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

Name: Fall 2014 - 2015 **ID#:** 2015 xxxx **Section: 11**

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)*

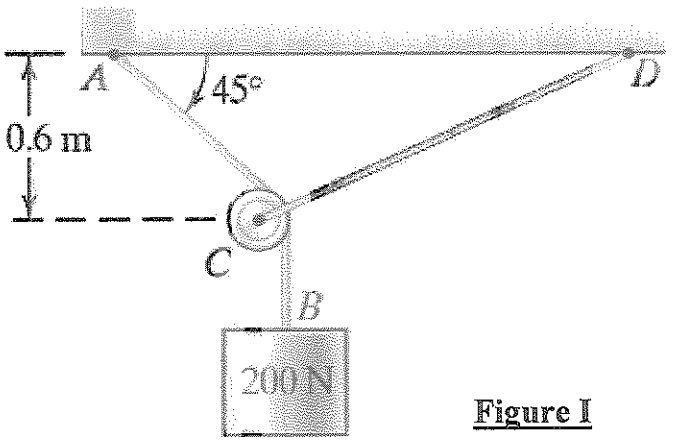


Figure I

The system shown in Figure I is in equilibrium:

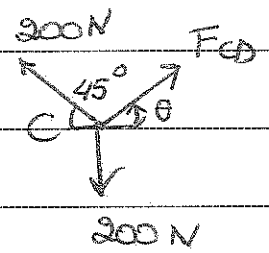
1. Determine the tension in cable CD? [hint: the pulley at C is a frictionless pulley). *(25 points)*
2. If a spring with stiffness 800 N/m was inserted in cable CD, with no change in the system's geometry, how far would it be stretched? *(10 points)*

Note: FBD must be included

Calculations and/or Diagrams:

Equilibrium at C:

$F_{CA} = 200\,N$



From Frictionless pulley $F_{BC} = F_{AC} = 200\,N$

$\stackrel{+}{\rightarrow} \Sigma F_x = 0 \Rightarrow -200\cos 45 + F_{CD}\cos\theta = 0$

$\Rightarrow F_{CD}\cos\theta = 141.42\,N$ ... (1)

$+\uparrow \Sigma F_y = 0 \Rightarrow 200\sin 45 + F_{CD}\sin\theta - 200 = 0$

$\Rightarrow F_{CD}\sin\theta = 58.58\,N$ ... (2)

$\Rightarrow \frac{(2)}{(1)} \Rightarrow \frac{F_{CD}\sin\theta}{F_{CD}\cos\theta} = \frac{58.58}{141.42} \Rightarrow \tan\theta = 0.414 =$

$\Rightarrow \boxed{\theta = 22.5^\circ}$

$\Rightarrow F_{CD} \cos 22.5 = 141.42$

$\Rightarrow \boxed{F_{CD} = 153.1\ N}$

2 $F_{CD} = K\Delta$

$\Rightarrow 153.1 = 800\,\Delta \Rightarrow \boxed{\Delta = 0.19\ m}$

Problem II: *(35 points)*

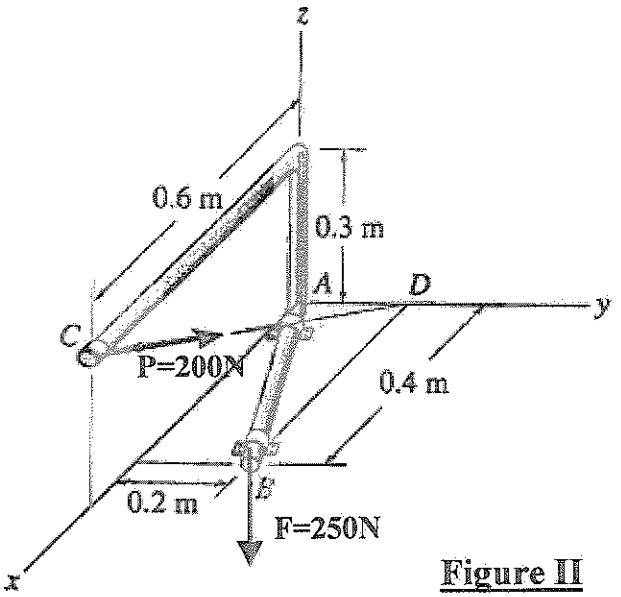


Figure II

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

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

Calculations and/or Diagrams:

Coordinates A(0,0,0) B(0.4,0.2,0) C(0.6,0,0.3)

D(0, 0.2, 0)

$\vec{P} = P\vec{u}_{CB} = 200\left\{\frac{(0-0.6)\vec{i} + (0.2-0)\vec{j} + (0-0.3)\vec{k}}{\sqrt{(-0.6)^2 + (0.2)^2 + (-0.3)^2}}\right\}$

$\Rightarrow \vec{P} = \{-171.43\vec{i} + 57.14\vec{j} - 85.71\vec{k}\}^N$

$\vec{F} = \{0\vec{i} + 0\vec{j} - 250\vec{k}\}^N$

Resultant force:

$F_{Rx} = 0 - 171.43 = -171.43N$

$F_{Ry} = 0 + 57.14 = 57.14N$

Calculations and/or Diagrams (cont'd):

$F_{Rz} = -250 - 85.71 = -335.71\ N$

Magnitude:

$F_R = \sqrt{(-171.43)^2 + (57.14)^2 + (-335.71)^2} = 381.25\ N$

Direction

$\cos\alpha = \frac{-171.43}{381.25}$ $\boxed{\alpha = 116.72^\circ}$

$\cos\beta = \frac{57.14}{381.25}$ $\boxed{\beta = 81.38^\circ}$

$\cos\gamma = \frac{-335.71}{381.25}$ $\boxed{\gamma = 151.71^\circ}$

2. $\vec{u}_{AB} = \frac{0.4\vec{i} + 0.2\vec{j} + 0\vec{k}}{\sqrt{(0.4)^2 + (0.2)^2 + (0)^2}} = 0.894\vec{i} + 0.447\vec{j} + 0\vec{k}$

$F_{P//AB} = \vec{F_R} \cdot \vec{u}_{AB} = \{-171.43\vec{i} + 57.14\vec{j} - 335.71\vec{k}\} \cdot \{0.894\vec{i} + 0.447\vec{j} + 0\vec{k}\}$

$\Rightarrow \boxed{F_{P//AB} = -126.4\ N}$

Expressed as Cartesian vector:

$\vec{F}_{P//AB} = F_{P//AB}\,\vec{u}_{AB} = -126.4\{0.894\vec{i} + 0.447\vec{j} + 0\vec{k}\}$

$\boxed{\vec{F}_{P//AB} = \{-113\vec{i} - 56.5\vec{j} + 0\vec{k}\}^N}$

Problem III: *(30 points)*

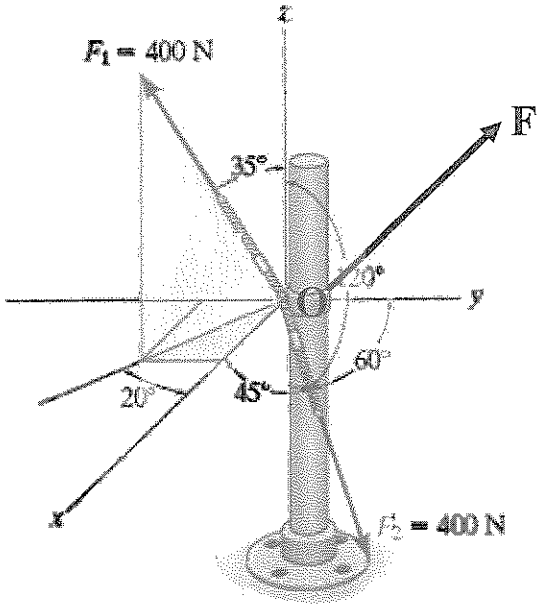


Figure III

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:

$\vec{F_1}$ expressed as Cartesian vector:

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

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

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

$\vec{F_1} = \{215.6\vec{i} - 78.47\vec{j} + 327.66\vec{k}\}$

F_2 expressed as Cartesian vector:

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

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

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

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

Calculations and/or Diagrams (cont'd):

F as cartesian vector:

$\vec{F} = \{F_x\vec{i} + F_y\vec{j} + F_z\vec{k}\}$

Equilibrium at O:

$\rightarrow \Sigma F_x = 0 \Rightarrow 215.6 + 282.84 + F_x = 0$

$\Rightarrow \boxed{F_x = -498.44\ N}$

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

$\Rightarrow \boxed{F_y = -121.53\ N}$

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

$\Rightarrow \boxed{F_z = -127.66\ N}$

$\vec{F} = \{-498.44\vec{i} - 121.53\vec{j} - 127.66\vec{k}\}$

$F = \sqrt{(-498.44)^2 + (-121.53)^2 + (-127.66)^2} = 528.69\ N$

Direction:

$\cos\alpha = \frac{-498.44}{528.69}$ $\boxed{\alpha = 160.52^\circ}$

$\cos\beta = \frac{-121.53}{528.69}$ $\boxed{\beta = 103.29^\circ}$

$\cos\gamma = \frac{-127.66}{528.69}$ $\boxed{\gamma = 103.97^\circ}$

Calculations and/or Diagrams (cont'd):

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: