Exam.1
Fall 2015
(October 06, 2015)
CIE200 – STATICS
CLOSED BOOK, 1 HR 15 Minutes

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NOTES

- 4PROBLEMS– 13 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:	___/25
Problem II:	___/25
Problem III:	___/25
Problem IV:	___/25
TOTAL:	/100

Problem I: *(25 points)*

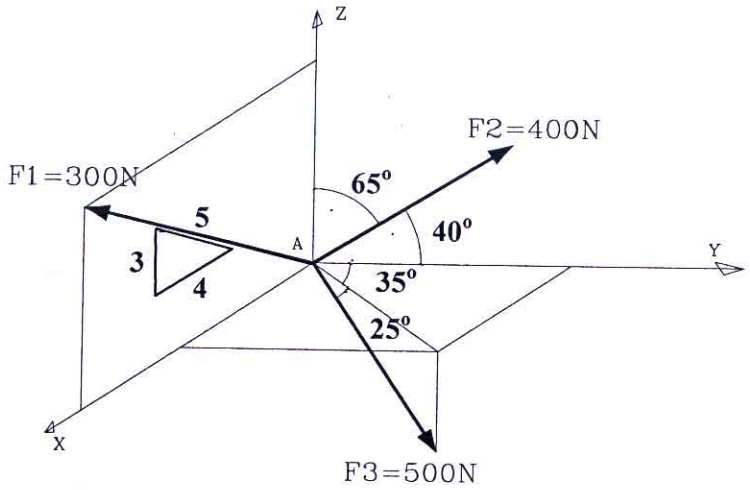


Figure I

For the force system acting on point ***A*** in Figure I, determine the magnitude of the resultant force and directions. Note that Force ***F1*** is in the ***Z-X*** plane and Force ***F2*** has $\alpha 2 > 90°$

Calculations and/or Diagrams:

$\vec{F_1} = \frac{300 \times 4}{5}\vec{i} + \frac{3}{5} \times 300\,\vec{k} = 240\vec{i} + 180\vec{k}$ (4 ✓)

$\vec{F_2} = ?$ $\quad \beta_2 = 40°$ $\quad \gamma_2 = 65°$

$\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$

$\cos^2\alpha + \cos^2 40 + \cos^2 65 = 1$

$\cos^2\alpha + 0.586 + 0.1786 = 1$ (5)

$\cos^2\alpha = 0.235$

$\cos\alpha = -0.485$ since $\alpha > 90$

$\alpha_2 = 119°$

$\vec{F_2} = 400\cos 119\,\vec{i} + 400\cos 40\,\vec{j} + 400\cos 65\,\vec{k}$

$\vec{F_2} = -194\,\vec{i} + 306.41\,\vec{j} + 169\,\vec{k}$

$\vec{F_3} = 500\cos 25 \sin 35\,\vec{i} + 500\cos 25 \cos 35\,\vec{j} - 500\sin 25\,\vec{k}$

$\vec{F_3} = 260\,\vec{i} + 371.2\,\vec{j} - 211.3\,\vec{k}$ (5)

$\vec{F_R} = (240 - 194 + 260)\vec{i} + \vec{j}(306.41 + 371.2) + \vec{k}(180 + 169 - 211.3)$

$\vec{F_R} = 306\,\vec{i} + 677.6\,\vec{j} + 137.7\,\vec{k}$ (4)

$F_R = \sqrt{306^2 + 677.6^2 + 137.7^2} = 756.13\ N$ (2)

Problem II: *(25 points)*

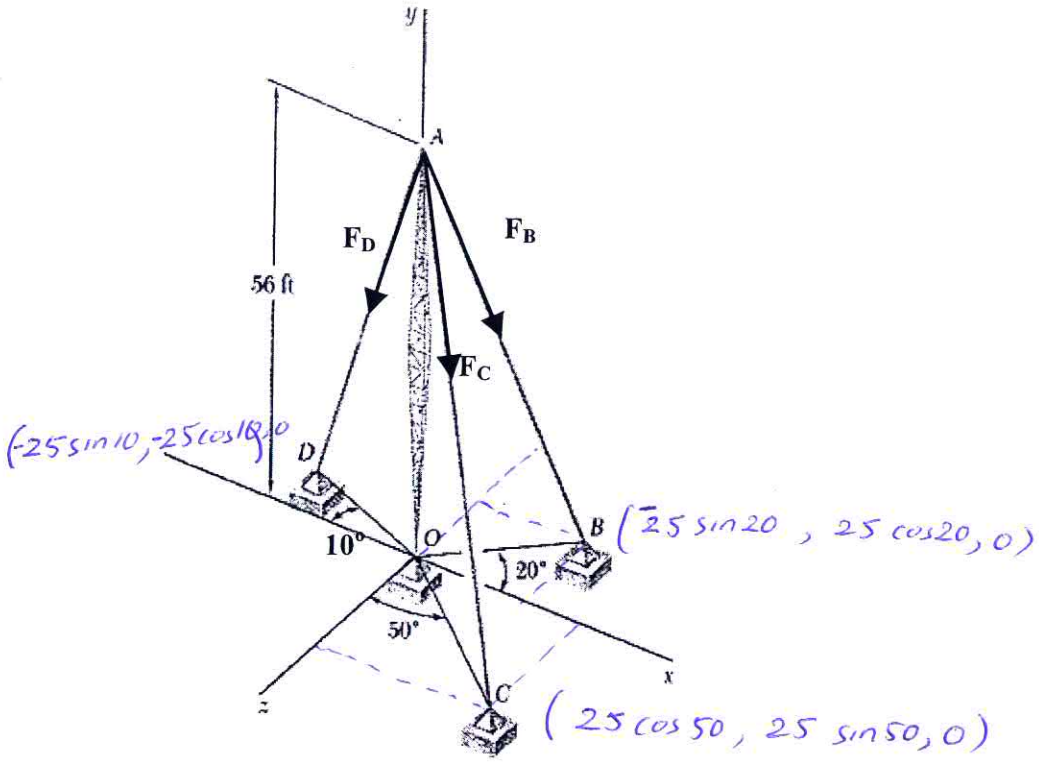


Figure II

For the cable system shown in Figure II, Force $F_C = F_B = F_D = 150$N and $OD = OB = OC = 25$ft.
It is required to:

i) Determine the magnitude of the resultant force and directions at point ***A***.
ii) Determine the magnitude of the projected component of the resultant along axis ***DA***. Express this component in vector form.

Calculations and/or Diagrams:

A (0, 0, 56)
B (-8.55, 23.5, 0)
C (16.06, 19.15, 0)
D (-4.34, -24.6, 0)

$\vec{F_C} = F_C \cdot \vec{U}_{AC}$

$\vec{F_C} = 150\left(\frac{16.06\,\vec{i} + 19.15\,\vec{j} - 56\,\vec{k}}{\sqrt{16.06^2 + 19.15^2 + 56^2}}\right) = 39.31\,\vec{i} + 46.84\,\vec{j} - 139.98\,\vec{k}$

$\sqrt{16.06^2 + 19.15^2 + 56^2} = 61.32$

3

$\vec{F_B} = F_B \cdot \vec{U}_{AB} = 150\left(\frac{-8.55\,\vec{i} + 23.5\,\vec{j} - 56\,\vec{k}}{\sqrt{8.55^2 + 23.5^2 + 56^2}}\right) = -20.91\,\vec{i} + 57.5\,\vec{j} - 139.9\,\vec{k}$

$\sqrt{8.55^2 + 23.5^2 + 56^2} = 61.32$

3

$$\vec{F}_D = F_D \vec{u}_{AD} = 150\left(\frac{-4.34\vec{i} - 24.6\vec{j} - 56\vec{k}}{\sqrt{4.34^2 + 24.6^2 + 56^2}}\right)$$

$$\vec{F}_D = -10.61\vec{i} - 60.17\vec{j} - 139.98\vec{k} \quad (61.32) \quad (3)$$

$$\vec{F}_R = (39.3 - 20.91 - 10.61)\vec{i} + \vec{j}(46.84 + 57.5 - 60.17) + \vec{k}(-139.98 \times 3) \quad (3)$$

$$\vec{F}_R = 7.78\vec{i} + 44.17\vec{j} - 420\vec{k}$$

$$F_R = \sqrt{7.78^2 + 44.17^2 + 420^2} = 422.4 \text{ lbs.} \quad (2)$$

$$\alpha = \cos^{-1}\frac{7.78}{422.4} = 88.94^\circ$$

$$\beta = \cos^{-1}\frac{44.17}{422.4} = 83.99$$

$$\gamma = \cos^{-1}\frac{-420}{422.4} = 173.8^\circ \quad (3)$$

(2) $$\vec{u}_{DA} = \frac{4.34\vec{i} + 24.6\vec{j} + 56\vec{k}}{\sqrt{4.34^2 + 24.6^2 + 56^2}} = 0.07\vec{i} + 0.40\vec{j} + 0.913\vec{k} \quad (2)$$

$\rightarrow 61.32$

$$F_{R\text{-}DA} = \vec{F}_R \cdot \vec{u}_{DA} = 7.78(0.07) + 44.17 \times 0.4 - 420 \times 0.913$$

$$= -365.24 \quad (4)$$

$$\vec{F}_{R\text{-}DA} = -365.24(0.07\vec{i} + 0.4\vec{j} + 0.913\vec{k})$$

$$\vec{F}_{R\text{-}DA} = -25.56\vec{i} - 146.1\vec{j} - 33.46\vec{k} \quad (2)$$

Calculations and/or Diagrams (cont'd):

Calculations and/or Diagrams (cont'd):

Problem III: *(25 points)*

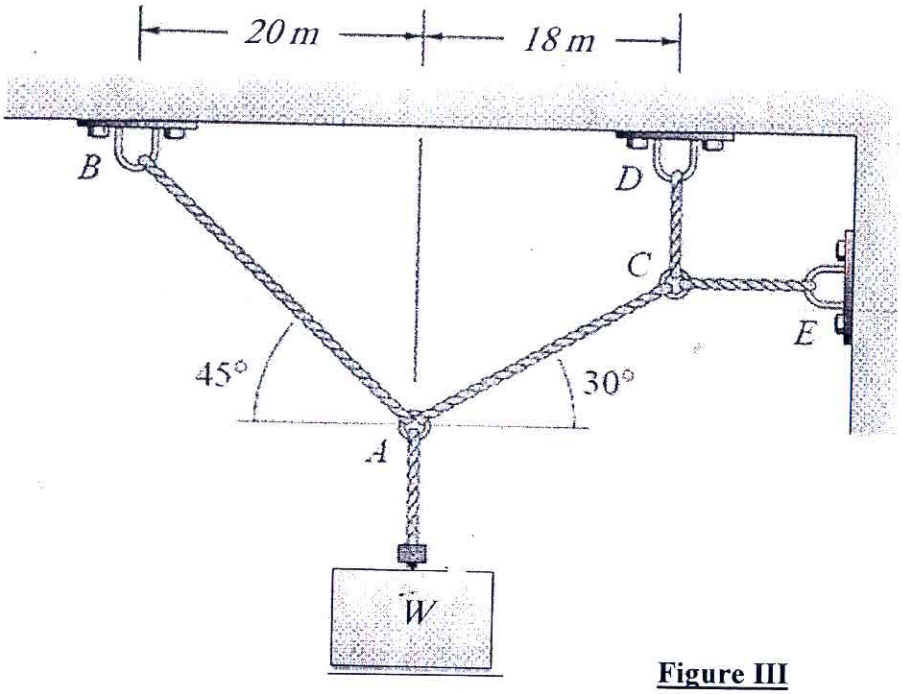
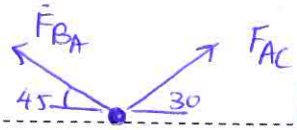


Figure III

Determine the maximum weight ***W*** of the crate shown in Figure III such that the maximum tension developed in each cable does not exceed 1000N.

Calculations and/or Diagrams:



(4)

At "A"

$\pm \rightarrow \Sigma F_x = 0$

$F_{AC}\cos 30 - F_{AB}\cos 45 = 0$ (1)

$F_{AC} = F_{AB}\frac{\cos 45}{\cos 30} = 0.816\, F_{AB}$ (3)

$+\uparrow \Sigma F_y = 0$ $\quad F_{AB}\sin 45 + F_{AC}\sin 30 - W = 0$ (3)

$0.707\, F_{AB} + 0.408\, F_{AB} - W = 0 \rightarrow F_{AB} = 0.9\, W$

$F_{AC} = 0.731\, W$

Problem IV: *(25 points)*

The spring system shown in Figure IV is in equilibrium and supporting a cylinder with mass ***M*** = 50 Kg attached at point ***B*** by vertical cable ***BE***. Each spring has a stiffness of ***k*** = 200 N/m. Determine the forces and corresponding displacements in springs ***AB***, ***DB*** and ***CB***.

