GNG 1105 E
ENGINEERING MECHANICS

Mid-term Exam

October 24, 2013

Times: 80 minutes

Prof. A. Skaff

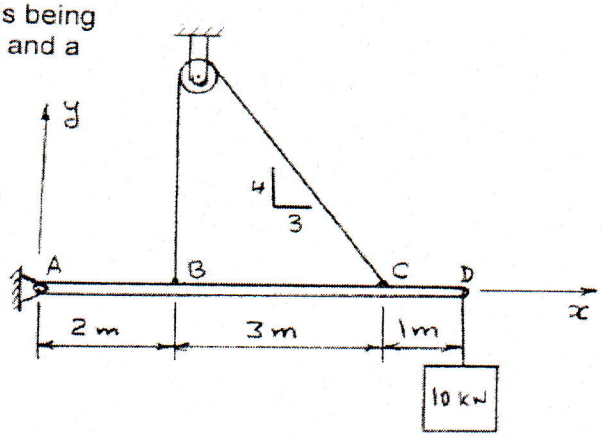
Closed book Examination. Only non- programmable calculators are allowed

1- (15 marks)

Rod AD, carries a load of 10KN at point D, is being supported by a pin joint at A and by a cable and a pulley system as shown in the diagram.

a) Draw the FBD of AD.

b) Find the x and y components of the reaction at A and the tension (T) in the cable.

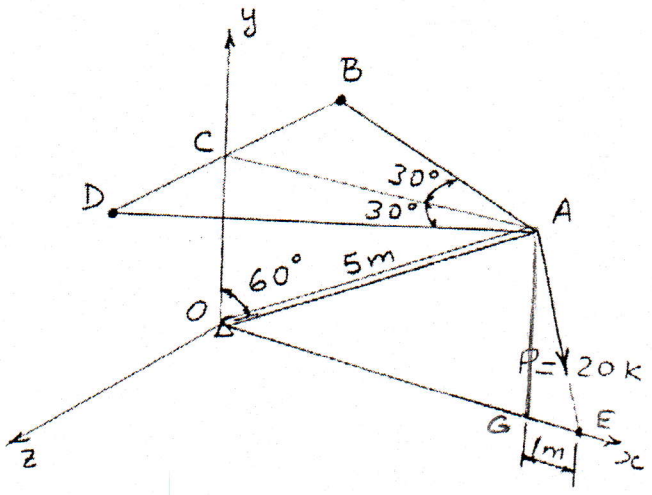


2- (15 marks)

Load P = 20KN is supported by rod OA and cables AB and AD. Rod OA lies in the xy plane and the force in it is along its longitudinal axis. Cables AB and AD lies in a plane parallel to the xz plane.

a) Write the forces in rod OA and cables AB and AD and the force P in vector form.

b) Determine the force in rod OA and the tension in cables AB and AD.



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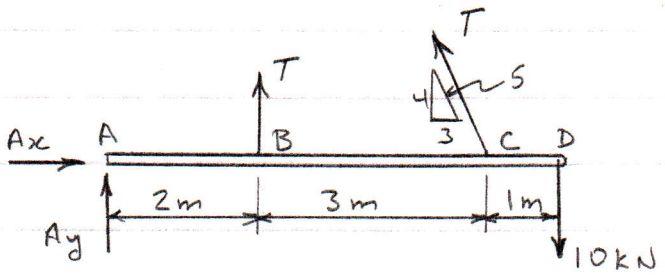
1.

a) FBD of ABCD

See Diagram



b) $+\circlearrowleft \Sigma M_A = 0$

$T \times 2m + T \times \frac{4}{5} \times 5m - 10kN \times 6m = 0$

$2T + 4T - 60 = 0$

$6T = 60$; $\therefore T = \frac{60}{6} = \underline{\underline{10\,KN}}$ ANS.

$\pm \rightarrow \Sigma F_x = 0$

$A_x - T \times \frac{3}{5} = 0$

$A_x - 10 \times \frac{3}{5} = 0$

$A_x - 6 = 0$; $\therefore A_x = 6\,KN = \underline{\underline{6\,KN \rightarrow}}$ ANS.

$+\uparrow \Sigma F_y = 0$

$A_y + T + T \times \frac{4}{5} - 10kN = 0$

$A_y + 10 + 10 \times \frac{4}{5} - 10 = 0$

$A_y + 10 + 8 - 10 = 0$; $\therefore A_y = -8\,KN = \underline{\underline{8\,KN \downarrow}}$ ANS.

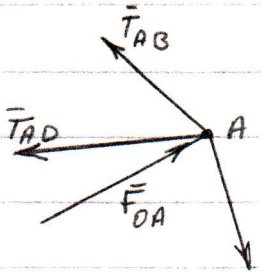
2.

a) $\bar{F}_{OA} = F_{OA}\dfrac{\bar{OA}}{OA}$

$\bar{OA} = 5\sin 60^\circ \bar{i} + 5\cos 60^\circ \bar{j}$

$\therefore \bar{F}_{OA} = \dfrac{F_{OA}}{5}(5\sin 60^\circ \bar{i} + 5\cos 60^\circ \bar{j})$

$\bar{F}_{OA} = F_{OA}(0.866\bar{i} + 0.5\bar{j})$ — ANS.



$\bar{T}_{AB} = T_{AB}\dfrac{\bar{AB}}{AB}$; $AB = \dfrac{AC}{\cos 30^\circ} = \dfrac{5\sin 60^\circ}{\cos 30^\circ} = 5m$ ($AC = 5\sin 60^\circ$)

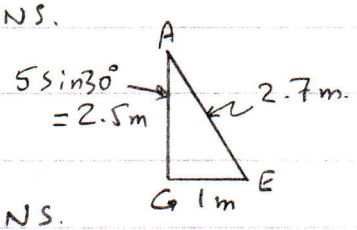
$\bar{AB} = -5\cos 30^\circ \bar{i} - 5\sin 30^\circ \bar{k}$

$\therefore \bar{T}_{AB} = \dfrac{T_{AB}}{5}(-5\cos 30^\circ \bar{i} - 5\sin 30^\circ \bar{k})$

$\bar{T}_{AB} = T_{AB}(-0.866\bar{i} - 0.5\bar{k})$ ——— ANS.

Similarly,

$\bar{T}_{AD} = T_{AD}(-0.866\bar{i} + 0.5\bar{k})$ ——— ANS.



$\bar{P} = \dfrac{P}{2.7}(+1\bar{i} - 2.5\bar{j}) = 20(0.37\bar{i} - 0.93\bar{j})$

i.e. $\bar{P} = 7.4\bar{i} - 18.6\bar{j}$ ——— ANS.

b) $\Sigma F_x = 0$; $0.866F_{OA} - 0.866T_{AB} - 0.866T_{AD} + 7.4 = 0$ ——— (1)

$\Sigma F_y = 0$; $0.5F_{OA} - 18.6 = 0$ ——— (2)

$\therefore F_{OA} = 37.2\,kN$ ——— ANS.

$\Sigma F_z = 0$; $-0.5T_{AB} + 0.5T_{AD} = 0$ ——— (3)

$\therefore T_{AB} = T_{AD}$

Insert $F_{OA} = 37.2\,kN$ and $T_{AD} = T_{AB}$ in (1):

$0.866 \times 37.2 - 0.866T_{AB} - 0.866T_{AB} + 7.4 = 0$

$32.2 - 1.732T_{AB} + 7.4 = 0$

$\therefore T_{AB} = T_{AD} = \dfrac{-39.6}{-1.732} = 22.86\,kN$ ——— ANS.