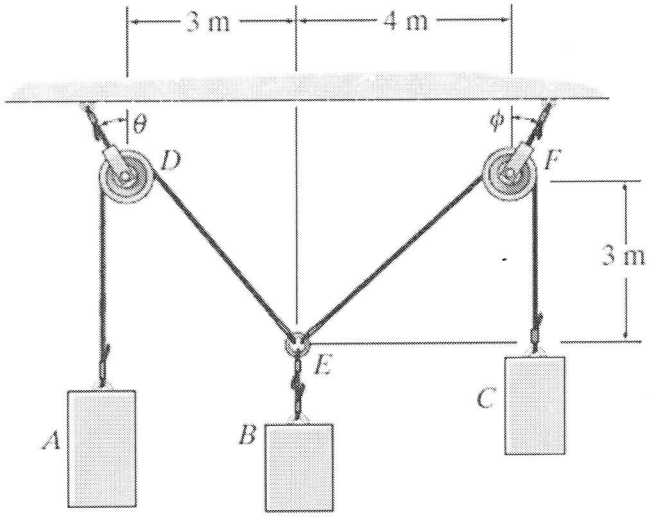
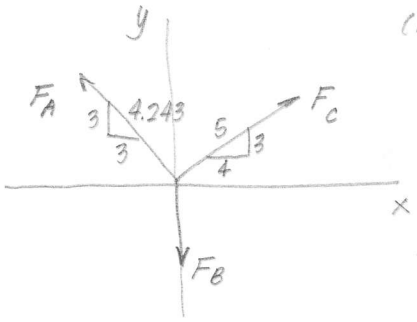
CME 250 – Statics
Exam #3 (09/27/2023)

StarID or TechID (no names) Grading

Show your work (you will not receive any credit if all you have is a final answer, right or wrong).
Do one of the two problems shown below (the second problem is on the back).

1. Block A has a mass of 20 kg. Determine the weight of block B and the weight of block C so that the system is in equilibrium as shown. Also determine the angle θ shown above pulley D.




(1 pt)

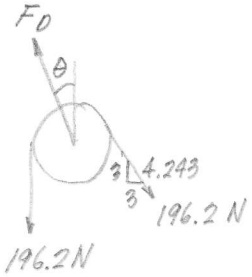
$F_A = (20\,kg)(9.81\,\frac{m}{s^2}) = 196.2\,N$ (0.5 pts)

$\sum F_x = 0,\ \frac{-3}{4.243}(196.2\,N) + \frac{4}{5}F_C = 0$

$F_C = 173.4\,N \rightarrow \boxed{173\,N}$ (3 pts)

$\sum F_y = 0,\ \frac{3}{4.243}(196.2\,N) + \frac{3}{5}(173.4\,N) - F_B = 0$

$F_B = 242.8\,N \rightarrow \boxed{243\,N}$ (3 pts)




$\sum F_x = 0,\ -F_D \sin\theta + \frac{3}{4.243}(196.2\,N) = 0$ (1 pt)

$\sum F_y = 0,\ F_D \cos\theta - 196.2\,N - \frac{3}{4.243}(196.2\,N) = 0$ (1 pt)

$F_D \sin\theta = 138.7\,N$

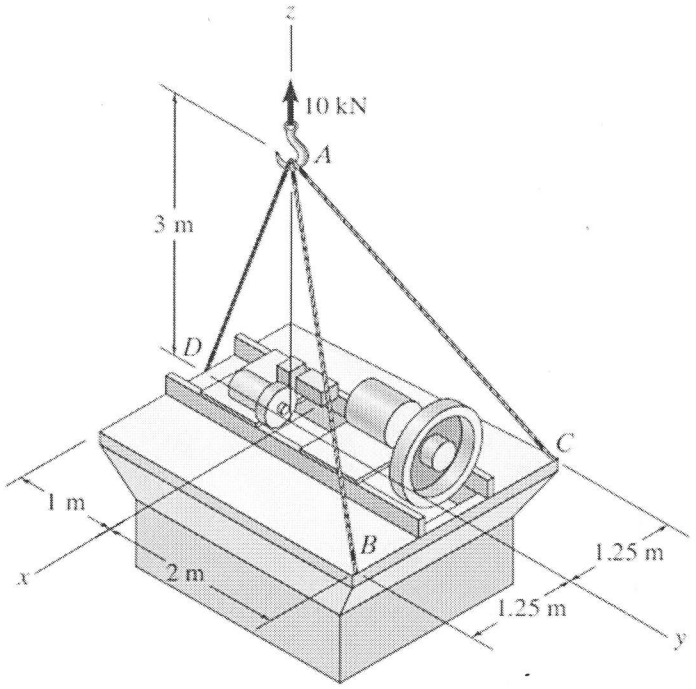
$F_D \cos\theta = 334.9\,N$

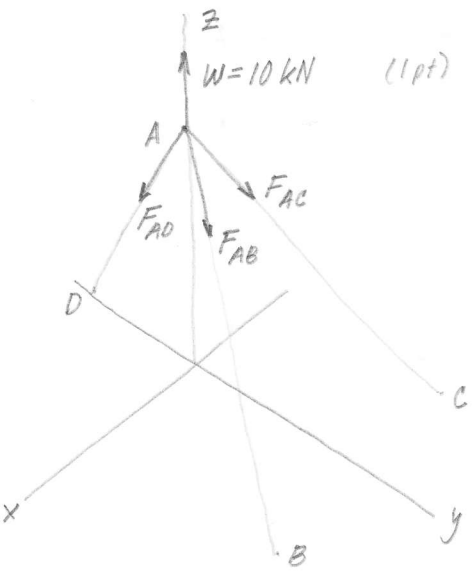
$\frac{F_D \sin\theta}{F_D \cos\theta} = \frac{138.7\,N}{334.9\,N}$

$\tan\theta = 0.4142$

$\boxed{\theta = 22.5^\circ}$ (0.5 pts)

2. What is the tension in each cable assuming the piece of equipment is in equilibrium as shown.




(1 pt)

$$\vec{F}_{AB} = F_{AB}\frac{\vec{r}_{AB}}{r_{AB}}$$

$\vec{r}_{AB} = 1.25i + 2j - 3k$ (m) (1 pt)

$r_{AB} = 3.816$ (m)

$\vec{F}_{AB} = 0.3276F_{AB}i + 0.5241F_{AB}j - 0.7861F_{AB}k$ (1 pt)

$\vec{F}_{AC} = -0.3276F_{AC}i + 0.5241F_{AC}j - 0.7861F_{AC}k$ (1 pt)

$$\vec{F}_{AD} = F_{AD}\frac{\vec{r}_{AD}}{r_{AD}}$$

$\vec{r}_{AD} = -1j - 3k$ (m) (1 pt)

$r_{AD} = 3.162$ (m)

$\vec{F}_{AD} = -0.3162F_{AD}j - 0.9488F_{AD}k$ (1 pt)

$\vec{W} = 10k$ (kN)

$\Sigma F_x = 0$: $0.3276F_{AB} - 0.3276F_{AC} = 0$ ... (1) (1 pt)

$\Sigma F_y = 0$: $0.5241F_{AB} + 0.5241F_{AC} - 0.3162F_{AD} = 0$ ... (2) (1 pt)

$\Sigma F_z = 0$: $-0.7861F_{AB} - 0.7861F_{AC} - 0.9488F_{AD} = -10$ kN ... (3) (1 pt)

from calculator: $\boxed{F_{AB} = 2.12 \text{ kN}}$

$\boxed{F_{AC} = 2.12 \text{ kN}}$ (1 pt)

$\boxed{F_{AD} = 7.03 \text{ kN}}$

by hand:

from (1): $F_{AB} = F_{AC}$ ... (4)

from (2): $0.3162F_{AD} = 1.0482F_{AC}$

$F_{AD} = 3.315F_{AC}$ ... (5)

subst (4) & (5) into (3):

$-0.7861F_{AC} - 0.7861F_{AC} - (0.9488)(3.315F_{AC}) = -10$ kN

$4.7175F_{AC} = 10$ kN

$F_{AB} = F_{AC} = 2.120$ kN, $F_{AD} = 3.315(2.120 \text{ kN})$

$F_{AD} = 7.027$ kN