# TEST 2
## Fall 2014
(27th November, 2014)
## CIE200 – STATICS
## CLOSED BOOK, 75 MINUTES

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

***NOTES***

- 3 problems (12 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.
- ***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.***

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***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:* | 30 /30 |
| *Problem II:* | 35 /35 |
| *Problem III* | 35 /35 |
| ***TOTAL:*** | 100 /100 |

**Problem I:** *(30 points)*

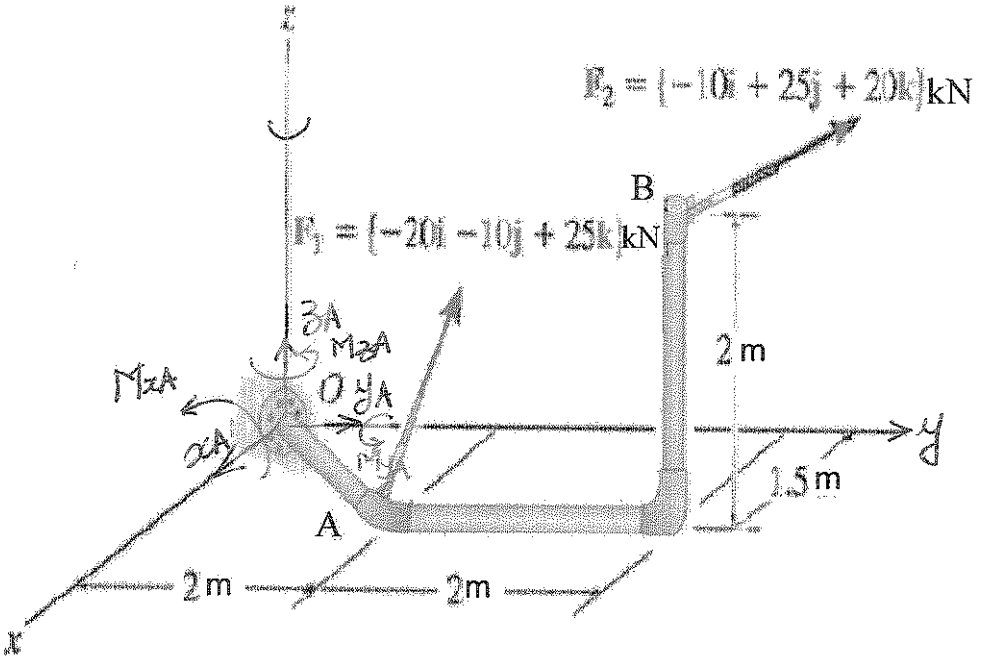



**Figure I**

Member OAB shown in Figure I is supported by a fixed support at O and subjected to two forces at A and B.

1- Use vector approach, compute the reactions at the support O. Express results in Cartesian vector. *(20 points).*
2- Use scalar Approach, Re-compute the reactions at the fixed support and compare with question 1. *(10 points).*

*Note: FBD must be included*

Calculations and/or Diagrams: Vector Approach

$\overset{+}{\rightarrow} \Sigma F_x = 0 \Rightarrow x_A - 20 - 10 = 0 \Rightarrow x_A = 30$ KN

$\overset{+}{\rightarrow} \Sigma F_y = 0 \Rightarrow y_A - 10 + 25 = 0 \Rightarrow y_A = -15$ KN

$+\uparrow \Sigma F_z = 0 \Rightarrow z_A + 25 + 20 = 0 \Rightarrow z_A = -45$ KN

A(1.5, 2, 0) B(1.5, 4, 2)

Calculations and/or Diagrams:

$\vec{r}_{OA} = \{1.5\vec{i} + 2\vec{j} + 0\vec{k}\}^m$ & $\vec{r}_{OB} = \{1.5\vec{i} + 4\vec{j} + 2\vec{k}\}^m$

$\vec{M}_A = \vec{r}_{OA} \times \vec{F}_1 + \vec{r}_{OB} \times \vec{F}_2$

$$\vec{M}_A = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 1.5 & 2 & 0 \\ -20 & -10 & 25 \end{vmatrix} + \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 1.5 & 4 & 2 \\ -10 & 25 & 20 \end{vmatrix}$$

$= \{50\vec{i} - 37.5\vec{j} + 25\vec{k}\} + \{30\vec{i} - 50\vec{j} + 77.5\vec{k}\}$

$= \{80\vec{i} - 87.5\vec{j} + 102.5\vec{k}\}$ KN.m

$\overset{+}{\circlearrowleft} \Sigma M_x = 0 \Rightarrow M_{x_A} + 80 = 0 \Rightarrow M_{x_A} = -80$ KN.m

$\overset{+}{\circlearrowright} \Sigma M_y = 0 \Rightarrow M_{y_A} - 87.5 = 0 \Rightarrow M_{y_A} = 87.5$ KN.m

$\overset{+}{\circlearrowleft} \Sigma M_z = 0 \Rightarrow M_{z_A} + 102.5 = 0 \Rightarrow M_{z_A} = -102.5$ KN.m

Cartesian Vector:

$\vec{R}_A = \{30\vec{i} - 15\vec{j} - 45\vec{k}\}$ KN $\quad \vec{M}_{R_A} = \{-80\vec{i} + 87.5\vec{j} - 102.5\vec{k}\}$ KN.m

Scalar Approach

Same as Vector approach for $x_A$, $y_A$ and $z_A$

$\overset{+}{\circlearrowleft} \Sigma M_{x_A} = 0 \Rightarrow M_{x_A} + 25(2) - 25(2) + 20(4) = 0$

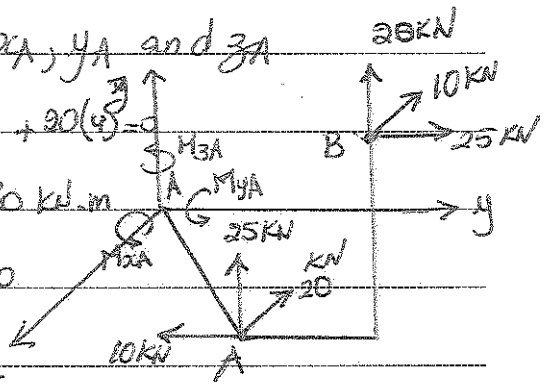
$\Rightarrow M_{x_A} + 80 = 0 \Rightarrow M_{x_A} = -80$ kN.m

$\overset{+}{\circlearrowright} \Sigma M_{y_A} = 0 \Rightarrow M_{y_A} - 25(1.5) - 10(2) - 20(1.5) = 0$

$M_{y_A} - 87.5 = 0 \Rightarrow M_{y_A} = 87.5$ KN.m

$\overset{+}{\circlearrowleft} \Sigma M_{z_A} = 0 \Rightarrow M_{z_A} + 20(2) - 10(1.5) + 25(1.5) + 10(4) = 0 \Rightarrow M_{z_A} = -102.5$ KN.m

Same as Q1. ok



**Problem II:** *(35 points)*

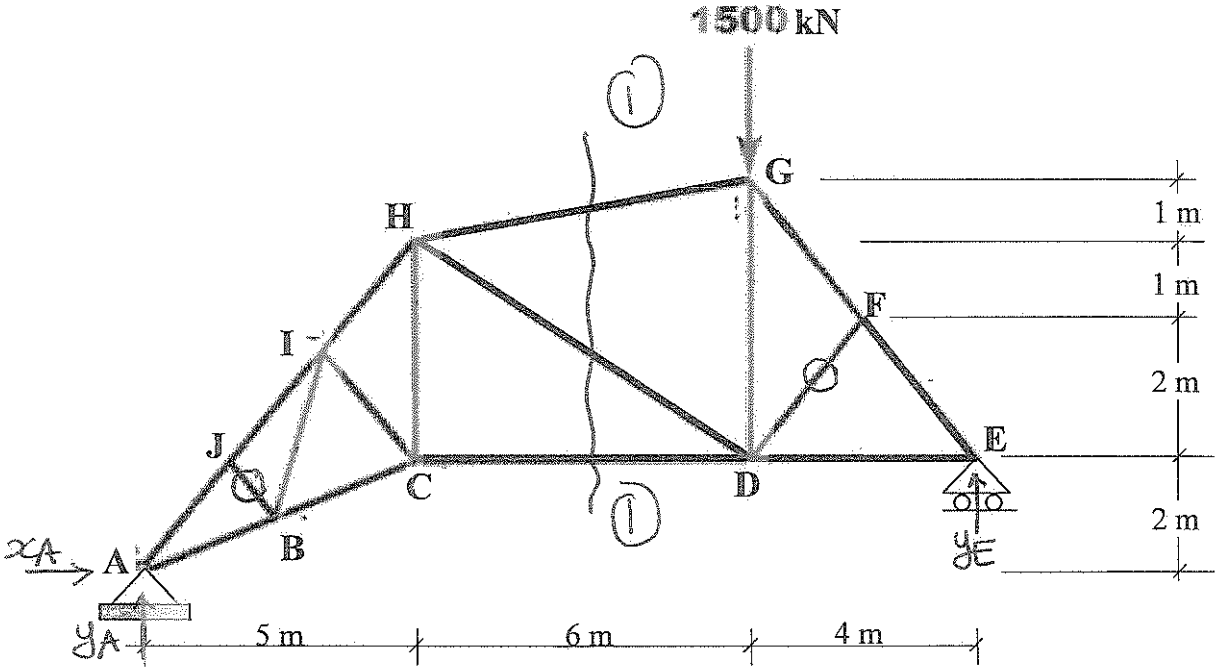



**Figure II**

The truss shown in Figure II is subjected to a force of 1500 kN at G:

1- Determine the external reactions at the pin support at A and the roller at E. *(5 points)*
2- Determine the force in members HG, HD, CD ***using the section method***. Also solve for the force on members EF, and DE using the appropriate method of analysis. *(25 points).*
3- Indicate Zero-force members. *(5points).*

*Note: FBD must be included*

Calculations and/or Diagrams:

1- Reactions:

$\stackrel{+}{\rightarrow} \Sigma F_x = 0 \Rightarrow x_A = 0$

$+\circlearrowleft \Sigma M_A = 0 \Rightarrow -1500(11) + y_E(15) = 0 \Rightarrow y_E = 1100\ kN \uparrow$

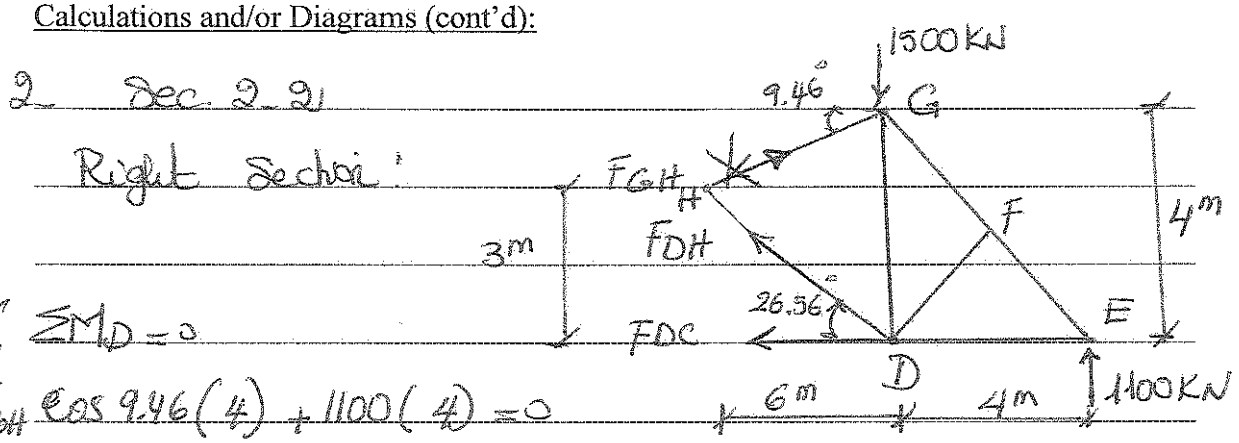
$+\circlearrowleft \Sigma M_E = 0 \Rightarrow 1500(4) - y_A(15) = 0 \Rightarrow y_A = 400\ kN \uparrow$

check! $+\uparrow \Sigma F_y = 0 \Rightarrow 400 - 1500 + 1100 = 0 \therefore$ o.k

Calculations and/or Diagrams (cont'd):

2- Sec. 2-2

Right Section:




$+\circlearrowleft \Sigma M_D = 0$

$F_{GH}\cos 9.46(4) + 1100(4) = 0$

$\Rightarrow F_{GH} = -1115.17\ KN = 1115.17\ KN\ (C)$

$+\circlearrowleft \Sigma M_H = 0 \Rightarrow -F_{DC}(3) - 1500(6) + 1100(10) = 0$

$\Rightarrow F_{DC} = 666.67\ KN\ (T)$

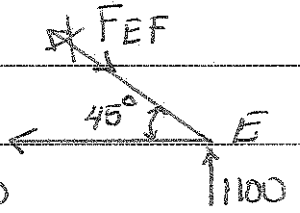
$+\uparrow \Sigma F_y = 0 \Rightarrow 1115.17 \sin 9.46 + F_{DH} \sin 26.56 - 1500 + 1100 = 0$

$\Rightarrow F_{DH} = 484.67\ KN\ (T)$

Check! $\pm\rightarrow \Sigma F_x = 0 \Rightarrow 1115.17\cos 9.46 - 484.67\cos 26.56 - 666.67 = 0$

ok ✓

Method of joint at E




$+\uparrow \Sigma F_y = 0 \Rightarrow F_{EF}\sin 45 + 1100 = 0 \Rightarrow F_{EF} = -1555.63 = 1555.63\ KN\ (C)$

$\pm\rightarrow \Sigma F_x = 0 \Rightarrow -F_{ED} + 1555.63\cos 45 = 0 \Rightarrow F_{ED} = 1100\ KN\ (T)$

3- Zero force members: JB and DF.

**Problem III:** *(35 points)*

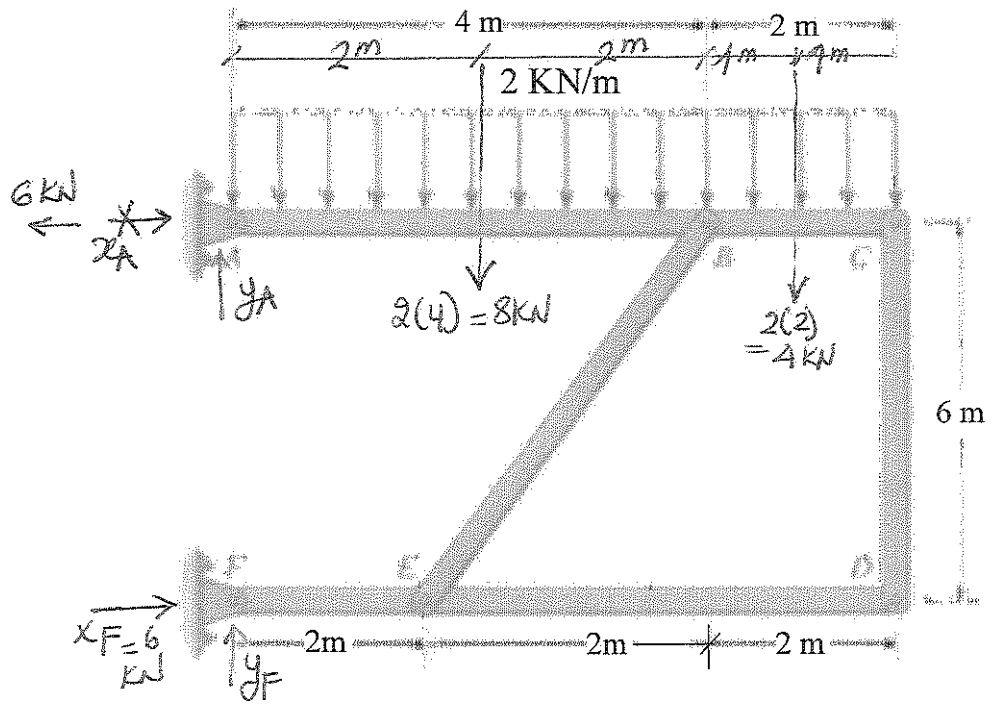



**Figure III**

The frame shown in Figure III is composed of four members **AC**, **CD**, **BE** and **FD**, connected by pins at **B**, **C**, **D** and **E**.

1. Determine the external reactions at pin supports A and F, and the internal forces of the frame at points **B**, **C**, **D** and **E**. *(35 points)*

*Note: FBD must be included*

Calculations and/or Diagrams:

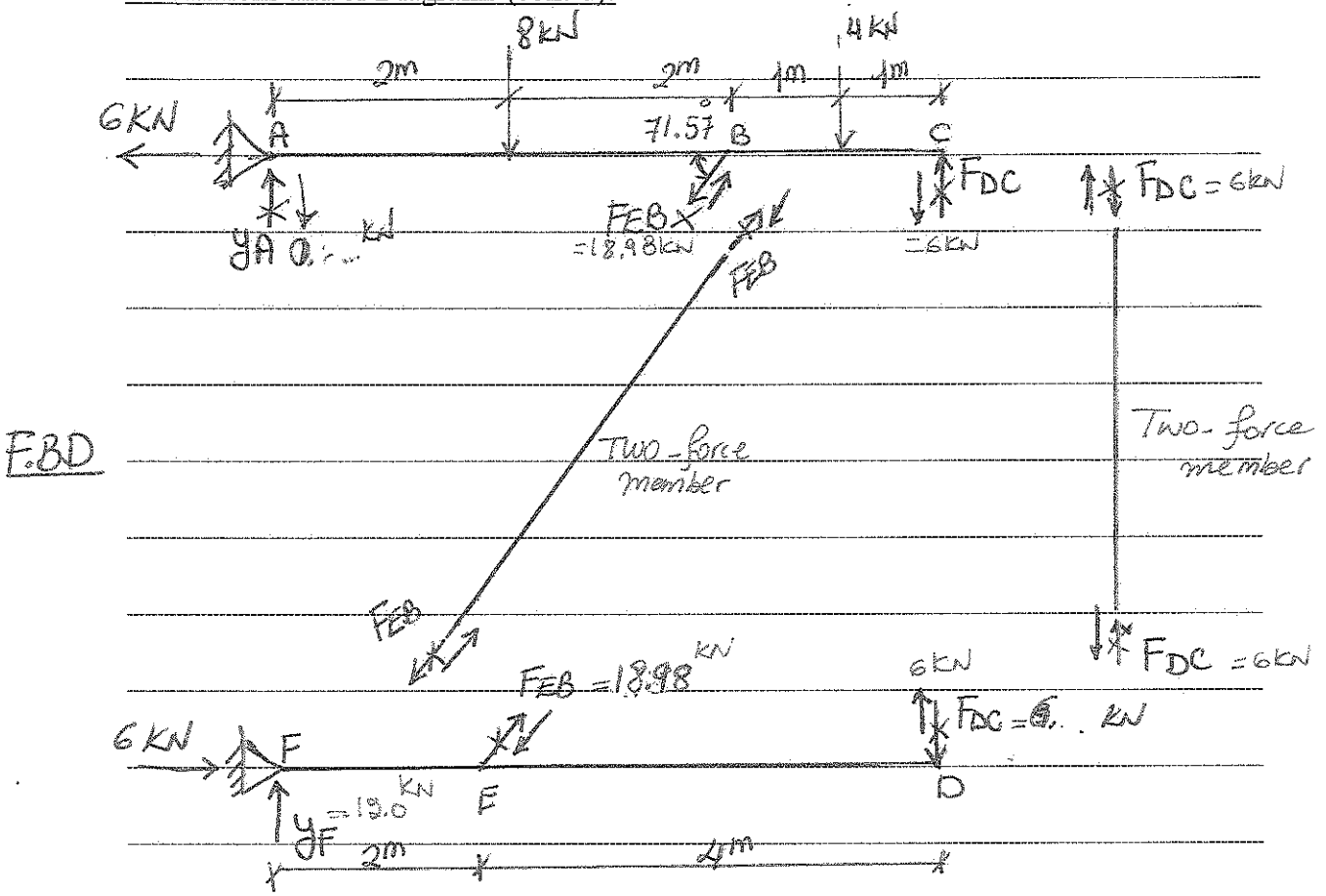
use the Whole frame:

$+\circlearrowleft \Sigma M_F = 0 \Rightarrow -X_A(6) - 8(2) - 4(5) = 0 \Rightarrow X_A = -6KN = 6KN \leftarrow$

$+\circlearrowleft \Sigma M_A = 0 \Rightarrow -8(2) - 4(5) + X_F(6) = 0 \Rightarrow X_F = 6KN \rightarrow$

check! $\pm \Sigma F_x = 0 \Rightarrow -6 + 6 = 0$ ✓ok

Calculations and/or Diagrams (cont'd):




Part ABC:

$\rightarrow \Sigma F_x = 0 \Rightarrow -6 - F_{EB}\cos 71.57 = 0 \Rightarrow F_{EB} = -18.98 = 18.98$ KN ↗

$+\circlearrowleft \Sigma M_A = 0 \Rightarrow -8(2) + 18.98 \sin 71.57\,(4) - 4(5) + F_{DC}(6) = 0$

$F_{DC} = -6.0$ kN $= 6.0$ KN ↓

$+\uparrow \Sigma F_y = 0 \Rightarrow y_A - 8 + 18.98 \sin 71.57 - 4 - 6.0 = 0$

$y_A = 0.$.. kN

Part FED:

$+\uparrow \Sigma F_y = 0 \Rightarrow y_F - 18.98 \sin(71.57) + 6.0 = 0 \Rightarrow y_F = 12.0$ kN ↑

check! $\pm \Sigma F_x = 0 \Rightarrow 6 - 18.98 \cos 71.57 = 0$ ✓ ok.