Université d'Ottawa
Faculté de génie

University of Ottawa
Faculty of Engineering

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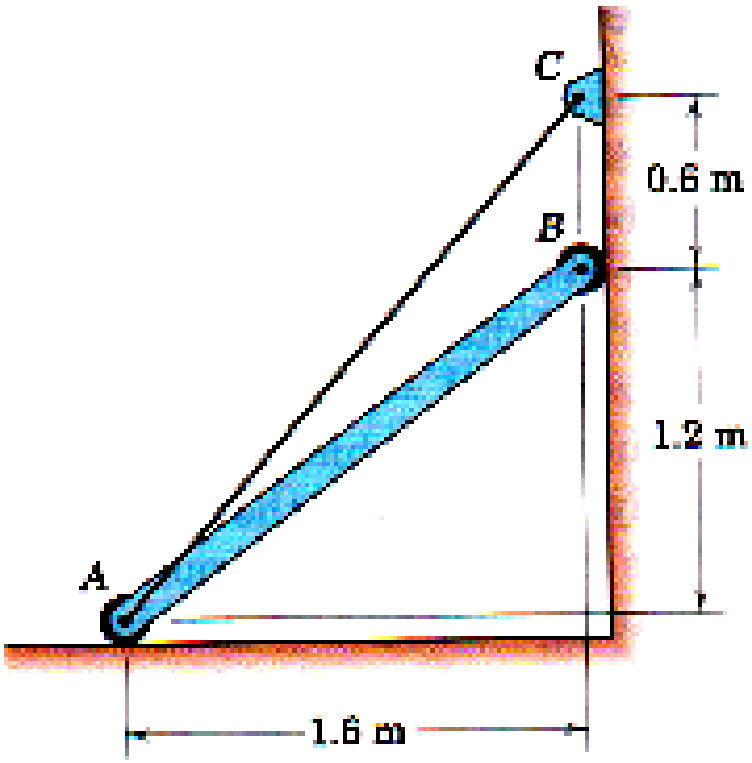
GNG 1105 A- Engineering Mechanics

Mid-Term Exam — 03 November 2016
Professor A. Skaff — Time: 80 min.

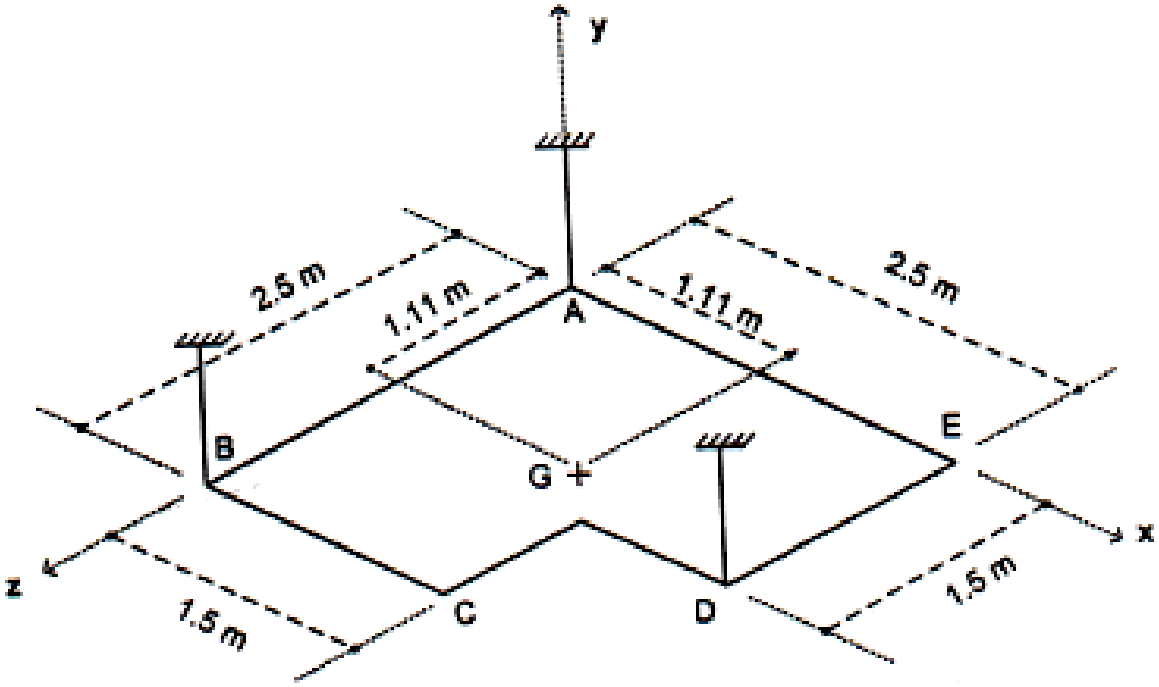
Closed Book. Non programmable calculators are allowed. Free-body diagrams must be drawn wherever appropriate.

1. **(15 marks)** The uniform 30 kg bar with end rollers is supported by the horizontal and vertical surfaces and by the wire *AC*. Calculate the tension *T* in the wire and the reactions against the rollers at *A* and at *B*.



2. (15 marks) Plate ABCDE is suspended by three vertical cables at *A*, *B*, and *D*. The weight of the plate is 3 kN, which acts at the center of gravity, *G*.

a) Write, in vector form, the moment of the all forces about point *A*.
b) Calculate the tension in each of the three cables.



