Exam.2
Fall 2015
(November 17, 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)*

Cable AB exerts a force of 80 N at the end of the 3-m long boom ***OA***. The cylinder hung from point ***B*** weighs 150 N.

Determine the magnitude of the moment due to the cable ***AB*** force and the cylinder about point ***A*** using: (1) Cartesian approach and (2) Scalar approach.

Express this moment in Cartesian form and find it's direction angles.

0

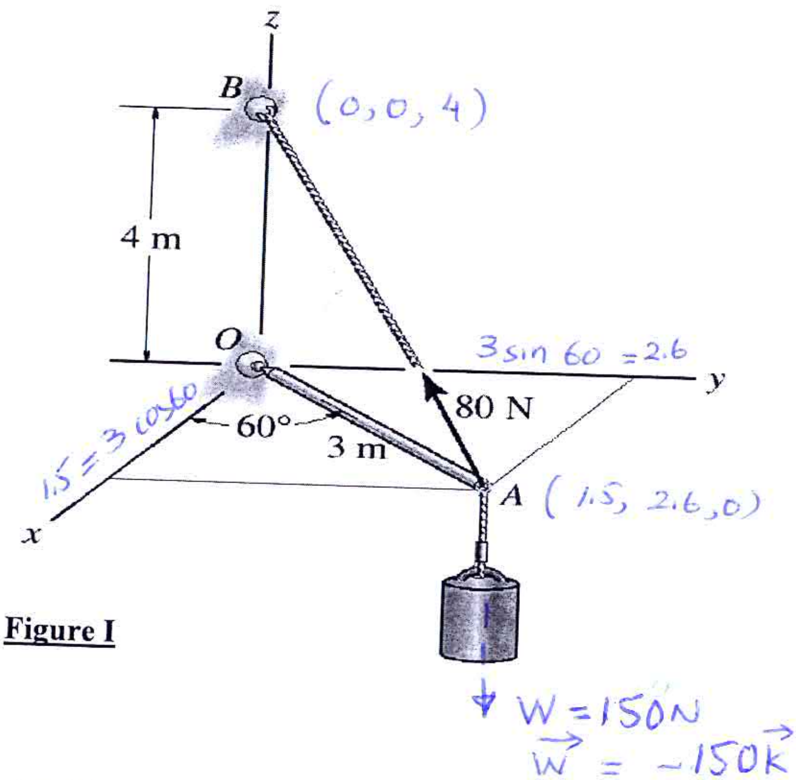

Figure I

Calculations and/or Diagrams:

(1) Cartesian approach:

$W = -150\vec{k}$ (1)

$\vec{F}_{AB} = 80\,\vec{u}_{AB}$

$\vec{u}_{AB} = \dfrac{-1.5\vec{i} - 2.6\vec{j} + 4\vec{k}}{\sqrt{1.5^2 + 2.6^2 + 4^2}} = -0.3\vec{i} - 0.52\vec{j} + 0.81$

$\sqrt{\ } \to 5$

$\vec{F}_{AB} = -24\vec{i} - 41.6\vec{j} + 64\vec{k}$ (4)

$\vec{M}_o = \vec{r}_{OA} \times \vec{F}_{AB} + \vec{r}_{OA} \times \vec{W}$

$= \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 1.5 & 2.6 & 0 \\ -24 & -41.6 & 64 \end{vmatrix} + \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 1.5 & 2.6 & 0 \\ 0 & 0 & -150 \end{vmatrix} =$ (4)

Calculations and/or Diagrams (cont'd):

$= \vec{i}(2.6 \times 64) - \vec{j}(1.5 \times 64) + \vec{k}(1.5 \times -41.6 + 24 \times 2.6)$

$+\vec{i}(2.6 \times -150) - \vec{j}(1.5 \times -150)$ (2)

$= 166.4\vec{i} - 96\vec{j} + \vec{k}(-62.4 + 62.4)$

$-390\vec{i} + 225\vec{j}$

$\vec{M}_O = -223.6\vec{i} + 129\vec{j}$ (2)

$M_O = \sqrt{} = 258.14$

$\alpha = \cos^{-1}\frac{-223.6}{258.14} = 150.01^\circ$

$\beta = \cos^{-1}\frac{129}{258.14} = 60^\circ$ (2)

$\gamma = \cos^{-1} 0 = 90^\circ$

Scalar Approach

Due to $\vec{W} = -150\vec{k}$ → $M_x = -150 \times 2.6$, $M_y = +150 \times 1.5$

(10)

Due to $\vec{F}_{AB}$

$F_x = 24 \rightarrow 0$

$F_y = -41.6 \rightarrow 0$

$F_z = +64 \rightarrow M_x = +64 \times 2.6$, $M_y = -64 \times 1.5$

$\vec{M}_O = \vec{i}(-150 \times 2.6 + 64 \times 2.6) + \vec{j}(150 \times 1.5 - 64 \times 1.5)$

$= -223.6\vec{i} + 129\vec{j}$ ✓

$M_O = 258.14$ ✓

Problem II: *(25 points)*

Replace the force system acting on the frame by an equivalent resultant force and couple moment acting at point O. Can you replace the whole force system by a single Equivalent resultant force located on the x-axis? If yes, deduce the location of this resultant force on the x-axis.

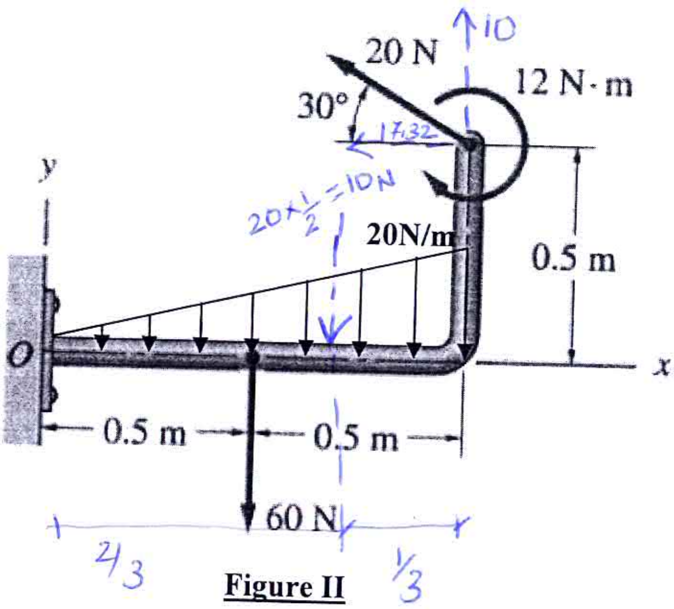

Figure II

Calculations and/or Diagrams:

$\vec{F_R} = ? = F_{Rx}\vec{i} + F_{Ry}\vec{j}$

$\xrightarrow{+}$ $F_{Rx} = -20\cos 30 = -17.32$ N

$F_{Ry} = -60 - 10 + 20\sin 30 = -60$ N. (4)

$\vec{F_R} = -17.32\vec{i} - 60\vec{j}$ $F_R = \sqrt{\quad}$ (2)

$F_R = 62.45$ N

17.32, 60, θ, F_R

$\tan\theta = \frac{60}{17.32} \rightarrow \theta = 73.9°$ (2)

Calculations and/or Diagrams (cont'd):

M_R about O

(+) $\sum M @ O = -12 + 10(1) + 17.32(0.5) - 60(0.5) - 10(\frac{2}{3})$

$= -30$ N.m.

30 N.m ↻ clockwise.

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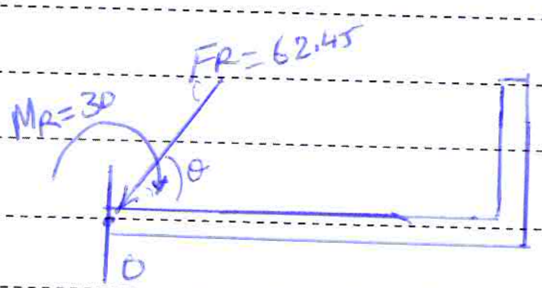
Equivalent system



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Can replace above system by a Single Force $\vec{F_R}$ located at d from "O"

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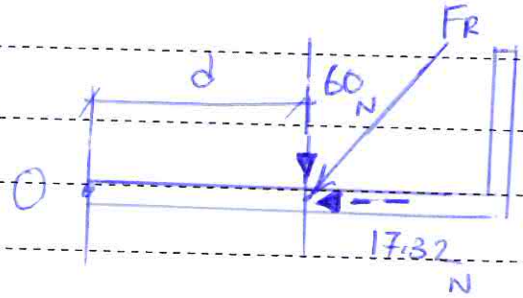
↻ $60 \times d = 30$ ↻

$d = \frac{30}{60} = 0.5$ m.



