.

a) Find the components of the reaction at the fixed support D.

b) Calculate the components of the forces at joints B, C and E.



4- A force P = 50 N is applied to a 35 kg block resting on an inclined surface at an angle of θ = 15° with respect to the horizontal. The coefficients of static and kinetic friction between the block and the inclined surface are $\mu_s = 0.10$ and $\mu_k = 0.05$ respectively. The force P is applied to the block at an angle of β = 30° with respect to the inclined place, as shown in the diagram.



a) Verify that the block is in motion and determine its direction.

b) Determine the actual friction force between the block and the inclined surface.

c) Determine the block's acceleration under these conditions.

d) If the block starts at rest, determine the time required for it to travel a distance of 3 m and its velocity at that moment.

Useful Equations

$$x = x_o + vt$$

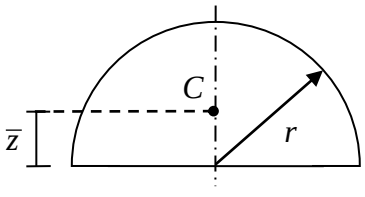
$$v = v_o + at$$

$$x = x_o + v_o t + \frac{1}{2}at^2$$

$$v^2 = v_o^2 + 2a\left(x - x_o\right)$$

$$\sum \vec{F} = m\vec{a}$$

Centroid



$$\bar{z} = \frac{4r}{3\pi}$$