Good luck,

GNG 1105 A

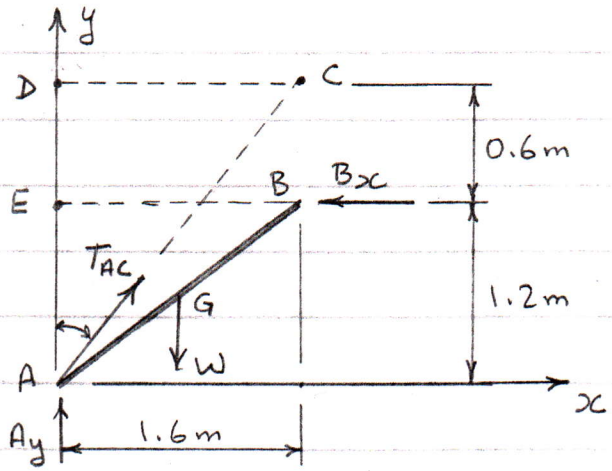
ENGINEERING MECHANICS

MID-TERM EXAM — NOV. 3, 2016

SOLUTIONS

1.

FBD - Bar AB



$W = 30\ kg \times 9.81 = 294.3\ N$

$\angle DAC = \tan^{-1}\frac{1.6}{1.8} = 41.634°$

$+\circlearrowleft \Sigma M_E = 0$

$T_{AC} \sin 41.634° \times 1.2m - 294.3 \times 0.8m = 0$

$0.797\, T_{AC} - 235.44 = 0$

$\therefore T_{AC} = \frac{235.44}{0.797} = \underline{\underline{295.41N}}$ ANS.

$\pm \Sigma F_x = 0$

$T_{AC} \sin 41.634° - B_x = 0$

$295.41 \sin 41.634 = B_x$

$\therefore B_x = \underline{\underline{196.26\ N \leftarrow}}$ ANS.

$+\uparrow \Sigma F_y = 0$

$A_y + T_{AC} \cos 41.634° - W = 0$

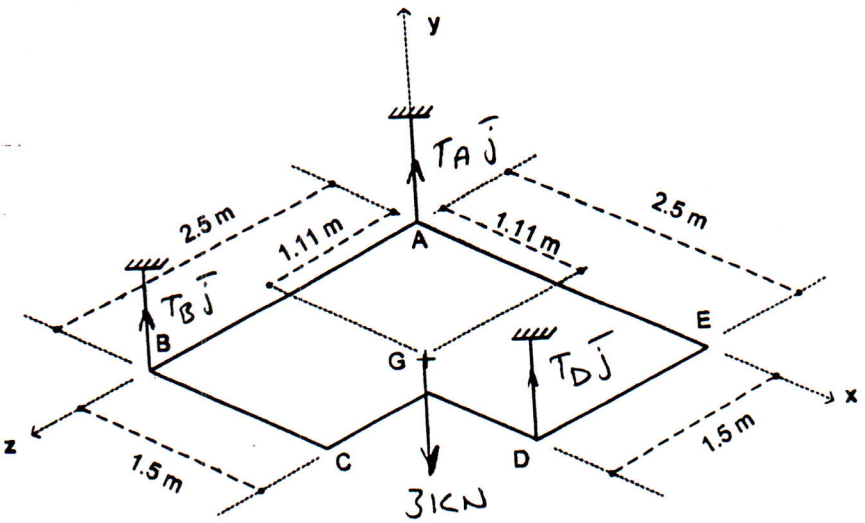
$A_y + 295.41 \cos 41.634 - 294.3 = 0$

$A_y + 220.79 - 294.3 = 0$

$\therefore A_y = 294.3 - 220.79 = \underline{\underline{73.51N \uparrow}}$ ANS.

2.

FBD - Entire plate



a) $\Sigma M_A =$

$$\bar{r}_{B/A} \times T_B\bar{j} + \bar{r}_{D/A} \times T_D\bar{j} + \bar{r}_{G/A} \times (-3\bar{j}) = 0$$

$$2.5\bar{k} \times T_B\bar{j} + (2.5\bar{i} + 1.5\bar{k}) \times T_D\bar{j} + (1.11\bar{i} + 1.11\bar{k}) \times (-3\bar{j}) = 0$$

$$-2.5T_B\bar{i} + 2.5T_D\bar{k} - 1.5T_D\bar{i} - 3.33\bar{k} + 3.33\bar{i} = 0$$

$$\therefore \Sigma M_A = (3.33 - 2.5T_B - 1.5T_D)\bar{i} + (2.5T_D - 3.33)\bar{k} = 0$$

b) Equate coefficients of unit vectors to zero:

$\bar{i}$: $3.33 - 2.5T_B - 1.5T_D = 0$

$\bar{k}$: $2.5T_D - 3.33 = 0$; $\therefore T_D = \frac{3.33}{2.5} = \underline{\underline{1.332\ KN}}$ ANS.

$$3.33 - 2.5T_B - 1.5 \times 1.332 = 0$$

$$2.5T_B = 3.33 - 1.998 = 1.332$$

$$\therefore T_B = \frac{1.332}{2.5} = \underline{\underline{0.533\ KN}}$$ ANS.

$\Sigma F_y = 0$

$$T_A + T_B + T_D - 3\ kN = 0$$

$$T_A + 0.533 + 1.332 - 3kN = 0$$

$T_A = 1.135\ KN$; i.e. $T_A = \underline{\underline{1.135\ KN}}$ ANS.