UNIVERSITE Concordia UNIVERSITY

Faculty of Engineering and Computer Science

ENGR 242/4 WW STATICS **Winter 2016**

Test 1 (February 18th, 2016)

Instructions:

1. Time allowed: **75 minutes**.
2. Answer all **three** questions.
3. Any missing data should be reasonably assumed with sufficient explanation.
4. Only non-programmable calculators are permitted.
5. Test includes **five** pages.
6. Write on both sides of the test, if needed.
7. Draw clear **sketches** and **FBD**, when applicable.

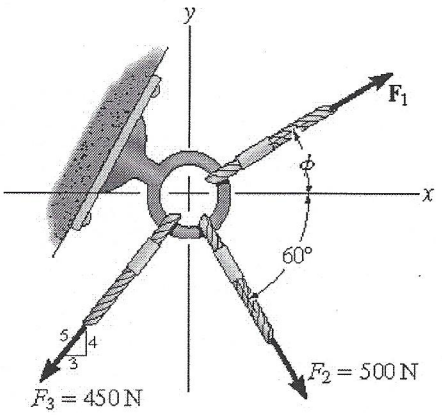
Name: Solution of the test

Student ID: .....

Signature: .....

Question 1 (30 marks)

If the magnitude of the resultant force acting on the eyebolt is 600 N and its direction measured clockwise $\theta = 30°$ from the positive x axis, determine the magnitude of $\mathbf{F}_1$ and the angle ϕ.



Resultant = 600 N

+ve →

$\Sigma F_x = R_x$

$F_1 \cos\phi + 500 \cos 60 - 450\left(\frac{3}{5}\right) = 600 \cos 30$

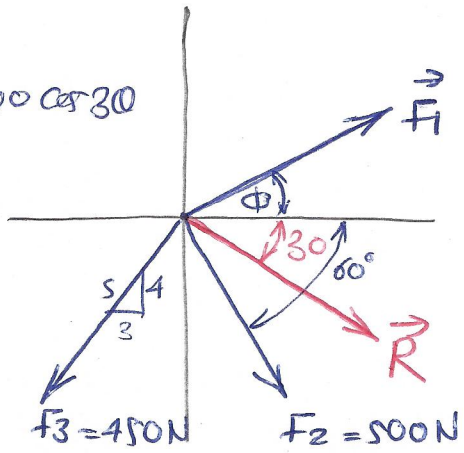
$F_1 \cos\phi = 539.62 \rightarrow (1)$

+ve ↑

$\Sigma F_y = R_y$

$F_1 \sin\phi - 500 \sin 60 - 450\left(\frac{4}{5}\right) = -600 \sin 30$

$F_1 \sin\phi = 493.01 \rightarrow (2)$



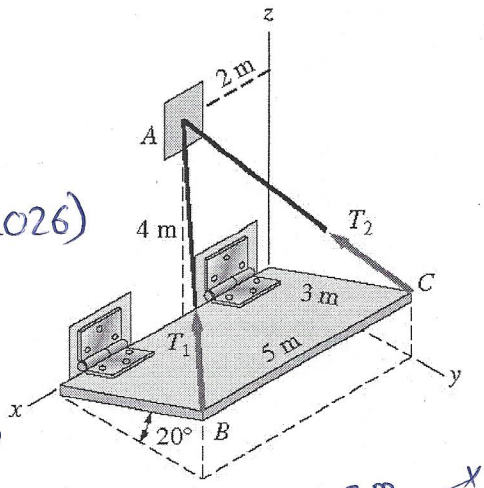
Solving (1) & (2)

$\phi = 42.42°$

$F_1 = 730.92\,\text{N}$

Question 2 (40 Marks)

Knowing that the tension in cable *AC* is 1200 N, determine the moment about each of the coordinate axes of the force exerted on the plate at C.



$A = (2, 0, 4)$; $C = (0, 2.819, 1.026)$

$\vec{r}_{O/C} = 2.819\,j + 1.026\,k$

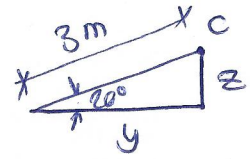
$\vec{CA} = 2\,i - 2.819\,j + 2.974\,k$

$CA = \sqrt{(2)^2 + (2.819)^2 + (2.974)^2} = 4.56\ m$

$\lambda_{CA} = \frac{\vec{CA}}{CA} = 0.4386\,i - 0.6182\,j + 0.6522\,k$

$\vec{F}_{CA} = F_{CA} \cdot \lambda_{CA} = 1200(\lambda_{CA})$

$= 526.32\,i - 741.84\,j + 782.64\,k$

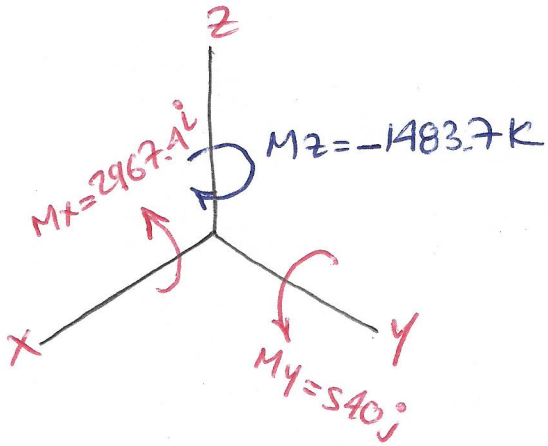


$z = 3\sin 20° = 1.026\ m$

$y = 3\cos 20° = 2.819\ m$

$\vec{M}_O = \vec{r}_{O/C} \times \vec{F}_{CA}$

$$\vec{M}_O = \begin{vmatrix} i & j & k \\ 0 & 2.819 & 1.026 \\ 526.32 & -741.84 & 782.64 \end{vmatrix}$$



$\vec{M}_O = i\,(2.819 * 782.64 - 1.026 \times (-741.84))$

$-j\,(0 - 1.026 \times 526.32)$

$+k\,(0 - 2.819 \times 526.32)$

$\vec{M}_O = 2967.4\,i + 540.\,j - 1483.7\,k = M_x + M_y + M_z$

$M_x = 2967.4\,i$

$M_y = 540.\,j$

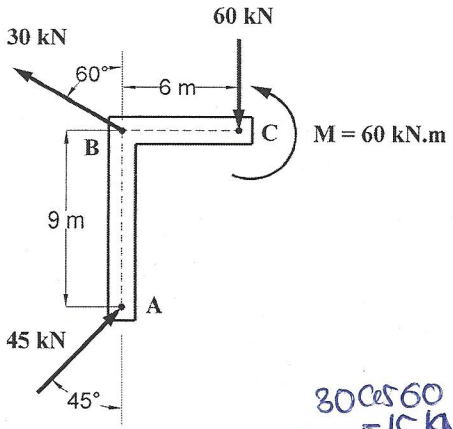
$M_z = -1483.7\,k$

Question 3 (30 Marks)

A couple of magnitude M = 60 kN . m and three forces are applied as shown.

(a) Find the resultant of this system of forces (magnitude and direction);

(b) Locate the points where the line of action of the resultant intersects lines BC and AB.



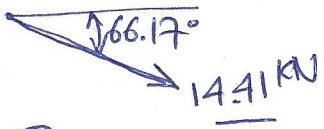
a) $R_x = \Sigma f_x = 31.82 - 26 = 5.82$ kN (+ve →)

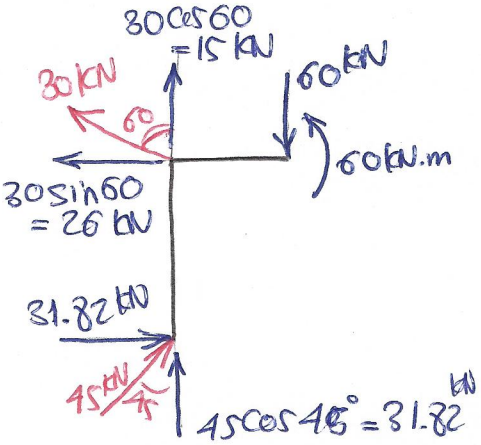
$R_y = \Sigma f_y = 31.82 + 15 - 60 = -13.18$ kN (+ve ↑)

$= 13.18$ kN ↓

$R = \sqrt{R_x^2 + R_y^2} = 14.41$ kN

$\theta = \tan^{-1}\frac{R_y}{R_x} = 66.17°$





b) Equivalent force couple at (B)

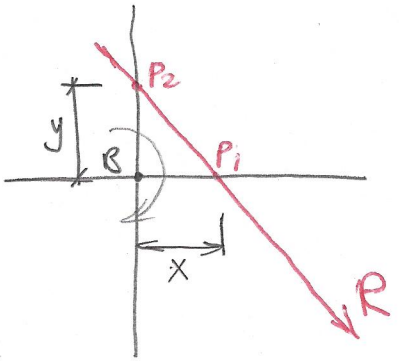
(+ve ↻) $\Sigma M_B = 31.82 \times 9 - 60 \times 6 + 60 = -13.62$ kN.m

$= 13.62$ kN.m ↻

Assume Rat p_1

$\Sigma M_B = 13.62$ ↻ kN.m $= R_y \cdot x$ ↻

$x = \frac{13.62}{R_y} = 1.03$ m



Assume Rat p_2

$\Sigma M_B = 13.62$ ↻ kN.m $= R_x \cdot y$ ↻

$y = \frac{13.62}{R_x} = 2.34$ m

(Check $\tan^{-1}\frac{y}{x} = 66.17°$) the same θ as (a)