TEST 1
Fall 2014-15
(28th October, 2014)
CIE200 – STATICS
CLOSED BOOK, 75 MINUTES

Name: Fall 2014-2015 **ID#:** 2015**** **Section: 13**

NOTES

- 3 problems (11 pages).
- All your answers should be provided on the question sheets.
- Three extra sheets is 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.
- ***Every FBD needed for the solution of a problem should be clearly shown.***
- ***Points will be deducted for any missing/ incomplete/incorrect FBD.***
- ***Points will be deducted for answers not supported by proper calculations.***

YOUR COMMENT(S)

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DO NOT WRITE IN THE SPACE BELOW

MY COMMENT(S)

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YOUR GRADE

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

Problem I: *(35 points)*

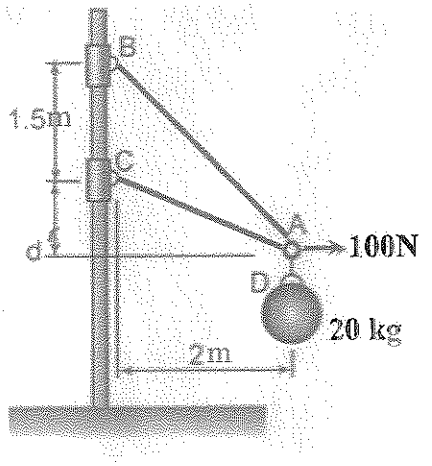


Figure I

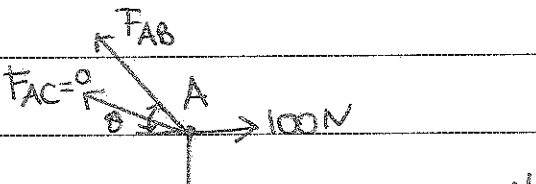
The cylinder D has a mass of 20 kg. If a force of 100N is applied horizontally to the ring A and supported by two separate cables AB and AC

1. Determine the dimension d so that the force in cable AC is zero. *(15 points)*
2. If a spring with stiffness 800 N/m was inserted in cable AB, with no change in the system's geometry, how far would it be stretched? *(20 points)*

Note: FBD must be included

Calculations and/or Diagrams:

FBD at A



$\rightarrow \sum F_x = 0 \Rightarrow -F_{AB}\cos\theta + 100 = 0$

$\Rightarrow F_{AB}\cos\theta = 100 \quad (1)$

$+\uparrow \sum F_y = 0 \Rightarrow F_{AB}\sin\theta - 196.2$

$\Rightarrow F_{AB}\sin\theta = 196.2 \quad (2)$

$\Rightarrow \frac{(2)}{(1)} \Rightarrow \frac{F_{AB}\sin\theta}{F_{AB}\cos\theta} = \frac{196.2}{100} \Rightarrow \tan\theta = 1.962$

$\Rightarrow \boxed{\theta = 63°}$

Calculations and/or Diagrams:

$\Rightarrow \tan\theta = \frac{1.5+d}{2} \Rightarrow \tan 63 = \frac{1.5+d}{2}$

$\Rightarrow d = 9.424\ m$

From Eq.(1) $F_{AB} = \frac{100}{\cos(63)} \Rightarrow \boxed{F_{AB} = 220.27\ N}$

2-

$F_{AB} = K\Delta \Rightarrow 220.27 = 800\Delta \Rightarrow \boxed{\Delta = 0.275\ m}$

Problem II: *(35 points)*

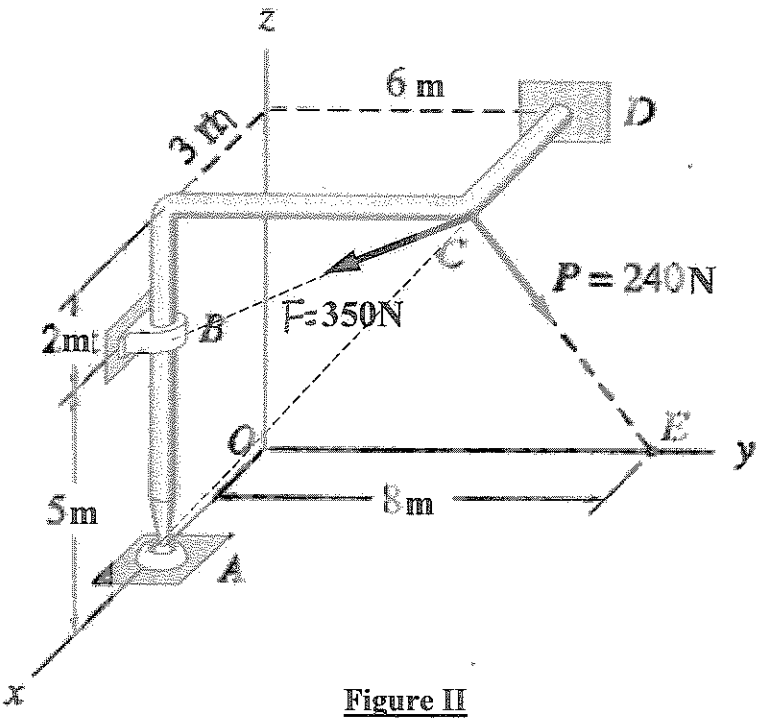


Figure II

The system shown in **Figure II** is subjected to two forces:

1. Determine the magnitude and direction angles of the resultant force acting at C. Express your result as Cartesian vector. *(20 points)*
2. Determine the projected component of the force ***P*** along line CA. Express the result as a Cartesian vector. *(15 points)*

Calculations and/or Diagrams:

Coordinates: $A(3,0,0)$ $B(3,0,5)$, $C(3,6,7)$

$D(0,6,7)$ $E(0,8,0)$

$$\vec{P} = P\,\vec{\mu}_{CE} = 240\left\{\frac{(0-3)\vec{i}+(8-6)\vec{j}+(0-7)\vec{k}}{\sqrt{(0-3)^2+(8-6)^2+(0-7)^2}}\right\}$$

$$\Rightarrow \vec{P} = \{-91.44\vec{i} + 60.96\vec{j} - 213.36\vec{k}\}\ N$$

$$\vec{F}_{CB} = F\,\vec{\mu}_{CB} = 350\left\{\frac{(3-3)\vec{i}+(0-6)\vec{j}+(5-7)\vec{k}}{\sqrt{(0)^2+(-6)^2+(-2)^2}}\right\} = \{0\vec{i} - 332.04\vec{j} - 110.68\vec{k}\}\ N$$

Calculations and/or Diagrams (cont'd):

$\Rightarrow \vec{F}_{CB} = \{0\vec{i} - 332.04\vec{j} - 110.68\vec{k}\}^N$

$F_{Rx} = 0 - 91.44 = -91.44\ N$

$F_{Ry} = -332.04 + 60.96 = -271.08\ N$

$F_{Rz} = -110.68 - 213.36 = -324.04\ N$

Resultant: $\vec{F}_R = \{-91.44\vec{i} - 271.08\vec{j} - 324.04\vec{k}\}^N$

Magnitude $F_R = \sqrt{(91.44)^2 + (-271.08)^2 + (-324.04)^2}$

$\Rightarrow F_R = 432.26\ N$

Direction:

$\cos\alpha = \frac{-91.44}{432.26} \Rightarrow \boxed{\alpha = 102.91^\circ}$

$\cos\beta = \frac{-271.08}{432.26} \Rightarrow \boxed{\beta = 128.9^\circ}$

$\cos\gamma = \frac{-324.04}{432.26} \Rightarrow \boxed{\gamma = 138.6^\circ}$

2. $\vec{u}_{CA} = \frac{(3-3)\vec{i} + (0-6)\vec{j} + (0-7)\vec{k}}{\sqrt{(0)^2 + (-6)^2 + (-7)^2}} = 0\vec{i} - 0.65\vec{j} - 0.76\vec{k}$

$F_{R//CA} = \vec{F}_{R//CA} \cdot \vec{u}_{CA} = \{-91.44\vec{i} - 271.08\vec{j} - 324.04\vec{k}\}\{0\vec{i} - 0.65\vec{j} - 0.76\vec{k}\}$

$\Rightarrow F_{R//CA} = 422.47\ N$

Expressed as Cartesian vector:

$\vec{F}_{R//CA} = F_{R//CA}\,\vec{u}_{CA} = 422.47\{0\vec{i} - 0.65\vec{j} - 0.76\vec{k}\}$

$\vec{F}_{R//CA} = \{0\vec{i} - 274.61\vec{j} - 321.08\vec{k}\}^N$

Problem III: *(30 points)*

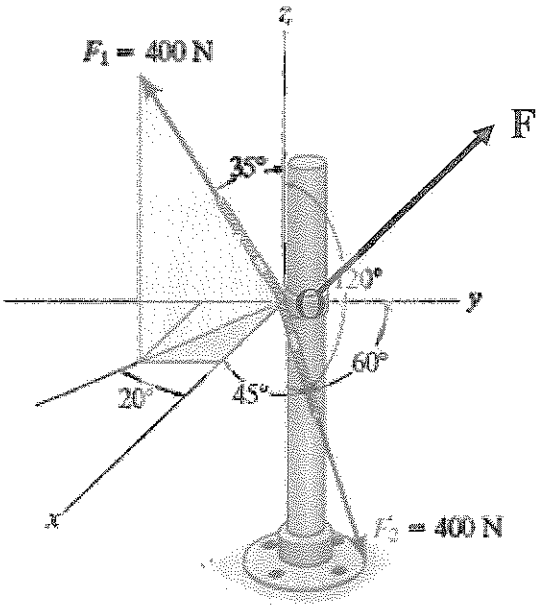


Figure III

Given the magnitude and direction of F_1 and F_2:

1 - Determine the magnitude of the force *F* required to keep the system at *O* in equilibrium. Express your result as Cartesian vector. *(20 points)*
2- Determine the direction of force *F*. *(10 points)*

Calculations and/or Diagrams:

F_1 expressed as Cartesian vector:

$F_{1x} = 400 \cos 20 \sin 35 = 215.6\,N$

$F_{1y} = -400 \sin 20 \cos 35 = -78.47\,N$

$F_{1z} = 400 \cos 35 = 327.66\,N$

$\vec{F}_1 = \{215.6\,\vec{i} - 78.47\,\vec{j} + 327.66\,\vec{k}\}\,N$

F_2 expressed as Cartesian vector:

$F_{2x} = 400 \cos 45 = 282.84\,N$

$F_{2y} = 400 \cos 60 = 200\,N$

$F_{2z} = 400 \cos 120 = -200\,N$

Calculations and/or Diagrams (cont'd):

$\vec{F_2} = \{282.84\,\vec{i} + 200\vec{j} - 200\vec{k}\}^N$

$\vec{F} = \{F\cos\alpha + F\cos\beta + F\cos\gamma\} = \{F_x\vec{i} + F_y\vec{j} + F_z\vec{k}\}$

$+\rightarrow \Sigma F_x = 0$

$215.6 + 282.84 + F_x = 0$

$\Rightarrow F_x = -498.44\ N$

$+\rightarrow \Sigma F_y = 0 \Rightarrow -78.47 + 200 + F_y = 0$

$\Rightarrow F_y = -121.53\ N$

$+\uparrow \Sigma F_z = 0 \Rightarrow 327.66 - 200 + F_z = 0$

$\Rightarrow F_z = -127.66\ N$

$\vec{F} = \{-498.44\,\vec{i} - 121.53\vec{j} + 127.66\vec{k}\}^N$

2- $F = \sqrt{(-498.44)^2 + (-121.53)^2 + (-127.66)^2} = 528.7\ N$

$F_x = F\cos\alpha \Rightarrow \cos\alpha = \frac{-498.44}{528.7} \Rightarrow \boxed{\alpha = 160.52^\circ}$

$\cos\beta = \frac{F_y}{F} = \frac{-121.53}{528.7} \Rightarrow \boxed{\beta = 103.29^\circ}$

$\cos\gamma = \frac{-127.66}{528.7} = \boxed{\gamma = 103.97^\circ}$

EXTRA SHEET 1: Continued from page _____

Name: _____ **ID#:** _____

Calculations and/or Diagrams:

EXTRA SHEET 2: Continued from page _____

Name: _____ **ID#:** _____

Calculations and/or Diagrams:

EXTRA SHEET 3: Continued from page _____

Name: _____ **ID#:** _____

Calculations and/or Diagrams: