Quiz.1
Fall 2014-2015
(October 22, 2014)
CIVE210 – STATICS
CLOSED BOOK, 1 HR 15 Minutes

Name: ___ **ID#:** _

NOTES

- 3PROBLEMS– 10 PAGES.
- ALL YOUR ANSWERS SHOULD BE PROVIDED ON THE QUESTION SHEETS.
- **TWO EXTRA SHEETS ARE PROVIDED AT THE END.**
- **ASK FOR ADDITIONAL SHEETS IF YOU NEED MORE SPACE.**
- SOME ANSWERS MAY REQUIRE MUCH LESS THAN THE SPACE PROVIDED.
- ***DO NOT*** USE THE BACK OF THE SHEETS FOR ANSWERS.
- QUESTION SHEETS SHOULD BE RETURNED.

YOUR COMMENT(S)

- -

- -

DO NOT WRITE IN THE SPACE BELOW

MY COMMENT(S)

- -

- -

YOUR GRADE

Problem I:	/30
Problem II:	/35
Problem III:	___ /35
TOTAL:	/100

Problem I: *(30 points)*

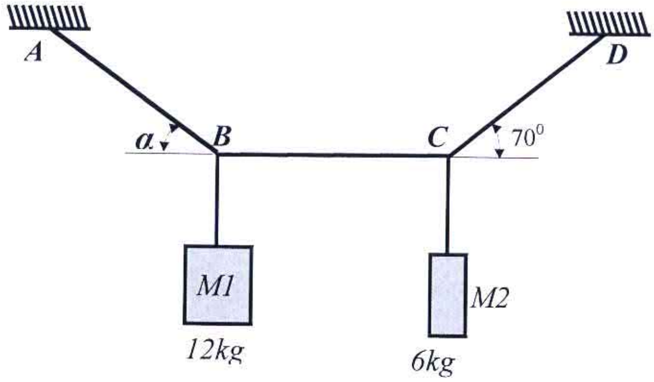


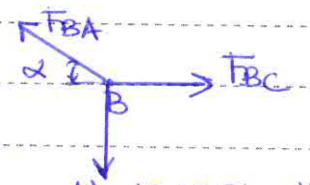
Figure I

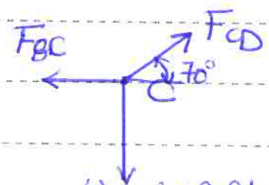
The masses M_1=12kg and M_2=6kg are suspended by the cable system shown in Figure I.

1. Determine the angle **α** and the tension in cables ***AB***, ***BC*** and ***CD***.

Calculations and/or Diagrams:

F.BD at B F.BD at C





$W = 12 \times 9.81 = 117.72\,N$ $W = 6 \times 9.81 = 58.86\,N$

Equilibrium at C:

$\overset{+}{\rightarrow} \sum F_x = 0 \Rightarrow -F_{BC} + F_{CD} \cos 70 = 0$ ---- (1)

$+\uparrow \sum F_y = 0 \Rightarrow F_{CD} \sin 70 - 58.86 = 0$ ---- (2)

From Eq.(2) $\Rightarrow \boxed{F_{CD} = 62.64\,N}$

From Eq.(1) $\Rightarrow -F_{BC} + 62.64 \cos 70 = 0 \Rightarrow \boxed{F_{BC} = 21.42\,N}$

Calculations and/or Diagrams (cont'd):

Equilibrium at B

$\xrightarrow{+} \sum F_x = 0 \Rightarrow -F_{BA} \cos\alpha + 21.42N = 0$

$\Rightarrow F_{BA} \cos\alpha = 21.42$ ——— (3)

$+\uparrow \sum F_y = 0 \Rightarrow F_{BA} \sin\alpha - 117.72 = 0$

$\Rightarrow F_{BA} \sin\alpha = 117.72$ ——— (4)

$\frac{Eq. (4)}{Eq. (3)} \Rightarrow \frac{F_{BA} \sin\alpha = 117.72}{F_{BA} \cos\alpha = 21.42} \Rightarrow \tan\alpha = \frac{117.72}{21.42}$

$\Rightarrow \boxed{\alpha = 79.7^\circ}$

From Eq. (3) $\Rightarrow F_{BA} \cos 79.7 = 21.42$

$\Rightarrow \boxed{F_{BA} = 119.8\ N}$

Problem II: *(35 points)*

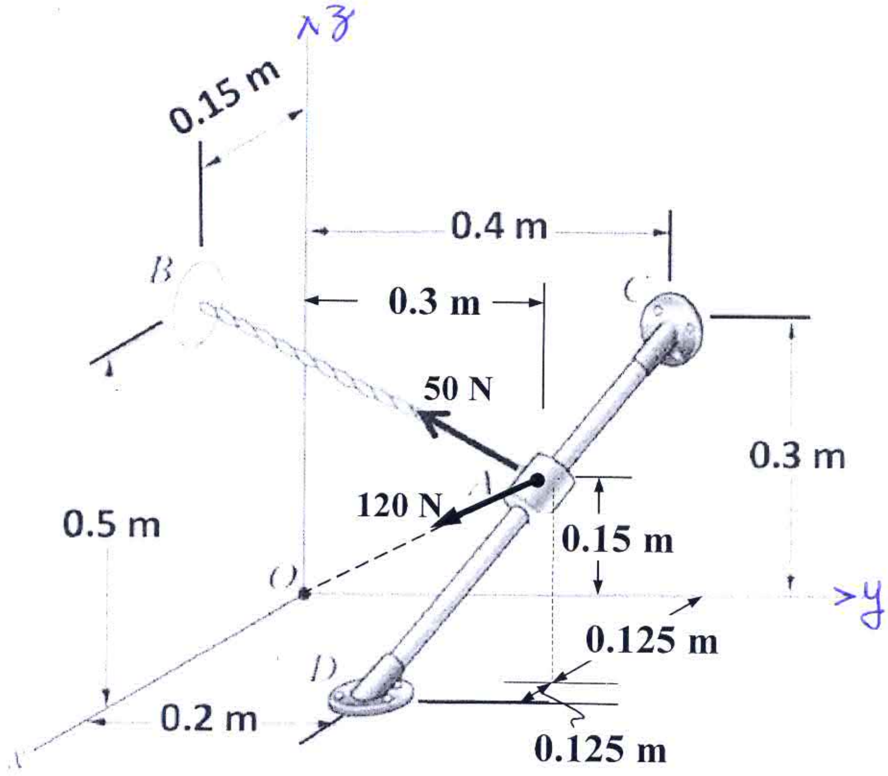


Figure II

The rod CD is subjected to two forces as shown in Figure II.

1. Determine the magnitude and direction of the resultant force F_R .*(18 points)*
2. Determine the projected components of the resultant force F_R along line ***CD*** and perpendicular to the line ***CD***. *(10 points)* , Express results in cartesian vector.
3. Determine the angle between the two forces shown in Figure II. *(7 points)*

Calculations and/or Diagrams (cont'd):

1- Coordinates: $O(0,0,0)$ $A(0.125, 0.3, 0.15)$ $B(0.15, 0, 0.5)$

$C(0, 0.4, 0.3)$ $D(0.25, 0.2, 0)$

Express forces as cartesian vector:

$$\vec{F}_{AB} = F_{AB}\,\vec{u}_{AB} = 50\left\{\frac{(0.15-0.125)\vec{i} + (0-0.3)\vec{j} + (0.5-0.15)\vec{k}}{\sqrt{(0.025)^2 + (-0.3)^2 + (0.35)^2}}\right\}$$

$$\vec{F}_{AB} = \{2.71\vec{i} - 32.47\vec{j} + 37.88\vec{k}\}\ N$$

Calculations and/or Diagrams (cont'd):

$$\vec{F}_{AO} = F_{AO}\,\vec{u}_{AO} = 120\left\{\frac{-0.125\vec{i} - 0.3\vec{j} - 0.15\vec{k}}{\sqrt{(-0.125)^2+(-0.3)^2+(0.15)^2}}\right\}$$

$$\Rightarrow \vec{F}_{AO} = \{-41.9\vec{i} - 100.56\vec{j} - 50.28\vec{k}\}\ N$$

Resultant force:

$F_{Rx} = 2.71 - 41.9 = -39.19\ N$

$F_{Ry} = -32.47 - 100.56 = -133.03\ N$

$F_{Rz} = 37.88 - 50.28 = -12.4\ N$

$$\boxed{\vec{F}_R = \{-39.19\vec{i} - 133.03\vec{j} - 12.4\vec{k}\}\ N}$$

Magnitude: $F_R = \sqrt{(-39.19)^2 + (-133.03)^2 + (-12.4)^2} = 139.24\ N$

$\boxed{F_R = 139.24\ N}$

Direction

$\cos\alpha = \frac{-39.19}{139.24}$ $\boxed{\alpha = 106.35^\circ}$

$\cos\beta = \frac{-133.03}{139.24}$ $\boxed{\beta = 162.8^\circ}$

$\cos\gamma = \frac{-12.4}{139.24}$ $\boxed{\gamma = 95.1^\circ}$

2. $\vec{u}_{CD} = \frac{0.25\vec{i} - 0.2\vec{j} - 0.3\vec{k}}{\sqrt{(0.25)^2+(-0.2)^2+(-0.3)^2}} = 0.569\vec{i} - 0.456\vec{j} - 0.683\vec{k}$

$F_{R//CD} = F_R \cdot \vec{u}_{CD} = \{-39.19\vec{i} - 133.03\vec{j} - 12.4\vec{k}\} \cdot \{0.569\vec{i} - 0.456\vec{j} - 0.6$

Calculations and/or Diagrams (cont'd):

$\Rightarrow \boxed{F_{R//CD} = 46.83\ N}$

$F_{R\perp CD} = \sqrt{F_R^2 - F_{R//CD}^2} = \sqrt{(139.24)^2 - (46.83)^2} = 131.13\ N$

$\boxed{F_{R\perp CD} = 131.13\ N}$

$\vec{F}_{R//CD} = F_{R//CD}\,\vec{u}_{CD} = 46.83\left\{0.569\vec{i} - 0.456\vec{j} - 0.683\vec{k}\right\}$

$\boxed{\vec{F}_{R//CD} = \left\{26.65\vec{i} - 21.35\vec{j} - 31.98\vec{k}\right\} N}$

3- $\vec{F}_{AB} \cdot \vec{F}_{AD} = F_{AB}\,F_{AD}\cos\theta$.

$\left\{2.71\vec{i} - 32.47\vec{j} + 37.88\vec{k}\right\} \cdot \left\{-41.9\vec{i} - 100.56\vec{j} - 50.28\vec{k}\right\} = (50)(120)\cos\theta$

$\Rightarrow \boxed{\theta = 78°}$

Problem III: *(35 points)*

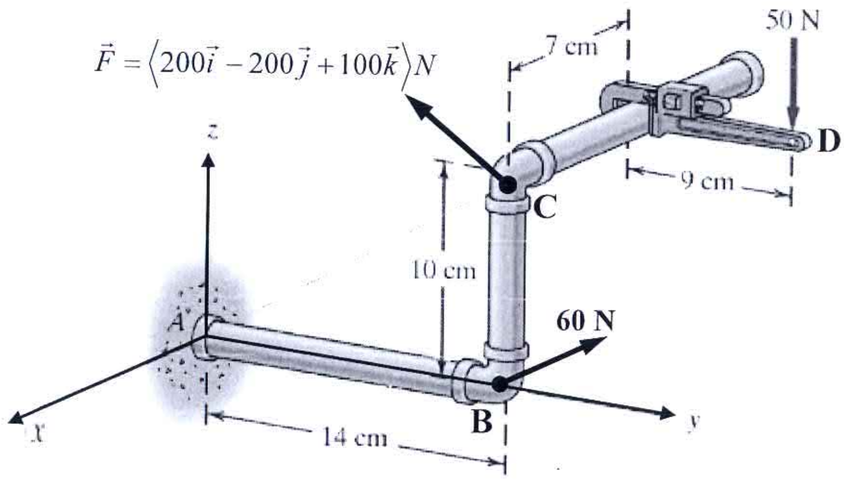


Figure III

The rigid pipe system is subjected to the forces shown in Figure III.

1. Use vector approach, compute the moment from the three forces at the support A. *(18 points).*
2. Use scalar Approach, Re-compute the three components Mx, My, and Mz at A due to the three forces, and compare with question 1. (*7 points*)
3. Determine the component of this moment about an axis extending between points A and C. Express the result as Cartesian vector. *(10 points)*

Calculations and/or Diagrams:

Coordinates: A(0, 0, 0) B(0, 14, 0) C(0, 14, 10)
D(−7, 23, 10)

1_ Vector Approach

$\vec{r}_{AB} = \{0\vec{i} + 14\vec{j} + 0\vec{k}\}^{cm}$

$\vec{r}_{AC} = \{0\vec{i} + 14\vec{j} + 10\vec{k}\}^{cm}$

$\vec{r}_{AD} = \{-7\vec{i} + 23\vec{j} + 10\vec{k}\}^{cm}$

$\vec{F}_B = \{-60\vec{i} + 0\vec{j} + 0\vec{k}\}^{N}$

Calculations and/or Diagrams (cont'd):

$$\vec{F_D} = \{0\vec{i} + 0\vec{j} - 50\vec{k}\}^N$$

$$\vec{M_A} = \vec{r_{AB}} \times \vec{F_B} + \vec{r_{AC}} \times \vec{F} + \vec{r_{AD}} \times \vec{F_D}$$

$$\begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 14 & 0 \\ -60 & 0 & 0 \end{vmatrix} + \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 14 & 10 \\ 200 & -200 & 100 \end{vmatrix} + \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ -7 & 23 & 10 \\ 0 & 0 & -50 \end{vmatrix}$$

$$= \{0\vec{i} + 0\vec{j} + 840\vec{k}\} + \{3400\vec{i} + 2000\vec{j} - 2800\vec{k}\} + \{-1150\vec{i} - 350\vec{j} + 0\vec{k}$$

$$\boxed{\vec{M_A} = \{2250\vec{i} + 1650\vec{j} - 1960\vec{k}\}^{N*cm}}$$

2- Scalar Approach:

$$M_x = 200(10) + 100(14) - 50(23) = 2250 \ N*cm$$

$$M_y = 200(10) - 50(7) = 1650 \ N*cm$$

$$M_z = 60(14) - 200(14) = -1960 \ N*cm$$

Same as Q1.

$$3- \ \vec{u_{AC}} = \frac{0\vec{i} + 14\vec{j} + 10\vec{k}}{\sqrt{(0)^2 + (14)^2 + (10)^2}} = 0\vec{i} + 0.814\vec{j} + 0.581\vec{k}$$

$$M_{A//AC} = \vec{M_A} \cdot \vec{u_{AC}} = \{2250\vec{i} + 1650\vec{j} - 1960\vec{k}\} \cdot \{0\vec{i} + 0.814\vec{j} + 0.5$$

$$\boxed{M_{A//AC} = 204.34 \ N*cm}$$

EXTRA SHEET 1: Continued from page ________

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Calculations and/or Diagrams:

$$\vec{M}_{A//AC} = M_{A//AC}\,\vec{u}_{AC}$$

$$= 204.34\,\{0\vec{i} + 0.814\vec{j} + 0.581\vec{k}\}$$

$$\boxed{\vec{M}_{A//AC} = \{0\vec{i} + 166.33\vec{j} + 118.72\vec{k}\}\ N * cm}$$

EXTRA SHEET 2: Continued from page _______

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Calculations and/or Diagrams: