Birzeit University
Faculty of Engineering & Technology
Civil Engineering Department
Statics - CE 232
Summer Semester 2018/2019

Midterm Exam – Saturday, July 20, 2019
Time total allowed = 75minutes

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Instructor and section:

Abdalrahman Hamdan – Section 1	
Abdalrahman Hamdan – Section 2	
Abdalrahman Hamdan – Section 3	✓
Dr. Omar Zamo – Section 4	
Farhat Majadbeh – section 5	

Grading

Problem 1	25
Problem 2	25
Problem 3	25
Problem 4	08
SUM/100	

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ملاحظات مهمه

- اكتب اسمك ورقمك في المكان المخصص على كل ورقه من أوراق الامتحان
- اختر شعبتك من الشعب اعلاة. ان عدم اختيار الشعبه او كتابتها بصوره خاطئة قد يؤدي لخصم من علاماتك المحصله بهذا الامتحان
- اجب في المكان المخصص فقط ويمكنك استعمال الوجه الاخر للورقة ان لزم
- الإجابات الغير مدعمه بحسابات صحيحة او تفسير منطقي لن تؤخذ بعين الاعتبار
- اكتب بخط واضح ومقروء ونظم حلك بتسلسل منطقي وترابط بحيث يسهل مراجعة خطواتك. سيتم اعتبار وضوح الحل وتسلسله عند تقيم الإجابات ولن يتم تقيم اي معلومات تقدمها غير مرتبطه بالحل الصحيح او لا تؤدي اليه.
- لتجنب الأخطاء الحسابية ينصح بفحص الإجابات للتأكد منها بكل طريقة ممكنه.
- عدد أسئلة الامتحان أربعة وعدد الصفحات ست

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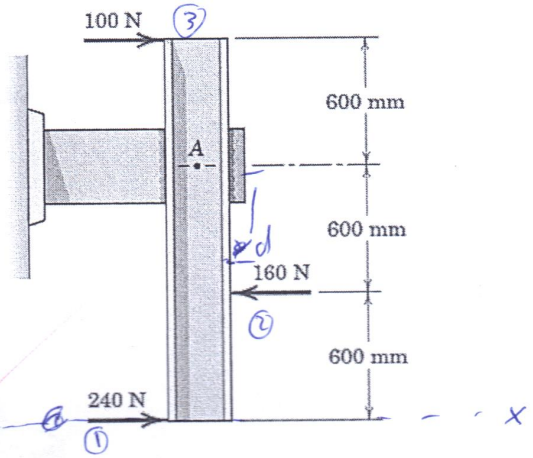
Problem 1 (Weight 25)

A. Replace the three forces shown by an equivalent force–couple system at point A.

B. If the forces are replaced by a single resultant force, determine the distance d below/ above point A to its line of action.



A. $\vec{F_1} = 240\ N\ \hat{i}$

$\vec{F_2} = -160\ N\ \hat{i}$

$\vec{F_3} = 100\ N\ \hat{i}$

at A $\vec{R} = (240 - 160 + 100)N\ \hat{i} = 180\ N\ \hat{i}$

~~$\vec{M}_A^R = \vec{d} \times \vec{F_1} + \vec{d} \times \vec{F_2} + \vec{d} \times \vec{F_3}$~~

$\vec{M}_A^R = \vec{d_1} \times \vec{F_1} + \vec{d_2} \times \vec{F_2} + \vec{d_3} \times \vec{F_3} = (1.2)(240) - (0.6)160 + 100(0.6)\ \hat{k}$

$= 288 - 96 - 60 = 132\ \hat{k}\ N \cdot m$

$\vec{R} = 180(N)\ \hat{i}$ & $M_A^R = 132\ \hat{k}\ (N \cdot m)$

B. $M_A^R = d\ (\vec{R}) \Rightarrow d = \frac{132}{180} = 0.733\ m$ below A

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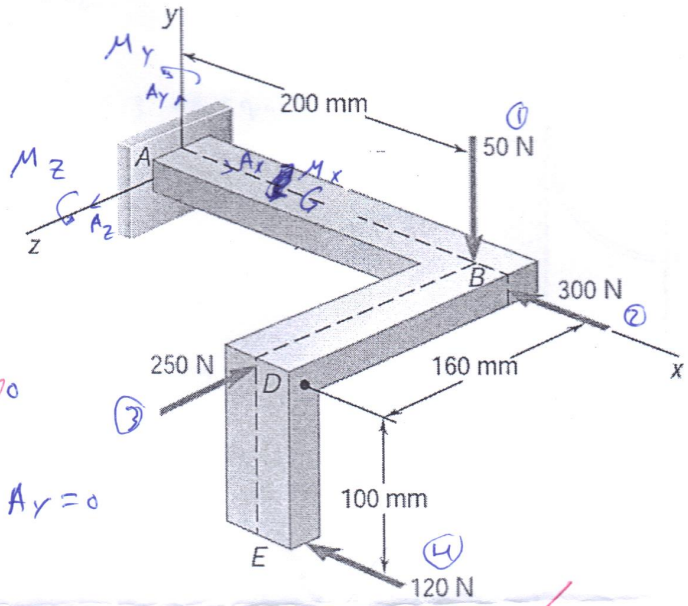
Problem 2 (Weight 25)

The frame ABDE is supported by a fixed support at A and subjected to four forces as shown in the diagram. Find the reaction of the support at A.



$\vec{F_1} = -50\,\hat{j}\ N$

$\vec{F_2} = -300\,\hat{i}\ N$

$\vec{F_3} = -250\,\hat{k}\ N$

$\vec{F_4} = -120\,\hat{i}\ N$

$\Sigma f_x = 0$

$-300 - 120 + A_x = 0$

$A_x = 420\ N$

$\Sigma f_y = 0 \Rightarrow -50 + A_y = 0$

$A_y = 50\ N$

$\Sigma f_z = 0 \Rightarrow -250 + A_z = 0 \Rightarrow A_z = 250\ N$

$\Sigma M_A = 0 \Rightarrow \Sigma \vec{r} \times \vec{F} = 0 \Rightarrow 0 = (0.2\hat{i}) \times (-50\,\hat{j}) + (0.2\,\hat{i}) \times (-300\,\hat{i}) + (0.2\,\hat{i} + 0.16\,\hat{k}) \times (-250\,\hat{k}) + (0.2\,\hat{i} - 0.1\,\hat{j} + 0.16\,\hat{k}) \times (-120\,\hat{i}) + M_x\,\hat{i} + M_y\,\hat{j} + M_z\,\hat{k}$

$\Rightarrow -10\,\hat{k} + 50\,\hat{j} + M_x\,\hat{i} = 0$

$-12\,\hat{k} - 19.2\,\hat{j}$

$+M_z\,\hat{k} + M_y\,\hat{j}$

$(M_z - 22)\,\hat{k} + (30.8 + M_y)\,\hat{j} + M_x\,\hat{i} = 0$

$M_x = 0$ $\quad M_y = -30.8\ N.m$ $\quad M_z = 22\ N.m$

$A = (420\,\hat{i} + 50\,\hat{j} + 250\,\hat{k})\ N$

$M_A = (-30.8\,\hat{j} + 22\,\hat{k})\ N.m$

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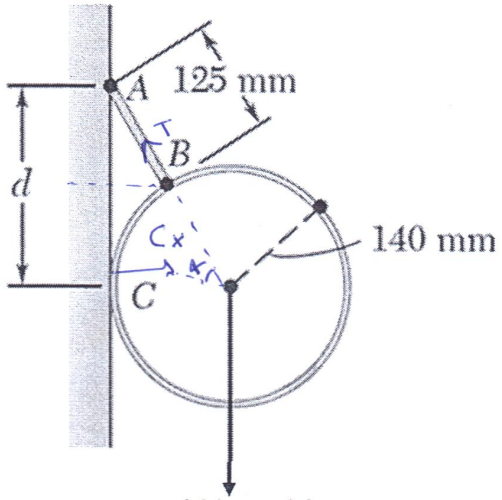
Problem 3 (Weight 25) = 0.14 m

A 20 N thin ring of radius r = 140 mm is held against a frictionless wall by a 125-mm string AB. Determine

(a) The distance d. = 0.125 m

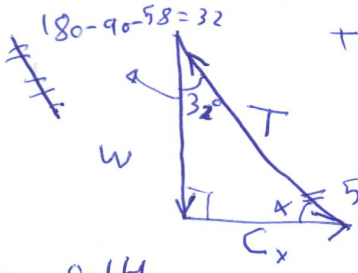
(b) The tension in the string,

(c) The reaction at C.



Concurrent Forces ⇒ equillibrium.

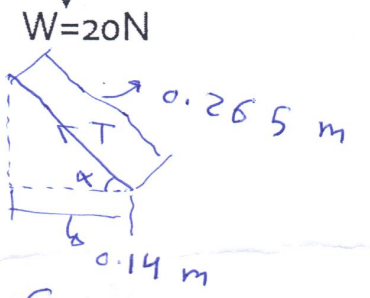
Triangular Forces.



(a)

$\cos\alpha = \frac{0.14}{0.265} = 0.53 \Rightarrow \boxed{\alpha = 58^\circ}$

$\sin\alpha = \frac{d}{0.265} = \sin 58^\circ \Rightarrow \boxed{d = (\sin 58^\circ)\,0.265 = 0.225\ m = 225\ mm}$



(b) Sines law (Triangular Forces):

$\frac{T}{\sin 90} = \frac{C_x}{\sin 32^\circ} = \boxed{\frac{W}{\sin 58^\circ} = 23.6}$

$\Rightarrow T = (23.6)\sin 90 = \boxed{23.6\ N = T_{BA}}$

$C_x = (23.6)\sin 32^\circ \Rightarrow \boxed{C_x = 12.5\ N\ \hat{i}}$

(c) $\alpha = \cos^{-1}\left(\frac{0.14}{0.265}\right)$

$\alpha = 58^\circ$

(a) $d = 0.225\ m$

(b) $\vec{T}_{BA} = T_{BA}(-\cos 58^\circ\,\hat{i} + \sin 58^\circ\,\hat{j}) = (-12.5\,\hat{i} + 20\,\hat{j})\ N$

(c) $C = (12.5\,\hat{i})\ N$

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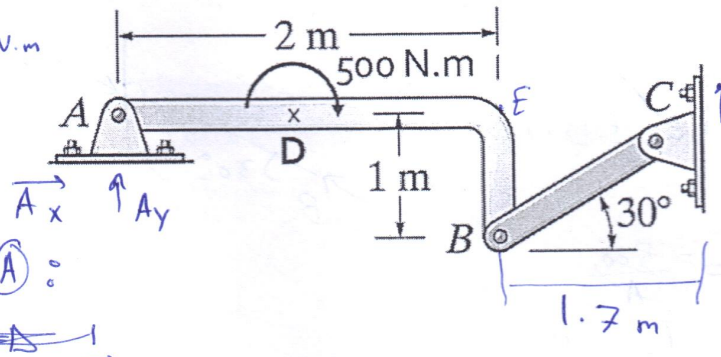
Problem 4 (Weight 25)

The frame shown consists two members ADB and BC that are joint together by a pin at B. A and C are pin (hinge) supports. A moment of 500 N.m is applied at D. Determine reactions at the pins A and C.



$M_D = -500\ \hat{k}$ N.m

$\tan 30 = \frac{\text{opposite}}{\text{adjacent}}$

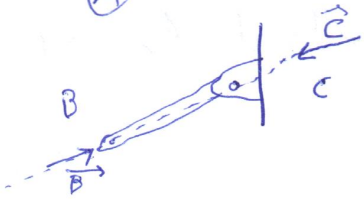
$\frac{\text{opposite}}{\tan 30} = \text{adjacent}$

$m\ 1.7 = \frac{1}{\tan 30} =$

Ⓐ

in Part Ⓐ:

Special Case: $\vec{B}$ and $\vec{C}$ Same magnitude & direction opposite Sence.



in Part Ⓑ:

$\Sigma F_x = 0 \Rightarrow A_x - B_x = 0$

$A_x = B_x$

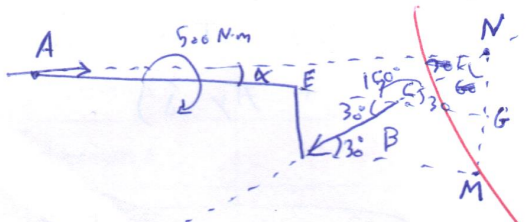
$\Sigma F_y = 0 \Rightarrow A_y - B_y = 0 \Rightarrow A_y = B_y$

$\Sigma M_A = 0 \Rightarrow (-500) - (2)B_y - (1)B_x = 0$

Ⓑ

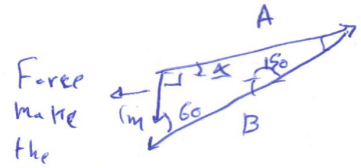
$M_A = -500 - B_y\, d - B_x\, d$

Part Ⓑ:



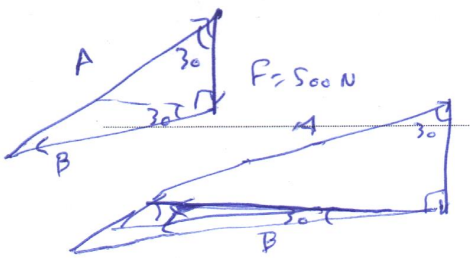
EC = 1.7 m
AE = 2 m
AC = 3.7 m
NG = NM −
x =

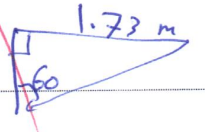
$\frac{A}{\sin 120} = \frac{B}{\sin(90+x)} = \frac{500}{\sin 30}$



Force make the moment

(500 N)(1 m)





F = 500 N.