Department of Mechanical Engineering (NITC)

S1ME **ZZ1001D ENGINEERING MECHANICS** **Tutorial Test 4-Set4**

Time: One Hour **Answer Key** Maximum Marks: 20

1. For the beam and loading shown in Fig. 1, determine the range of values of *W* for which the magnitude of the couple at *D* does not exceed 40 lb ft.

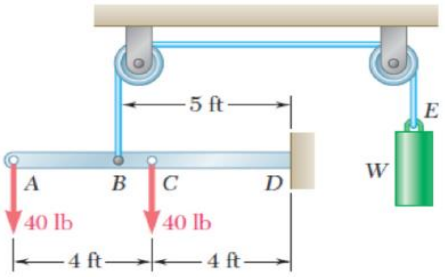
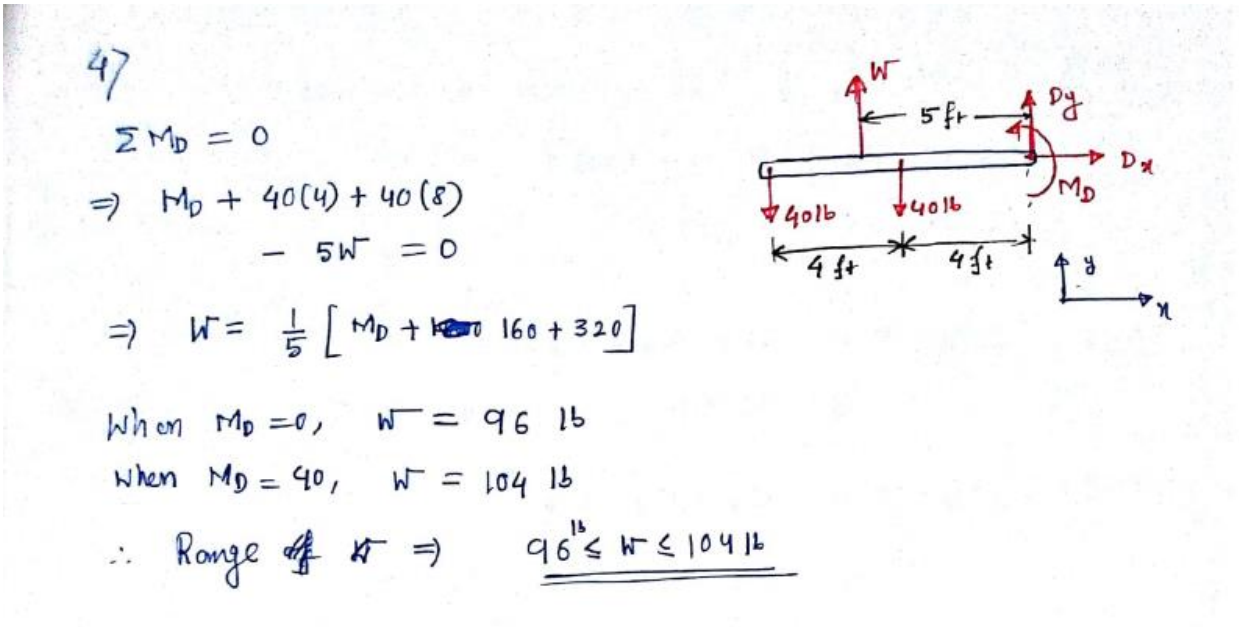


Figure 1

Solution:



2. Find the supporting force system for the cantilever beams connected to bar *AB* by pins (Fig. 2).

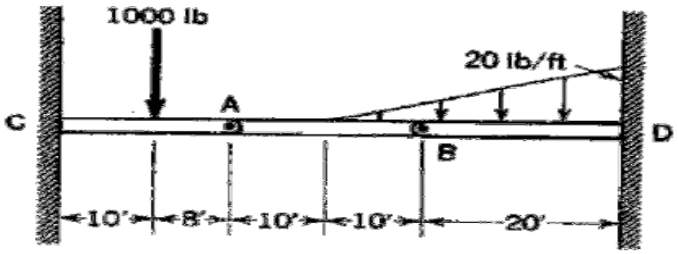
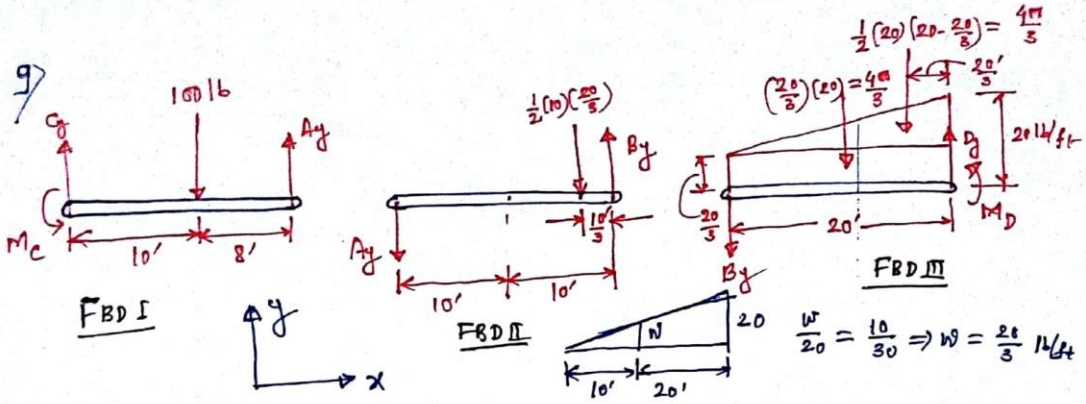


Figure 2

Solution:

9)



FBD III :

$$\Sigma F_y = 0 \Rightarrow D_y - B_y = \left(\frac{20}{3}\right)(20) + \frac{1}{2}(20)\left(20 - \frac{20}{3}\right)$$

$$\Rightarrow D_y - B_y = \frac{400}{3} + \frac{400}{3}$$

$$\Rightarrow D_y - B_y = \frac{800}{3} \quad \text{(i)}$$

$$\Sigma M_B = 0 \Rightarrow 20 D_y = \left(\frac{400}{3}\right)(10) + \left(\frac{400}{3}\right)\left(20 \cdot \frac{2}{3}\right) - M_D$$

$$= \frac{4000}{3} + \frac{16,000}{9} - M_D$$

$$\Rightarrow 20 D_y = \frac{28,000}{9} - M_D \quad \text{(ii)}$$

$$\Sigma M_D = 0 \Rightarrow 20 B_y = -M_D - \frac{400}{3}(10) - \frac{400}{3}\left(\frac{20}{3}\right)$$

$$\Rightarrow 20 B_y = -\frac{20,000}{9} - M_D \quad \text{(iii)}$$

FBD II :

$$\Sigma F_y = 0 \Rightarrow B_y - A_y - \frac{200}{6} = 0 \Rightarrow A_y = B_y - \frac{100}{3} \quad \text{(iv)}$$

$$\Sigma M_A = 0 \Rightarrow 20 B_y = \frac{100}{3}\left(20 - \frac{10}{3}\right) = \frac{5000}{9}$$

$$\Rightarrow \boxed{B_y = \frac{250}{9}} \quad \text{(v)}$$

(i) $\Rightarrow \quad D_y = \frac{800}{3} + B_y = \frac{800}{3} + \frac{250}{9} = \frac{2650}{9}$

$\Rightarrow \boxed{D_y = 294.44 \text{ lb}}$

(ii) $\Rightarrow \quad M_D = \frac{28,000}{9} - 20 D_y = \frac{28000}{9} - 20(294.44)$

$\Rightarrow \boxed{M_D = -2777.78} \text{ lb-ft}$

(iv) $\Rightarrow \quad A_y = B_y - \frac{100}{3} = \frac{250}{9} - \frac{100}{3} = -\frac{50}{9} \text{ lb}$

FBD I :

$\Sigma F_y = 0 \Rightarrow \quad C_y + A_y = 1000 \Rightarrow C_y = 1000 - A_y = 1000 + \frac{50}{9} = \frac{9050}{9}$

$\Rightarrow \boxed{C_y = 1005.55 \text{ lb}}$

$\Sigma M_c = 0 \Rightarrow \quad M_c + 18 A_y - 1000(10) = 0$

$\Rightarrow \quad M_c = 10,000 - 18\left(-\frac{50}{9}\right) = \frac{90,000 + 900}{9}$

$\Rightarrow \boxed{M_c = 10100 \text{ lb-ft}}$

$\therefore$ Ans:

$C_y = 1005.55 \text{ lb}$

$D_y = 294.44 \text{ lb}$

$M_c = 10100 \text{ lb-ft}$

$M_D = -2777.78 \text{ lb-ft}$

3. If P = 6kN, x = 0.75 m and y = 1 m, determine the tension developed in cables *AB*, *CD*, and *EF* (Fig. 3). Neglect the weight of the plate.

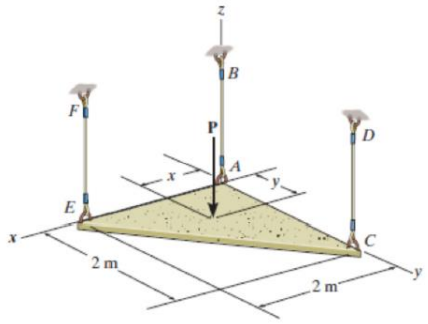


Figure 3

Solution:

14)

$\Sigma M_x = 0$

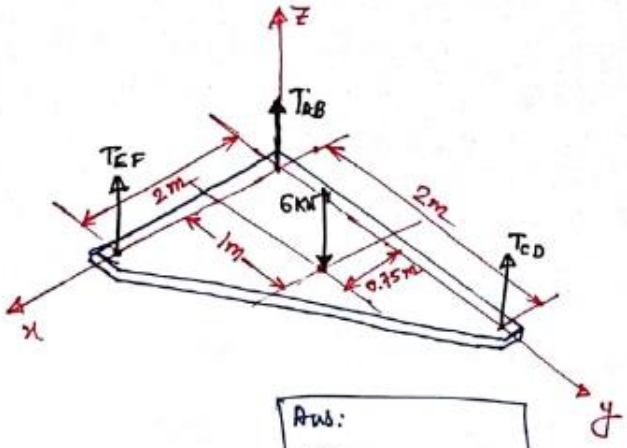
$\Rightarrow 2T_{CD} - 1(6) = 0$

$\Rightarrow T_{CD} = 3\ KN$

$\Sigma M_y = 0$

$\Rightarrow -2T_{EF} + 6(0.75) = 0$

$\Rightarrow T_{EF} = 2.25\ KN$



Ans:
$T_{AB} = 0.75KN$
$T_{CD} = 3\ KN$
$T_{EF} = 2.25\ KN$

$F_z = 0 \Rightarrow T_{AB} + T_{EF} + T_{CD} - 6 = 0$

$\Rightarrow T_{AB} = 6 - 3 - 2.25 \Rightarrow T_{AB} = 0.75\ KN$

4. Draw the free-body diagram of the dumpster *D* of the truck, which has a weight of 5000 lb and a centre of gravity at *G*. It is supported by a pin at *A* and a pin-connected hydraulic cylinder *BC* (short link). Explain the significance of each force on the diagram. (See Fig. 4.)

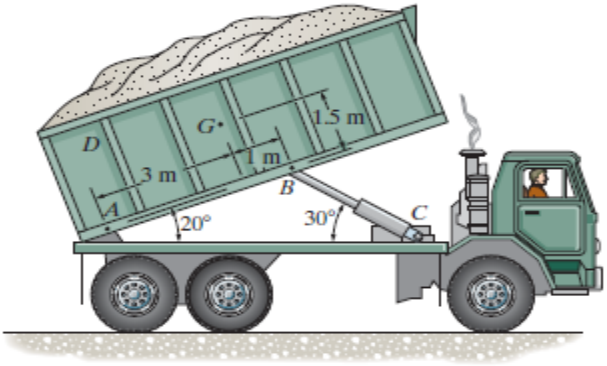
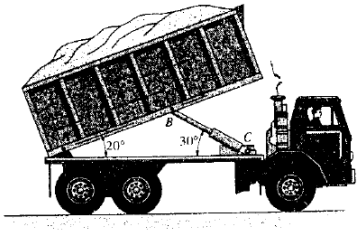
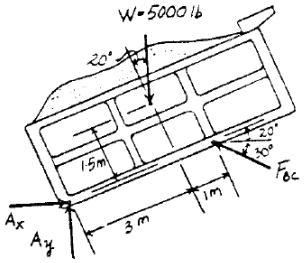


figure 4

Solution:

5-3. Draw the free-body diagram of the dumpster *D* of the truck, which has a weight of 5000 lb and a center of gravity at *G*. It is supported by a pin at *A* and a pin-connected hydraulic cylinder *BC* (short link) Explain the significance of each force on the diagram. (See Fig. 5–7*b*.)





The Significance of Each Force :

W is the effect of gravity (weight) on the dumpster.

A_y and A_x are the pin A reactions on the dumpster.

F_{BC} is the hydraulic cylinder BC reaction on the dumpster.