ANSWER

Ave: 60.82

MSE 221 Term Test 1 Oct. 11, 16

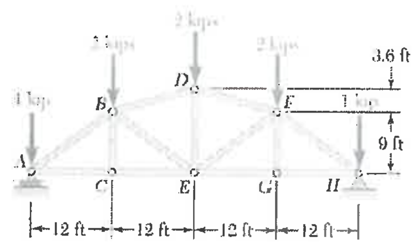
Max: 97.8

Student Name: ______________________ **Student No.** ______________________

Min: 24.2

1. True or False problems. Fill in "T" if it is true; otherwise fill in "F" (20 marks)

   1) F Truss and beam differs from their choice of material and construction; beams are usually built stronger than trusses.
   2) T For static analysis of frames and machines, it is wise to identify those two-force members first.
   3) T For the truss structure below, there is no tension or compression in truss BC.



   4)
   5) T The principle of transmissibility should be used with care in determining internal forces and deformations.
   6) F For two vectors **P** and **Q**, we have **P** x **Q** = **Q** x **P** (**x** is the cross product).
   7) T For unit vector **j**, these two equations are correct: **j** x **j** = 0, **j** · **j** = 1
   8) T The moment of a force couple is a free vector, which can be applied at any point.
   9) F In a free body diagram, one needs to find out all the forces on and by the rigid body of concern.
   10) F In a three-force body, all three forces must be collinear.

1	2	3	4	5
17.8	15.6	13.4	11.2	9

3x 2.2

6.6

13.4

4.4

8.8

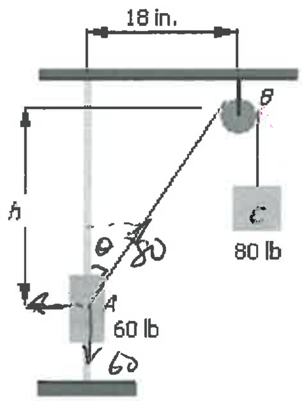
11.2

2.2

5

11.0

2. Multiple choice questions. Circle the closest answer (5 marks).



The 60-lb collar at *A* which can slide on the frictionless vertical rod shown is connected to a 80-lb counterweight *C*. Determine the value of *h* for which the system is in equilibrium.

For A to be in equilibrium,

$80\cos\theta = 60$

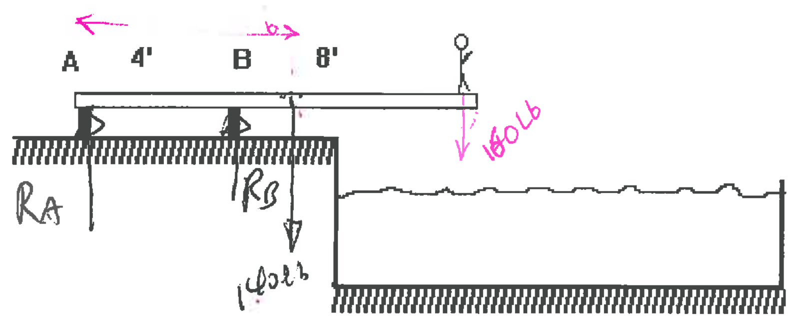
$\therefore \cos\theta = \frac{60}{80} = \frac{3}{4}$ $\quad \sin\theta = \sqrt{1-\cos^2\theta} = \frac{\sqrt{7}}{4}$

$\tan\theta = \frac{18}{h}$ $\quad \therefore h = \frac{18\cos\theta}{\sin\theta} = \frac{18\times\frac{3}{4}}{\frac{\sqrt{7}}{4}} = 20.4'$

The height (in in.) is h = ▸

a) 13.5" **b) 18"** **c) 20"** **d) 24"**

3. A 160 lb person is standing at the end of a diving board as shown below. The diving board weighs 140 lbs, and this weight may be considered to act at the center of the board. Calculate the vertical forces acting at each support, A & B. (10 marks)



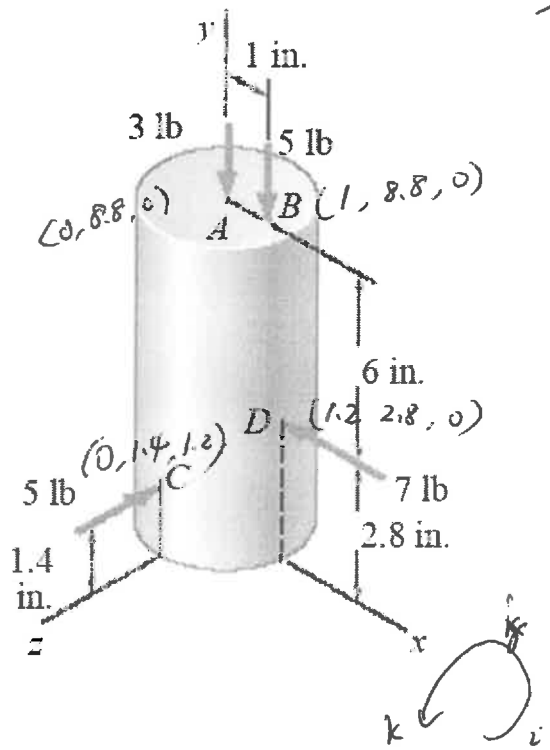
Let $\vec{M_A} = 0$

$R_B \cdot 4 - 140\times 6 - 160\times 12 = 0$

$\therefore R_B = 690$ lbs ↑

Let $\sum \vec{F_y} = 0$ $\quad R_A = 140 + 160 - R_B = -390$ lbs ↓

4. As plastic bushings are inserted into a 2.4–in. diameter cylindrical sheet metal container, the insertion tool exerts the forces shown on the enclosure. Each of the forces is parallel to one of the coordinate axes. Replace these forces with an equivalent force–couple system at C. (20 marks)



Solutions

$\vec{R}_C = -7\vec{i} - 8\vec{j} - 5\vec{k}$

$\Sigma \vec{F}_x = -7$ lb

$\Sigma \vec{F}_y = -8$ lb

$\Sigma \vec{F}_z = -5$ lb

$$\Sigma \vec{M}_C = \vec{r}_{CA} \times \vec{F}_A + \vec{r}_{CB} \times \vec{F}_B + \vec{r}_{CD} \times \vec{F}_D$$

$$= (7.4\vec{j} - 1.2\vec{k}) \times (-3\vec{j})$$

$$+ (\vec{i} + 7.4\vec{j} - 1.2\vec{k}) \times (-5\vec{j})$$

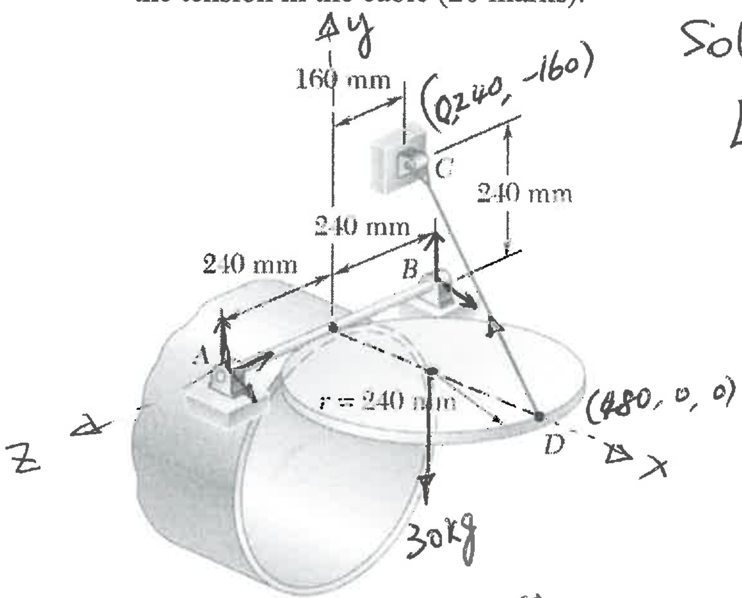
$$+ (1.2\vec{i} + 1.4\vec{j} - 1.2\vec{k}) \times (-7\vec{i})$$

$$= -3.6\vec{i} - 5\vec{k} - 6\vec{i} + 9.8\vec{k} + 8.4\vec{j}$$

$$= -9.6\vec{i} + 8.4\vec{j} + 4.8\vec{k}$$

5.

5. A uniform pipe cover of radius r=240 mm and mass 30 kg is held in a horizontal position by the cable CD. Assuming that the bearing at B does on exert any axial thrust, determine the tension in the cable (20 marks).



Solution

Let $\sum \vec{M}_{AB} = 0$ 6

$$\vec{\lambda}_{AB} = \vec{k}$$

$$\vec{r}_{DC} = -480\vec{i} + 240\vec{j} - 160\vec{k}$$

$$\frac{\vec{r}_{DC}}{|\vec{r}_{DC}|} = -\frac{6}{7}\vec{i} + \frac{3}{7}\vec{j} - \frac{2}{7}\vec{k}$$

-0.857 0.428 $\frac{2}{7} = 0.28$

$$\therefore \vec{M}_{T/AB} = \begin{vmatrix} 0 & 0 & 1 \\ 480 & 0 & 0 \\ -\frac{6}{7}T & \frac{3}{7}T & -\frac{2}{7}T \end{vmatrix} = \frac{480 \times 3}{7} T\,\vec{k}$$

6

$$M_{G/AB} = \begin{vmatrix} 0 & 0 & 1 \\ 240 & 0 & 0 \\ 0 & -30 \times 9.8 & 0 \end{vmatrix} = -240 \times 30 \times 9.8\,\vec{k}$$

6

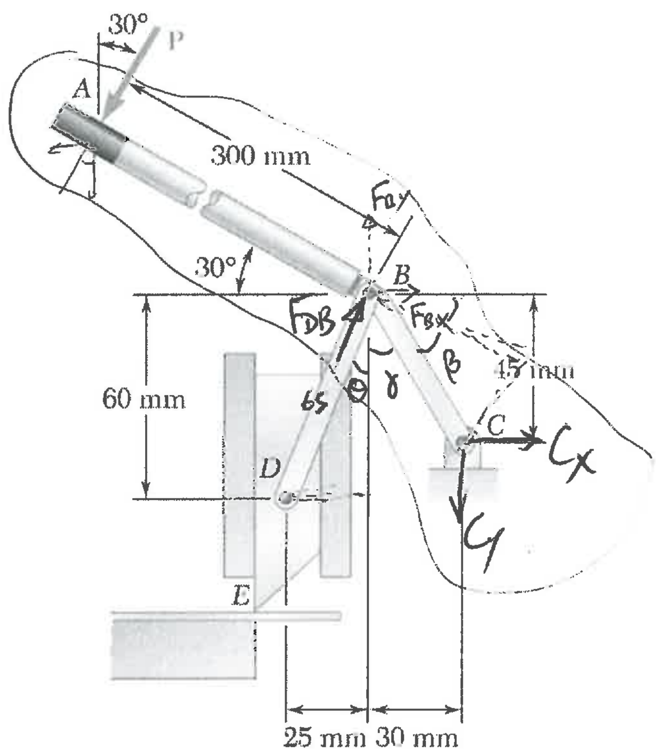
$$\Sigma M = M_{T/AB} + M_{G/AB} = 0$$

$$\therefore \frac{480 \times 3}{7} T = 240 \times 30 \times 9.8$$

$\therefore T = 343\ N$ along D→C direction

2 $\vec{T} = 343\left(-\frac{6}{7}\vec{i} + \frac{3}{7}\vec{j} - \frac{2}{7}\vec{k}\right) = -294\vec{i} + 147\vec{j} - 98\vec{k}\ (N)$

6. The shear shown is used to trim electronic-circuit-board laminates. Knowing that P = 600N, determine a) the vertical component of the force exerted on the shearing blade at D, b) the reaction at C (25 marks).



Let

$\vec{M}_C = 0$

$\therefore F_{DB}\cdot\cos\theta = F_{DB}\frac{60}{65} = F_{BY}$

$F_{DB}\sin\theta = F_{DB}\cdot\frac{25}{65} = F_{BX}$

$\tan\gamma = \frac{30}{45}$ $\quad \gamma = 33.7^\circ$

$\therefore \beta = 90^\circ - 30^\circ - 33.7^\circ = 26.3^\circ$

$\sum M_C$

$P \times (300 + \frac{45}{\cos\gamma}\cos\beta)$

$- F_{Bx}\times 45 - F_{By}\cdot 30 = 0$

$600(300 + \frac{45}{0.832}\cdot 0.896)$

$= F_{DB}(0.385\times 45 + 0.923\times 30)$

$\therefore \vec{F}_{DB} = 4646\,N$

$F_{By} = 4646\times\frac{60}{65} = 4289\,N \downarrow$

$\sum F_x = 0 \quad : \quad P\sin 30^\circ = F_{Bx} + C_x$

$\therefore C_x = -1487\,N \leftarrow$

$\sum F_y = 0 \quad -P\cos 30^\circ - C_y + 4290 = 0$

$C_y = 3769\,N \downarrow$