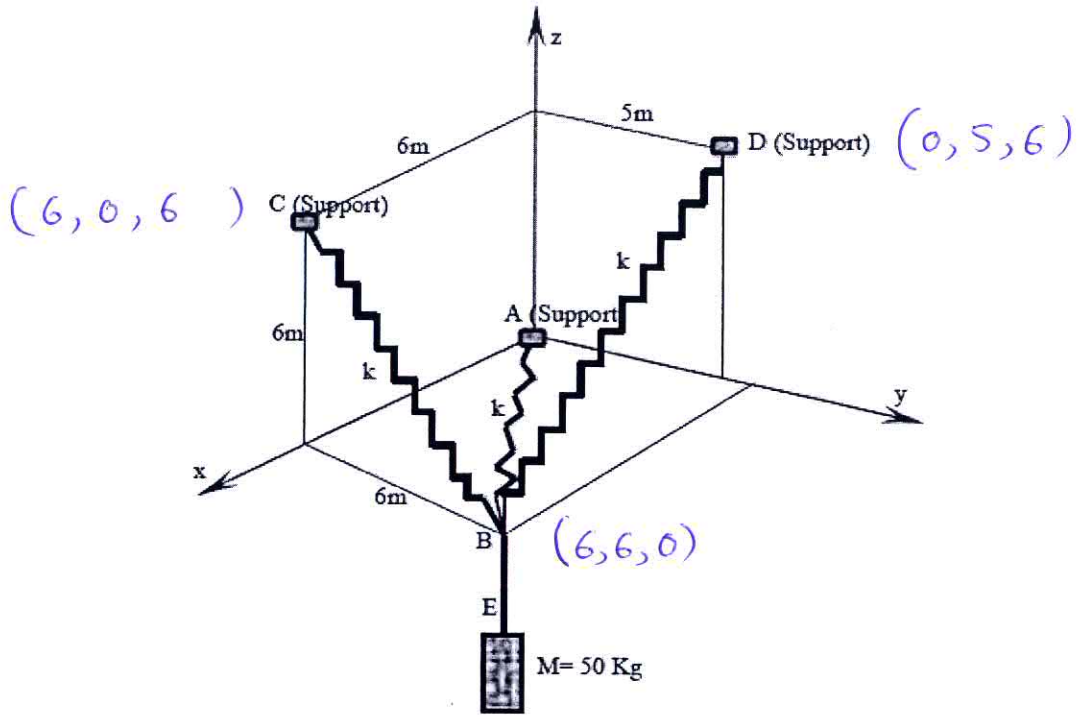
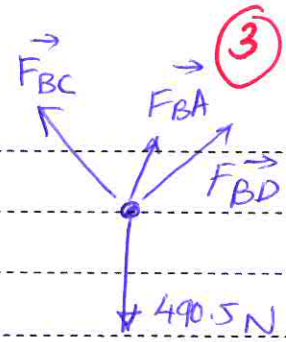


Figure IV

A(0,0,0)
B(6,6,0)
C(6,0,6)
D(0,5,6)

Calculations and/or Diagrams:



3

FBD at "B"

$\vec{F}_{BA} = \frac{(-6\vec{i} - 6\vec{j})}{\sqrt{36+36}} F_{BA} = -0.707 F_{BA}\vec{i} - 0.707 F_{BA}\vec{j}$ — (1) (3)

$\sqrt{36+36} \rightarrow 8.48$

$\vec{F}_{BC} = \frac{-6\vec{j} + 6\vec{k}}{8.48} F_{BC} = -0.707 F_{BC}\vec{j} + 0.707 F_{BC}\vec{k}$ — (2) (3)

$\vec{F}_{BD} = F_{BD}\left(\frac{-6\vec{i} - \vec{j} + 6\vec{k}}{\sqrt{73}}\right) = -0.702 F_{BD}\vec{i} - 0.11 F_{BD}\vec{j} + 0.702 F_{BD}$ (3)

$\sqrt{73} \rightarrow 8.54$

Calculations and/or Diagrams (cont'd):

$\Sigma F_x = 0$

$+\swarrow \quad -0.707 F_{BA} - 0.702 F_{BD} = 0 \quad (1)$

$+\rightarrow \quad \Sigma F_y = 0 \quad -0.707 F_{BA} - 0.11 F_{BD} - 0.707 F_{BC} = 0 \quad (2)$

$+\uparrow \quad \Sigma F_z = 0 \quad +0.707 F_{BC} + 0.702 F_{BD} - 490.5 = 0 \quad (3)$

(5)

(4)

$F_{BA} = -376\,(C)$ $\quad \Delta = -\frac{376}{200} = -1.89''$

$F_{BC} = 317\,N\,(T)$ $\quad \Delta = 317/200 = 1.56''$

$F_{BD} = 380\,N\,(T)$ $\quad \Delta = \frac{380}{200} = 1.91''$

(4)

EXTRA SHEET 1: Continued from page ____

Name: _____ **ID#:** _____

Calculations and/or Diagrams:

EXTRA SHEET 2: Continued from page _____

Name: _____ **ID#:** _____

Calculations and/or Diagrams: