King Fahd University of Petroleum & Minerals
CIVIL ENGINEERING DEPARTMENT

CE 201 STATICS
First Major Exam
[092]

Tue. 23 March 2010
7:00 p.m → 9:00 p.m.

Student Name: .....

Solved by the instructors who put the problems
(Coordinated course)

Student I.D. #: .....

SECTION: ☐

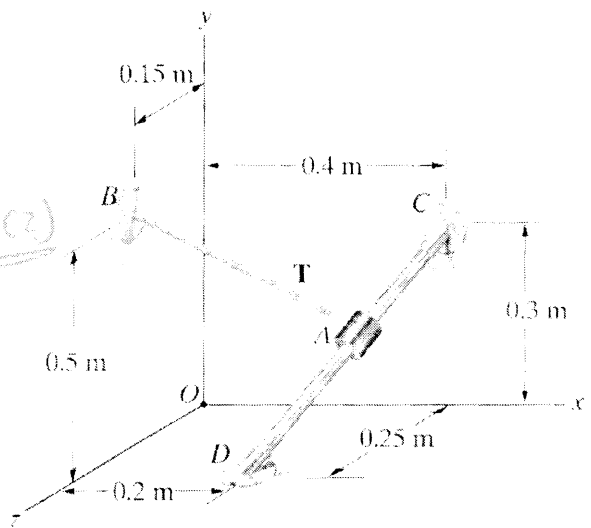
Question	Grade	Score
1	25	
2	25	
3	25	
4	25	
TOTAL	**100**	

Good luck !

Problem # 1 (25 points)

The cable (AB) exerts a 50-N force (T) on the collar at point (A). Point (A) is located midway between points (C) and (D).

Part A (10 points) Express the force (T) in Cartesian vector form.
Part B (10 points) Determine the magnitude of the components of (T) parallel and perpendicular to member (CD).
Part C (5 points) Find the angle between (T) and (AC).



(4) Magnitude of $\vec{CD} = \sqrt{(6)^2 + (-4)^2 + (-3)^2} = 7.81$ N

PART B (5 marks)

Angle between $(\vec{T})$ and $(\vec{CD}) = \phi$

$$\cos\phi = \frac{\vec{T} \cdot \vec{CD}}{|\vec{T}| \times |\vec{CD}|} = \frac{9.713}{50}$$

(5)

$$= 0.196$$

$$\therefore \phi = 78.7^\circ$$

Question # 2 (25 points)

In the cable assembly shown below:

AB = 897 N
AC = 732 N

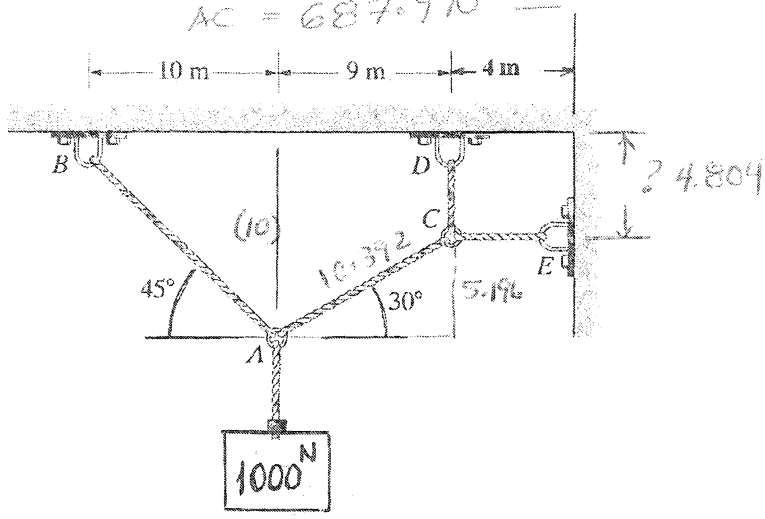
(10 points) Part A: Find the tension in cables (AB) and AC)?

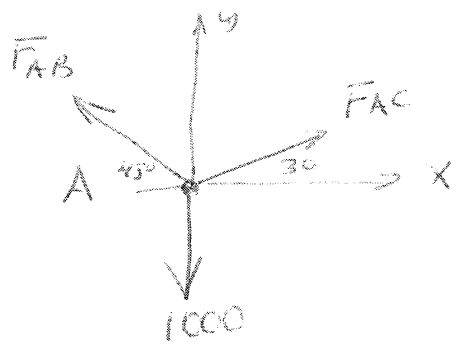
10, 8, 6, 4, 2, 0

(15 points) Part B: If cable (CE) is removed, what will the force be in cables (AB) and (AC)?

AB = 622.5 N
AC = 687.9 N

15, 12, 9, 6, 3, 0





$\Sigma F_x = 0 \xrightarrow{+} \quad F_{AC}\cos 30 - F_{AB}\cos 45 = 0$

$0.866\,F_{AC} - 0.707\,F_{AB} = 0 \quad \therefore \quad F_{AC} = 0.817\,F_{AB}$

$F_{AB} = 1.225\,F_{AC}$

$\Sigma F_y = 0 \uparrow^{+} \quad F_{AC}\sin 30^\circ + F_{AB}\sin 45^\circ - 1000 = 0$

$0.5\,F_{AC} + 0.707\,F_{AB} = 1000$

$0.5\,F_{AC} + 0.707(1.225)F_{AC} = 1000$

$1.366\,F_{AC} = 1000 \longrightarrow F_{AC} = 732\ N$

$\longrightarrow F_{AB} = 897\ N$ ANS

or add $0.866F_{AC} - 0.707F_{AB} = 0$

$0.5F_{AC} + 0.707F_{AB} - 1000 = 0$

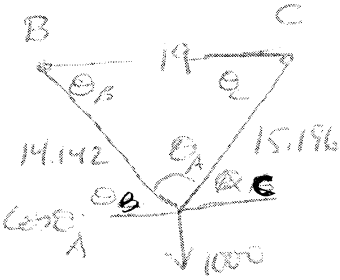
$1.366F_{AC} - 1000 = 0 \quad \therefore \quad F_{AC} = 732\ N$

Part B

Cable ACD = 10.392 + 4.804 = 15.196 m

Cable AB = $\sqrt{10^2 + 10^2} = \sqrt{200} = 14.142$ m

Distance BD = 19 m



$19 = \sqrt{14.142^2 + 15.196^2 - 2(14.142)(15.196)\cos\theta_A}$

$361 - 199.996 - 230.92 = -429.8\cos\theta_A$

-69.916

$\cos\theta_A = \frac{0.163}{0.16267} \longrightarrow \theta = 80.62^\circ$ 80.64°

angle at C → $14.142 = 19 + 15.196 - 2(19)(15.196)\cos\theta_C$

$199.996 = 361 + 230.92 - 577.448\cos\theta_C$

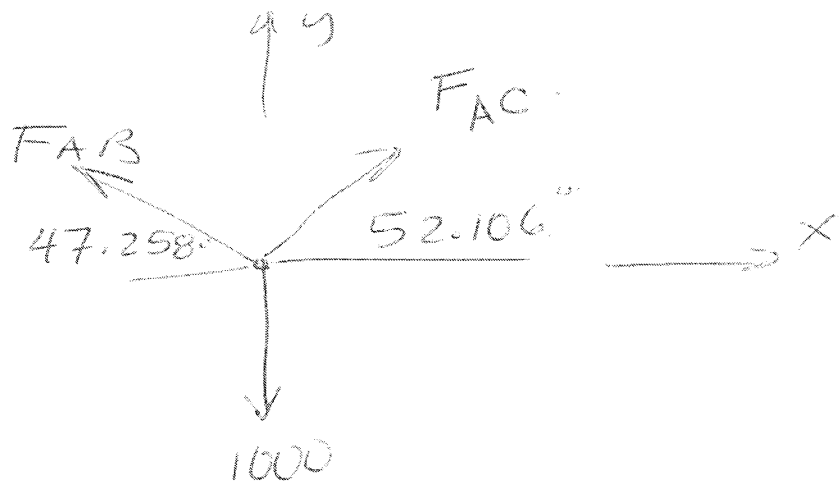
$\cos\theta_C = 0.6787 \rightarrow \theta_C = \underline{47.258^\circ}$

angle at B → $15.196^2 = 19^2 + 14.142^2 - 2(19)(14.142)\cos\theta_B$

$230.92 = 361 + 199.996 - 537.396\,\theta_B$

$\cos\theta_B = 0.6142 \rightarrow \theta_B = 52.106$

$\theta_A + \theta_B + \theta_C = 180.004^\circ$; OK.