Problem III: *(25 points)*

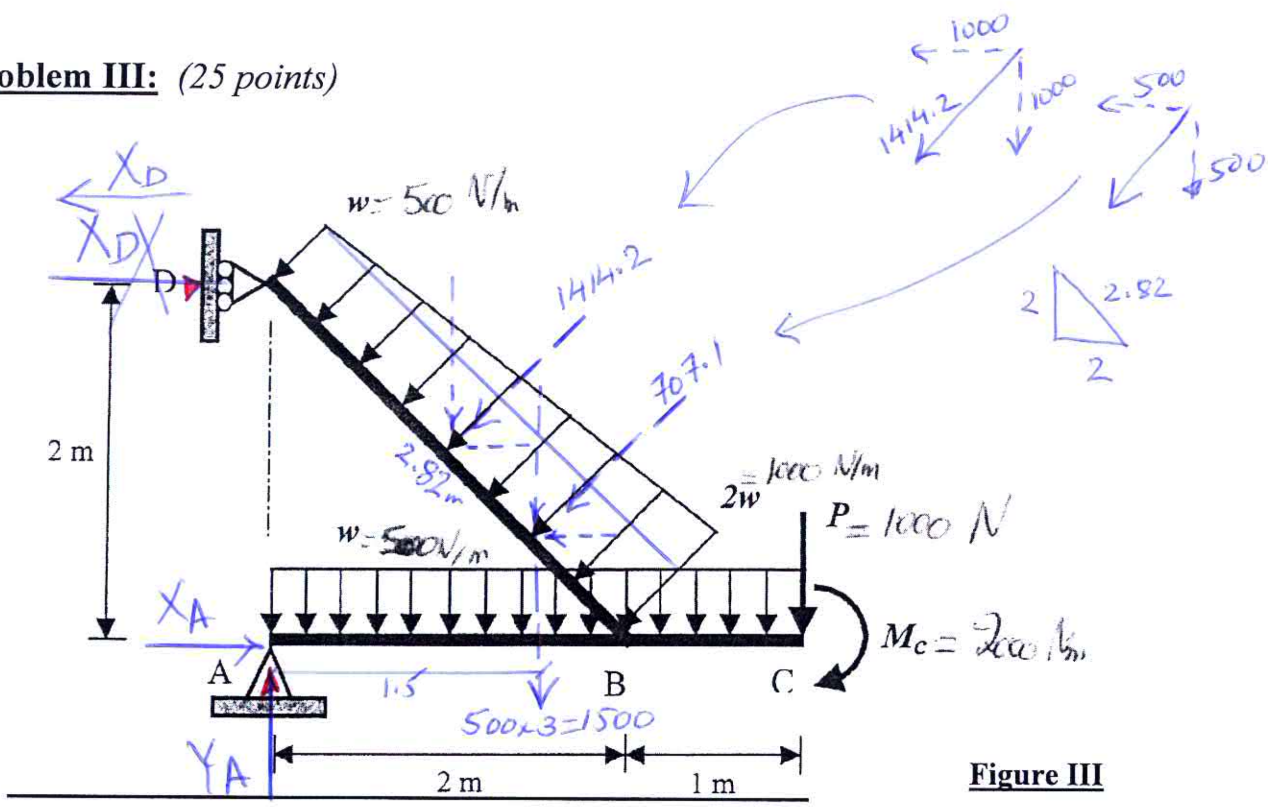


Figure III

The structural system shown in Figure III is stable and statically determinate.
Let w=500 N/m, P=1000 N, and M_C=2000 Nm. Determine the reactions at supports A and D. and draw the updated FBD showing only the positive values and positive directions.

Calculations and/or Diagrams:

(+) ΣM @ D = 0

$-1414.2\left(\frac{2.82}{2}\right) - 707.1 \times \frac{2.82 \times 2}{3}$

$-1000(3) - 2000 - 1500(1.5)$

$+ X_A (2) = 0$

$X_A = 5286.66$ N.

$\xrightarrow{+} \Sigma F_x = 0 \quad X_A + X_D - 500 - 1000 = 0$

$X_D = -3786.6$ N.

$+\uparrow \Sigma F_y = 0 \quad -1000 - 500 - 1000 - 1500 + Y_A = 0$

$Y_A = 4000$ N

Calculations and/or Diagrams (cont'd):

Problem IV: *(25 points)*

The block W shown has a weight of 2500 N. Bar *AB* rests against a smooth vertical wall at end *B* and is supported at end *A* with a ball-and-socket joint. The two cables are attached to a point D on the bar midway between the ends. Determine the reactions at supports *A* and B and the tension in cable CD.

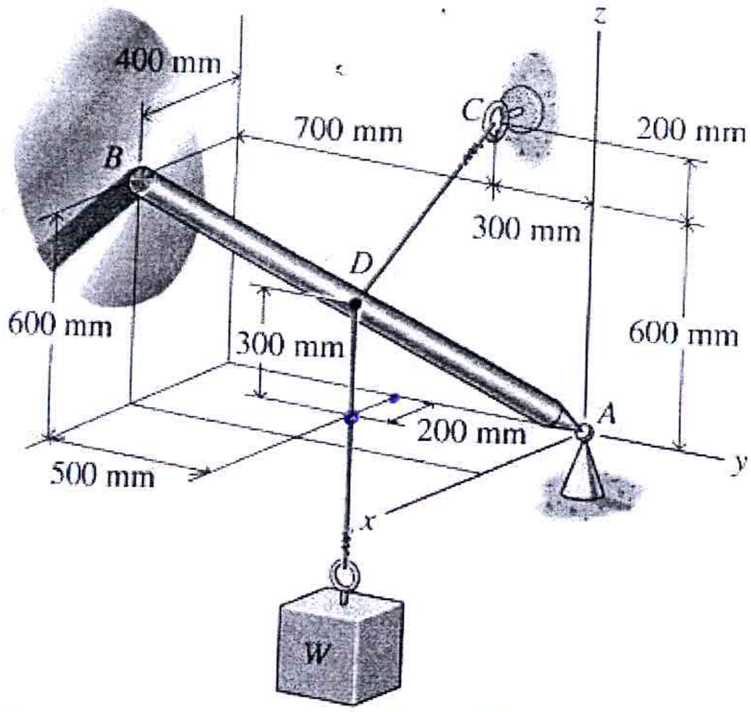
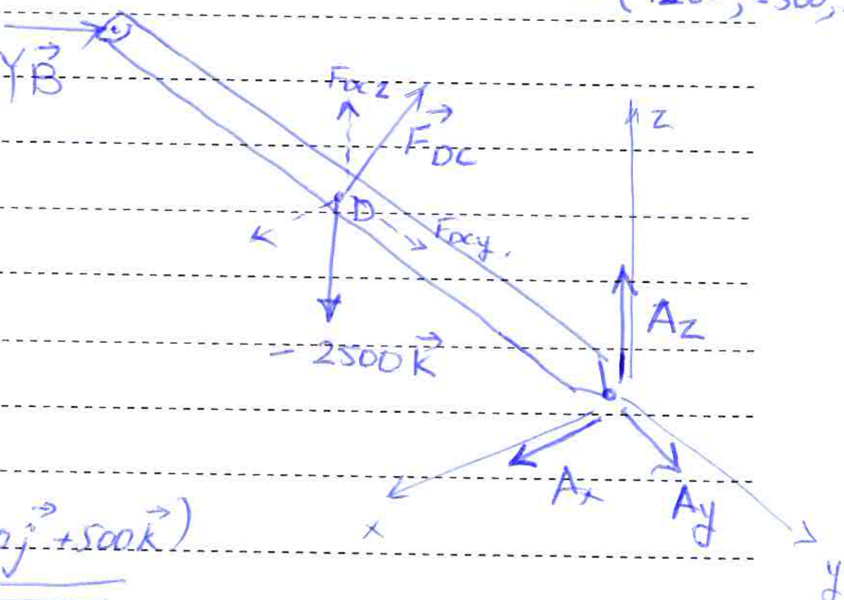


Figure IV

A(0,0,0)
B(400, -1000, 600)
C(0, -300, 800)
D(+200, -500, 300)

Calculations and/or Diagrams:

FBD



$\vec{Y_B} = Y_B\vec{j}$

$\vec{W} = -2500\vec{K}$

$\vec{F_{DC}} = F_{DC}\vec{u}_{DC}$

$= F_{DC}\dfrac{(-200\vec{i} + 200\vec{j} + 500\vec{k})}{\sqrt{200^2 + 200^2 + 500^2}}$ → 574.4

Calculations and/or Diagrams (cont'd):

$\vec{F}_{DC} = -0.348 F_{DC}\vec{i} + 0.348 F_{DC}\vec{j} + 0.87 F_{DC}\vec{k}$

$\sum F_x = 0 \quad -0.348 F_{DC} + A_x = 0 \quad -(1)$

$\sum F_y = 0 \quad 0.348 F_{DC} + A_y + Y_B = 0 \quad -(2)$

$+\uparrow \sum F_z = 0 \quad 0.87 F_{DC} - 2500 + A_z = 0 \quad -(3)$

$\sum M_{@}$ x-axis at $A = 0 \quad -Y_B(600) + 2500(500)$

$-(F_{DC} \times 0.348)(300) - 0.87 F_{DC}(500) = 0 \quad -4$

$\sum M_{@}$ Y axis at $A = 0$

$-0.348 F_{DC}(300) - 0.87 F_{DC}(200)$

$+2500(200) = 0$

$F_{DC} = \dfrac{2500 \times 200}{278.4}$

$F_{DC} = 1796\ N$

From (3) $A_z = 937.5\ N$.

From (4) $Y_B = 468.73 N$.

From (2) $A_y = -1093.7\ N$

From (1) $A_x = 625\ N$

EXTRA SHEET 1: Continued from page ________

Name: ____________________ **ID#:** ________________

Calculations and/or Diagrams:

EXTRA SHEET 2: Continued from page ________

Name: ______________________ **ID#:** ________________

Calculations and/or Diagrams: