



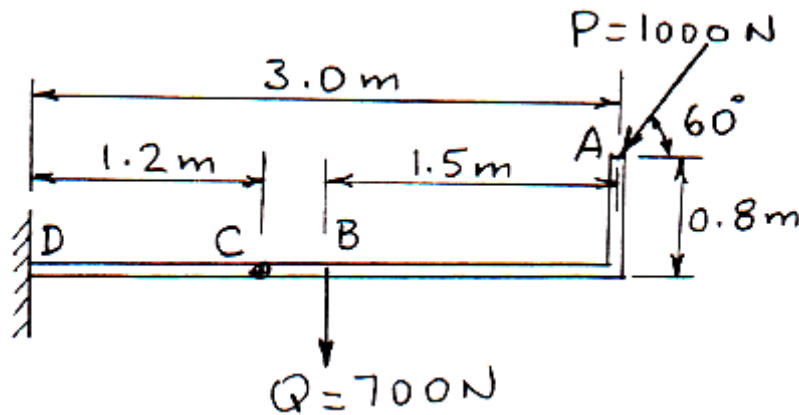
GNG 1105 A- Engineering Mechanics

Mid-Term Exam
Professor A. Skaff

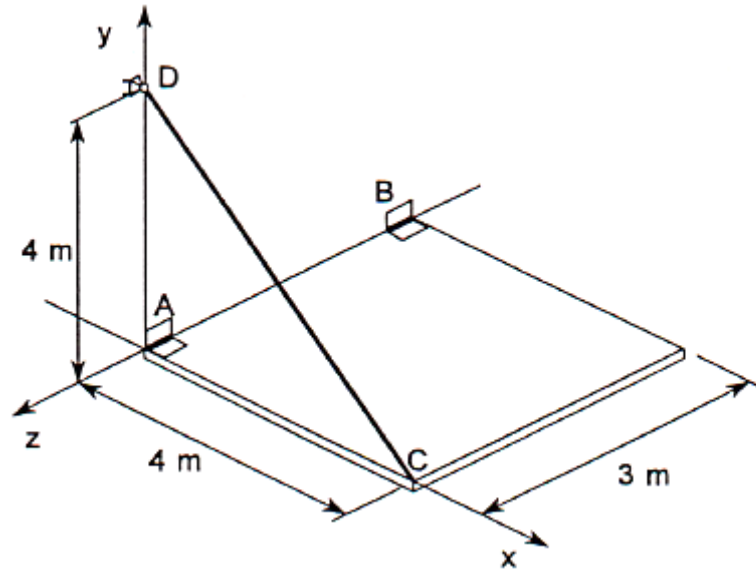
05 November 2015
Time: 80 min.

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

1. (15 marks) The bracket ABCD is loaded as shown. The support at D is a fixed connection.
 - a) Reduce the forces P and Q to an equivalent force-couple system at point C.
 - b) Find the reactions at support D.



2. (15 marks) A loading ramp ABC is supported by two hinges A and B fastened to a wall and is held in a horizontal position by a cable DC. The hinge pins are aligned along the Z axis, so that the hinges do not exert any moments in any direction. If the ramp weighs 30 kN at point G (the center of gravity of the ramp), determine the tension in the cable and the reactions at each of the two hinges. Assume that the hinge at B does not exert any force in the Z direction.



Good luck,

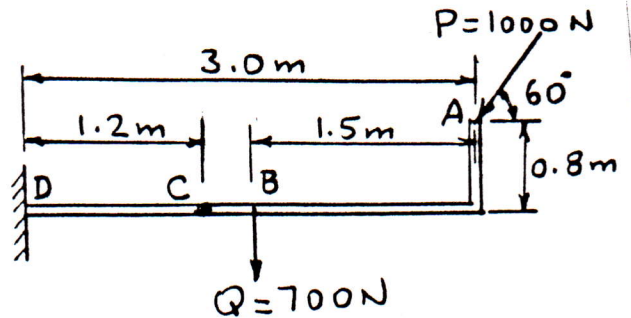
ENGINEERING MECHANICS

Mid-Term Exam

SOLUTIONS

1.

The bracket ABCD is loaded as shown.
The support at D is a fixed connection.



- a) Reduce the forces P and Q to an equivalent Force-couple system at point C.
- b) Find the reactions at point D.

a) $\vec{R} = \vec{P} + \vec{Q}$

$R_x = -1000 \text{ N} \cos 60^\circ = -500 \text{ N}$

$R_y = -1000 \text{ N} \sin 60^\circ - 700 \text{ N} = -1566 \text{ N}$

$\therefore R = \sqrt{(-500)^2 + (-1566)^2} = 1644 \text{ N} \text{ --- ANS.}$

$\alpha = \tan^{-1} \frac{-1566}{-500} = 72.29^\circ$; i.e. $R = \begin{matrix} 72.29^\circ \\ \swarrow \\ R = 1644 \text{ N} \end{matrix}$

$M_C = 1000 \cos 60^\circ \times 0.8 \text{ m} - 1000 \sin 60^\circ \times 1.8 \text{ m} - 700 \times 0.3 \text{ m}$
 $= 400 - 1559 - 210 = -1369 \text{ N.m. i.e. } M_C = 1369 \text{ N.m} \downarrow \text{ ANS.}$

b) $\sum F_x = 0$

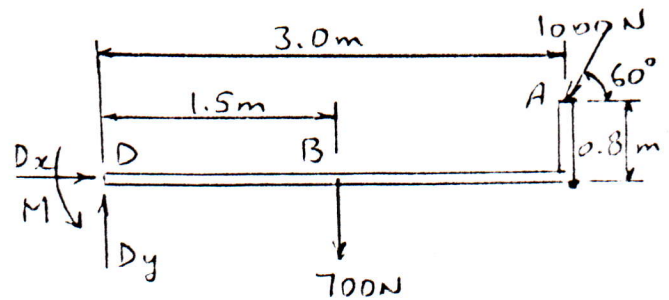
$D_x - 1000 \cos 60^\circ = 0$

$\therefore D_x = \underline{500 \text{ N}} \rightarrow \text{--- ANS.}$

$\sum F_y = 0$

$D_y - 1000 \sin 60^\circ - 700 = 0$

$D_y = \underline{1566 \text{ N}} \text{ --- ANS.}$



FBD - Bracket

$\sum M_D = 0$

$M + 1000 \cos 60^\circ \times 0.8 - 1000 \sin 60^\circ \times 3.0 - 700 \times 1.5 = 0$

$M + 400 - 2598 - 1050 = 0$

$\therefore M = \underline{3248 \text{ N.m}} \uparrow$

ANS.

2.

$$\sum M_A = 0;$$

$$r_{B/A} = -3\vec{k}$$

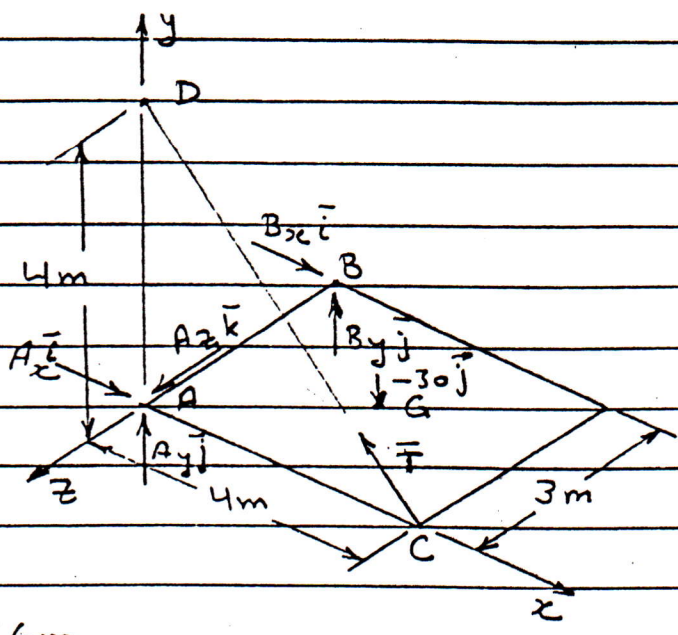
$$r_{C/A} = 4\vec{i}$$

$$r_{G/A} = 2\vec{i} - 1.5\vec{k}$$

$$\vec{CD} = -4\vec{i} + 4\vec{j}$$

$$\therefore CD = \sqrt{32} = 5.66\text{m}$$

$$\vec{T} = T \frac{\vec{CD}}{CD} = \frac{T}{5.66} (-4\vec{i} + 4\vec{j})$$



$$\sum M_A = 0; (r_{C/A} \times \vec{T}) + r_{G/A} \times (-30\text{kN})\vec{j} + r_{B/A} \times \vec{B} = 0$$

+	-	+		+	-	+	+	-	+	
\vec{i}	\vec{j}	\vec{k}		\vec{i}	\vec{j}	\vec{k}		\vec{i}	\vec{j}	\vec{k}
4	0	0	$\frac{T}{5.66} +$	2	0	-1.5	+	0	0	-3
-4	4	0		0	-30	0		B_x	B_y	0

Coeff. of (\vec{i}) : $0 - 45 + 3B_y = 0$; $\therefore B_y = +15\text{ kN} \uparrow$

Coeff. of (\vec{j}) : $0 + 0 + 3B_x = 0$; $\therefore B_x = 0$; Hence $B = (15\text{ kN})\vec{j}$

Coeff. of (\vec{k}) : $16 \times \frac{T}{5.66} - 60 + 0 = 0$;
 $2.83T = 60$; $\therefore T = 21.20\text{ kN}$

$$\sum \vec{F} = 0$$

$$\vec{A} + \vec{B} + \vec{T} - (30\text{ kN})\vec{j} = 0$$

Coeff. of (\vec{i}) : $A_x - \frac{4}{5.66} (21.2) = 0$; $\therefore A_x = 15\text{ kN} \rightarrow$

Coeff. of (\vec{j}) : $A_y + 15 + \frac{4}{5.66} (21.2) - 30 = 0$; $\therefore A_y = 0$

Coeff. of (\vec{k}) : $A_z + 0 + 0 = 0$; $\therefore A_z = 0$

$$\therefore A = \underline{(15\text{ kN})\vec{i}}$$

ANS.

END