$\Sigma F_x = 0 \xrightarrow{+}$

$F_{AC}\cos 52.106 - F_{AB}\cos 47.258^\circ = 0$

$0.6142\,F_{AC} - 0.6787\,F_{AB} = 0$

$F_{AC} = 1.105\,F_{AB}$

$F_{AB} = 0.905\,F_{AC}$

$\Sigma F_y = 0 \uparrow +$

$F_{AC}\sin 52.106 + F_{AB}\sin 47.258 - 1000 = 0$

$0.7891\,F_{AC} + 0.7344\,F_{AB} - 1000 = 0$

$0.7891(1.105)F_{AB} + 0.7344\,F_{AB} - 1000 = 0$

$0.872\,F_{AB} + 0.7344\,F_{AB} - 1000 = 0$

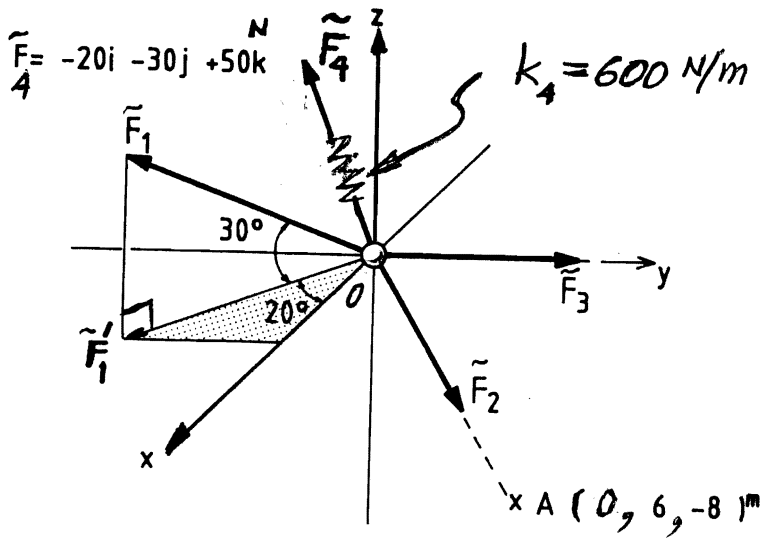
$1.6064\,F_{AB} = 1000 \therefore F_{AB} = \underline{622.5\ N}$

$F_{AC} = 1.105(622.5) = \underline{687.87\ N}$

Question # 3 (25 points)

(4 points) Part A: Find the elongation (Δ) of spring on F_4.

(21 points) Part B: Determine the magnitudes of forces $\tilde{F}_1$, $\tilde{F}_2$, & $\tilde{F}_3$ for the equilibrium of particle (O)?



Part (A):

$$|\tilde{F}_4| = \sqrt{(20)^2+(30)^2+(50)^2} = 61.6^{N}$$

$$\Delta = \frac{|F_4|}{k_4} = \frac{61.6^{N}}{600} = 0.103^{m}$$

Part (B):

(6) $\tilde{F}_1 = |\tilde{F}_1|\cos 30\cos 20\,\tilde{i} - |\tilde{F}_1|\cos 30\sin 20\,\tilde{j} + |\tilde{F}_1|\sin 30\,\tilde{k}$

$$\tilde{u}_{OA} = \frac{\tilde{r}_{OA}}{|\tilde{r}_{OA}|} = \frac{0\tilde{i}+6\tilde{j}-8\tilde{k}}{\sqrt{0^2+6^2+8^2}} = 0\tilde{i}+0.6\tilde{j}-0.8\tilde{k}$$

(6) $\tilde{F}_2 = |\tilde{F}_2|\,\tilde{u}_{OA} = 0\tilde{i} + 0.6|\tilde{F}_2|\tilde{j} - 0.8|\tilde{F}_2|\tilde{k}$

(2) $\tilde{F}_3 = |\tilde{F}_3|\,\tilde{j}$, $\tilde{F}_4 = -20\tilde{i} - 30\tilde{j} + 50\tilde{k}$ (N)

(2) $\sum F_x = 0 \Rightarrow |F_1|\cos 30\cos 20 - 20 = 0$ $\Rightarrow |F_1| = 24.57^{N}$

(3) $\sum F_y = 0 \Rightarrow -|\tilde{F}_1|\cos 30\sin 20 + 0.6|\tilde{F}_2| - 30 + |F_3| = 0$ --- (3)

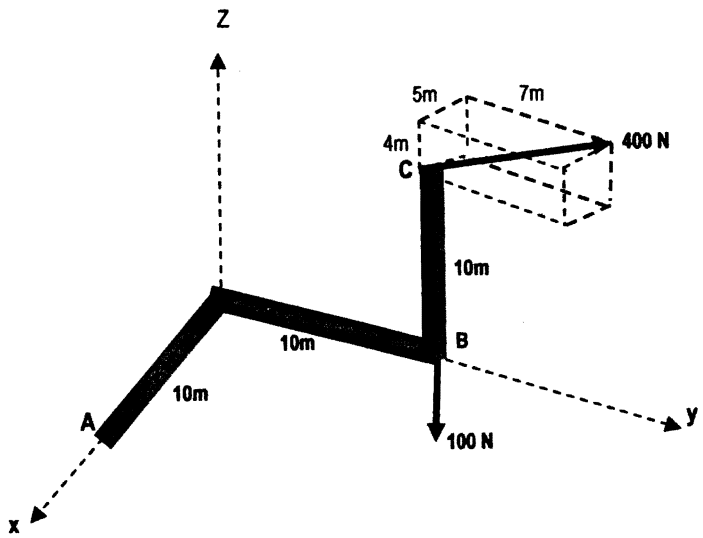
(2) $\sum F_z = 0 \Rightarrow |\tilde{F}_1|\sin 30 - 0.8|\tilde{F}_2| + 50 = 0$ --- (3)

from (3) $|\tilde{F}_2| = 77.86^{N}$

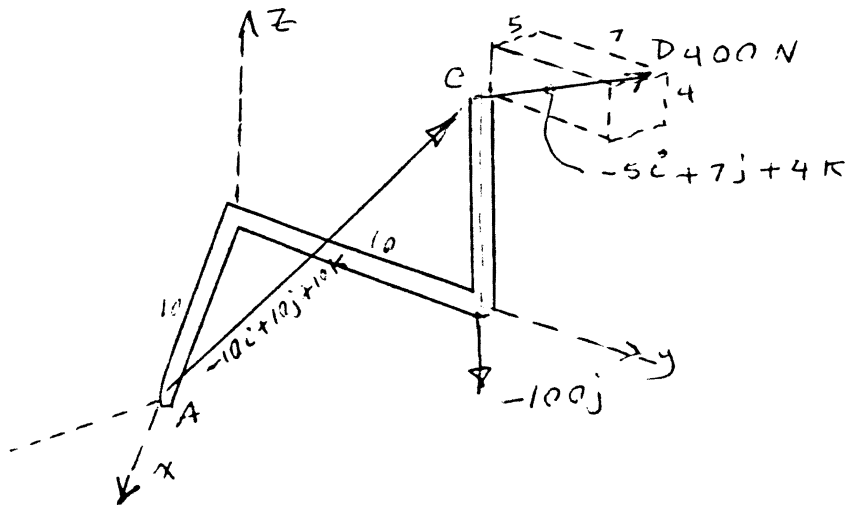
from (2) $|F_3| = -9.44^{N}$

Question # 4 (25 points)

In the figure shown below, find the resultant of moments caused by the 400^{N} force and the 100^{N} weight about point (A)? - use vector approach -



22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD



$$\vec{AC} = -10\,i + 10\,j + 10\,k$$
$$\vec{CD} = -5\,i + 7\,j + 4\,k$$

$$\vec{F} = (400)\left[\frac{-5\,\vec{i} + 7\,\vec{j} + 4\,\vec{k}}{\sqrt{25+49+16}}\right] = -210.8\,\vec{i} + 295.2\,\vec{j} + 168.7\,\vec{k}$$

$$M = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ -10 & +10 & +10 \\ -210.8 & +295.2 & +168.7 \end{vmatrix} + \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ -10 & 10 & 10 \\ 0 & 0 & -100 \end{vmatrix}$$

$$= \left[(+10)(+168.7) - (+10)(+295.2)\right]\vec{i} - \left[(-10)(168.7) - (+10)(-210.8)\right]\vec{j}$$
$$+ \left[(-10)(+295.2) - (+10)(-210.8)\right]\vec{k} + \left[(+10)(-100) - (10)(0)\right]\vec{i}$$
$$- \left[(-10)(-100) - (10)(0)\right]\vec{j} + \left[(-10)(0) - (10)(0)\right]\vec{k}$$

$$= \left[1687 - 2952 - 1000\right]\vec{i} + \left[1687 + 2108 - 1000\right]\vec{j}$$
$$+ \left[-2952 + 2108\right]\vec{k}$$

$$= 2265\,\vec{i} - 1420\,\vec{j} - 844\,\vec{k}$$