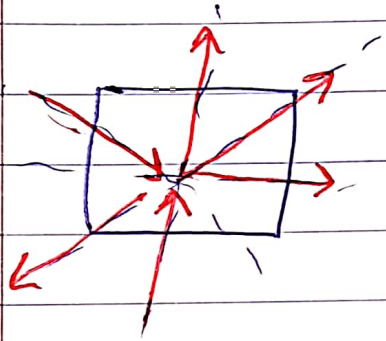
CHAPTER 4

in the equilibrium there is no Rotational motion and no translational motion

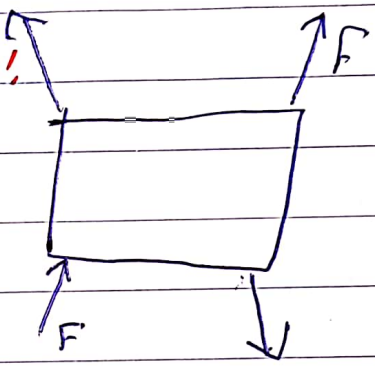
$$\sum F = 0$$
$$\sum M = 0$$

notice the difference

Ch 2:



Ch 4:



~~A~~ concuret forces don't make moment around the point so M is already zero ~~BAL F~~ ~~ts~~.

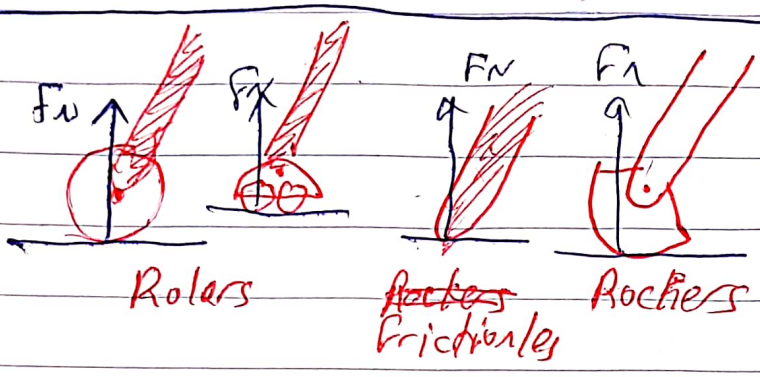
maybe F=0 but we should check M

Moment around any Axis's Any point

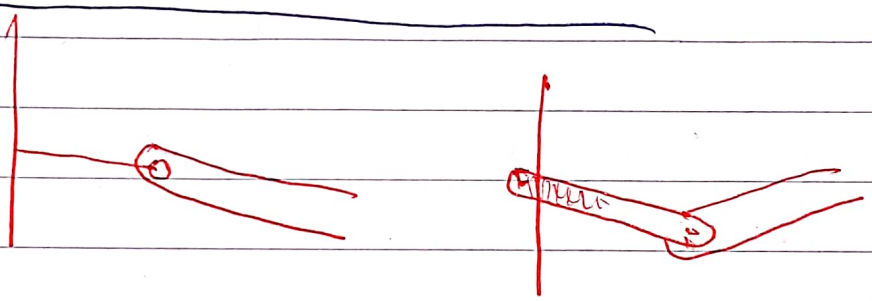
Any Axis even if not X/Y/Z should equal to zero

Net force should equal zero

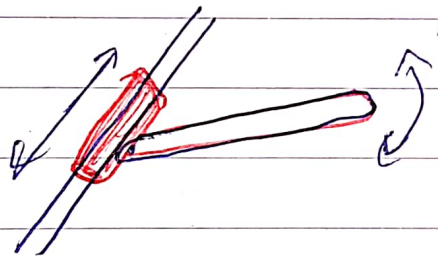
Some times chosing the axis of moment is a very big part of solution



Prevent moment in ~~z~~ direction force with known direction

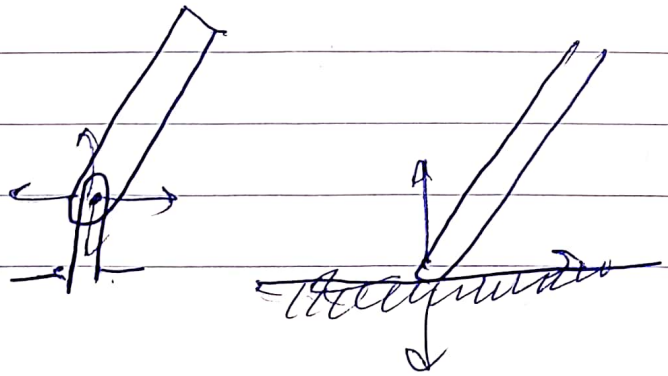


Force with known line of action

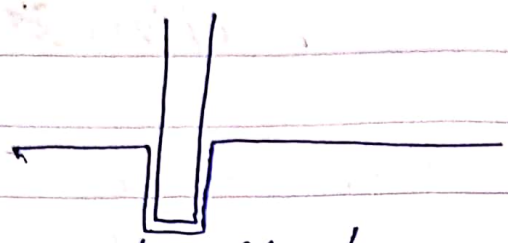


Force with known L.A

Friction less pin rough surface



Forces in 2 direction (unknown direction)

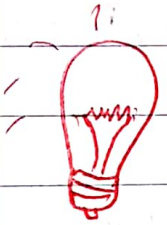


Fixed support

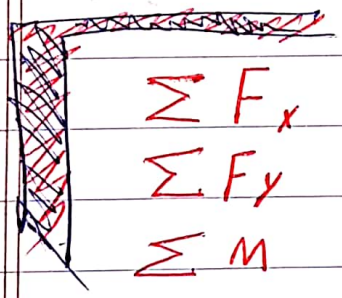
Force with unknown direction and a couple of unknown magnitude

⚠ when we have a force with unknown direction we can use F_x / F_y or F / α

the max number of reaction that we can calculate is 3 in 2D



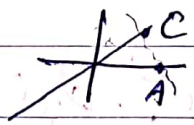
equilibrium equations in 2D are 3 at most



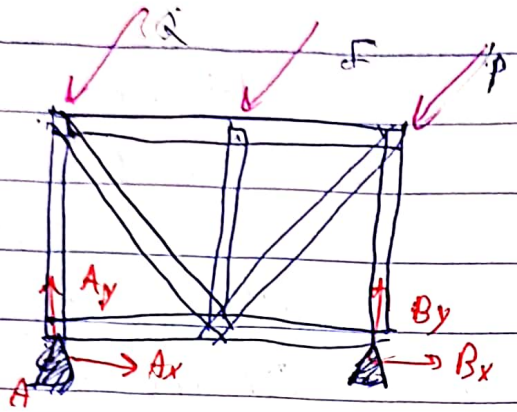
$\Sigma F_x = 0$

$\Sigma F_y = 0$

$\Sigma M = 0$ → at any point or any axis even axis AC

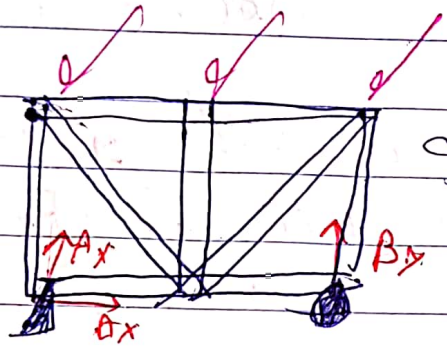


reactions = eq.



ثابت انشائياً
لكنه لا يمكن
تحليله في
الاستاتيكا
حتى الآن

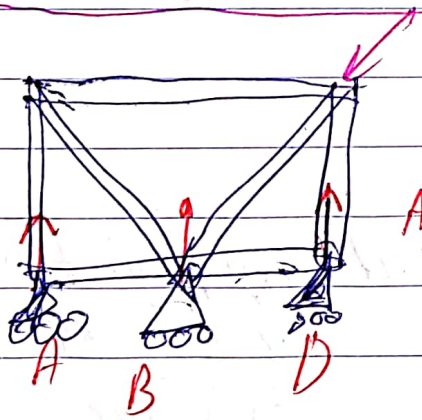
re. ≠ eq.



ثابت ويمكن تحليله
نظراً لكون عدد
Reactions له
يساوي عدد
المعادلات

The reaction is the resistance ~~force~~ force of ~~the~~ moving the body

re < eq.



Ay / By / Dy

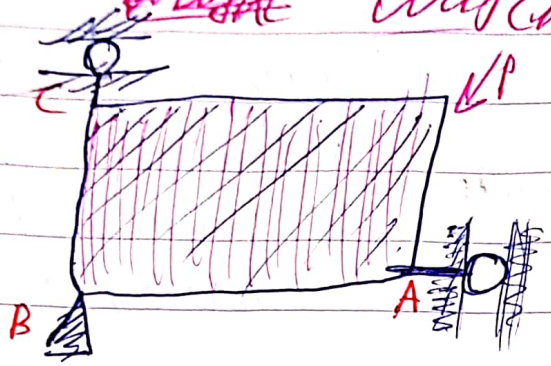
r = eq.

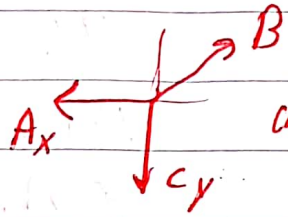
but it is not stable

if reactions are parallel
the body won't be stable

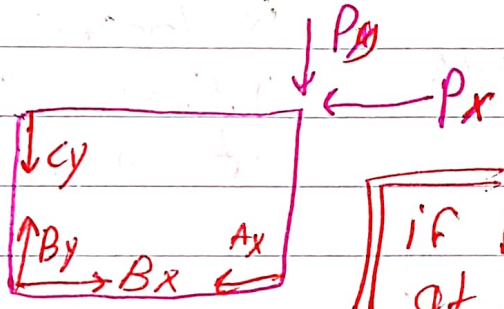
If reactions are concurrent !!!

watch this !





all are acting on point B (lines of action are meeting in B)



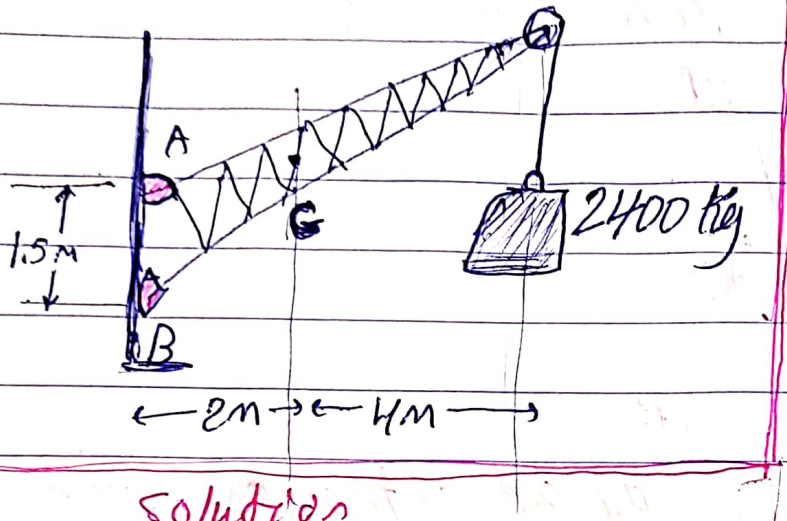
if Px made momen Mp at point B

Ax can't make moment because its line of action go through B

and the same for reaction Ey

1) 3 reactions to be able to determine for building a structure you can have more
2) not parallel reactions
3) & concurrent

Sample Problem



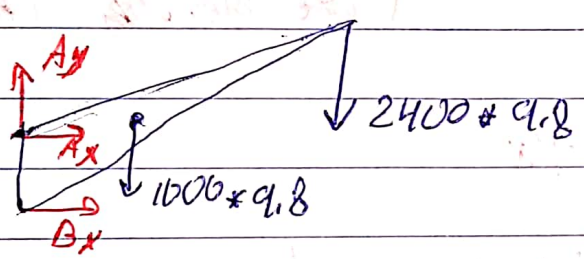
a fixed crane has a mass of 1000 kg and is used to lift a 2400 kg crate.

it's held in place by Pin at A and a rocker at B. the center of gravity of the crate is located at G.

Determine the reactions at A & B

Solution

Free Body diagram



$F_x \rightarrow$ 2 unknowns

$F_y \rightarrow$ one unknown

M_B = 2 unknowns / M_A = one unknown / M_G = 3 unknowns

always use the Point that reduce the unknowns

$$\Sigma F_y = 0 \rightarrow \boxed{\vec{A_y} = (2400 + 1000) * 9.8 = +33320 \uparrow}$$

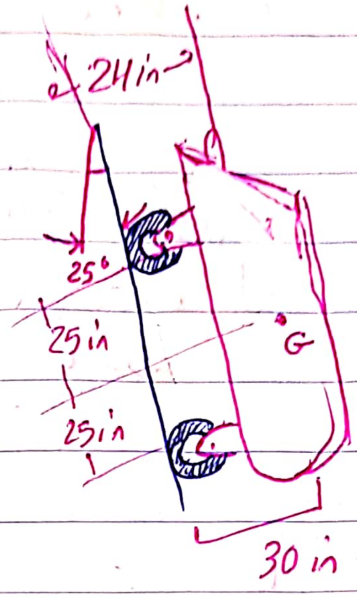
$$M_A = 0 \rightarrow 2400 * 9.8 * 6 + 1000 * 9.8 * 2 = B_x * 1.5$$

$$\boxed{B_x = 107146.67\ N}$$

$$\Sigma F_x = 0$$

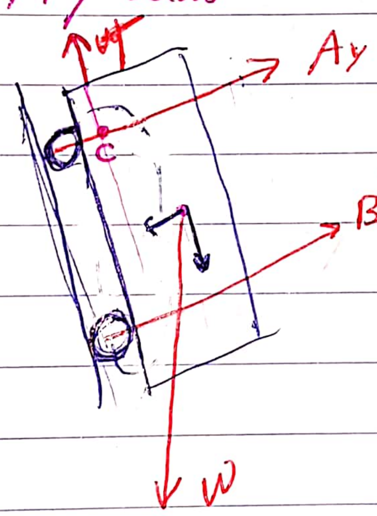
$$\boxed{A_x = -B_x = -107146.67}$$

Sample Problem



A loading car is at rest on an inclined track. the gross weight of the car and its load is 5500 Ib and it's applied at G. the cart is held in position by the cable. Determine the tension in the cable and the reaction at each pair of wheels

My solution



$\Sigma F_x = 0$

$W\cos 25 = T$

$T = 4984.7 Ib$

$M_c = 0$

(c) نقطة التقاء قطين قوه مانعرفش احنا نتخلص منه عزم قوتين

$W\sin 25 * 25$

$+ W\cos 25 * 6$

$- B_y * 50 = 0$

$B_y = \frac{25 W\sin 25 + W\cos 25 * 6}{50}$

$B_y = 1760.4\ Ib$

$A_y = ?$

$\Sigma F_y = 0$

$1760.4 + A_y - W\sin 25 = 0$

$A_y = 564$

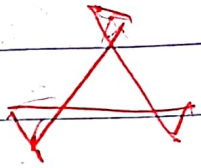
مهم طريقة اختيار المحاور

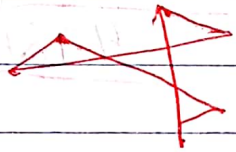
اختيار المحور او النقطة

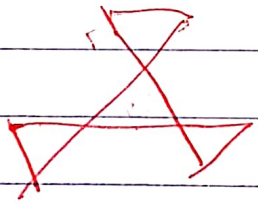
الهدف

اختر النقطة التي تتقاطع فيها خطوط تأثير القوى المجهولة ثم اجب العزوم عنها لتتلاشى هذه القوى

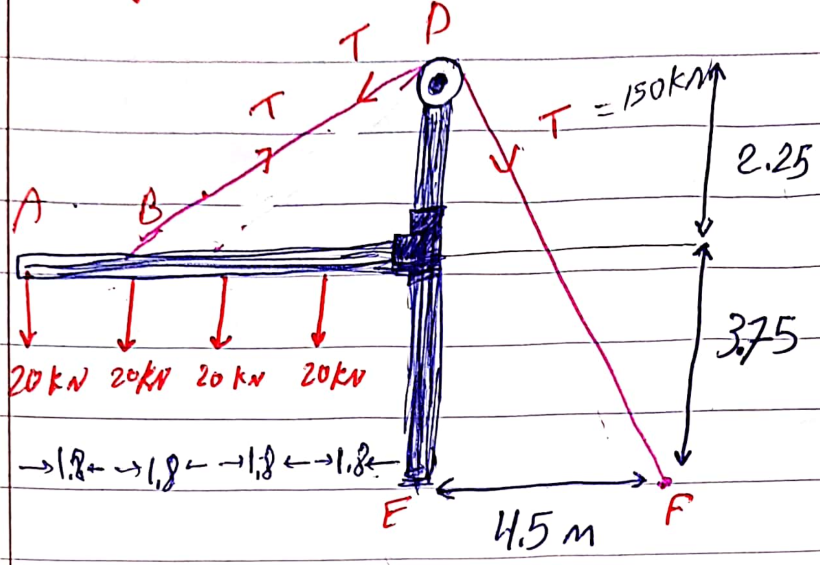
او اختار محور يمر باكثر من support لتتلاشى هذه الـ reactions الغير معلومة لايجاد a cirtain reaction







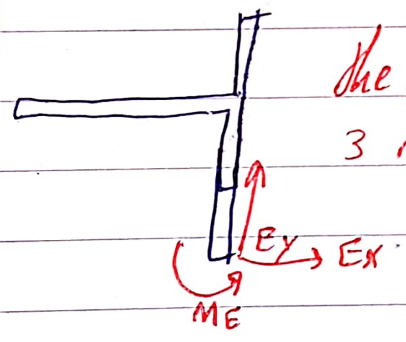
Sample



the Frame supports part of the roof of a small building. the tension in the cable is 150 kN Determine the reaction at the fixed end E

حاط في هذا السؤال
نقاش بيني والدكتور
وبين حول كون
الشد يمنع BD
عزم ام لا لكنه
لا يمنع عزم لانه
هنالك قوة معاكسة
للشد نفسه
وهي الشد DB

solution :-



the support has 3 reactions

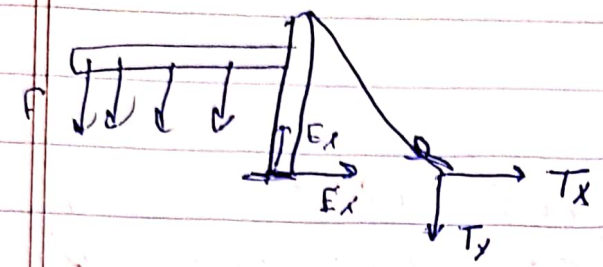
$$\Sigma F_y = 0 \rightarrow T \cdot \frac{(2.25+3.75)}{\sqrt{(4.5)^2+(6)^2}} + 80\,kN - E_y = 0$$

$$E_y = 120 + 80 = 200\ kN\ \text{up}$$

$$\Sigma F_x = E_x + T \cdot \frac{4.5}{\sqrt{4.5^2+6^2}}$$

$$E_x = -90\ kN = 90\ kN\ \text{left}$$

اختيار النقطة E موفق جداً لحساب العزم المحاصل
ذلك لانه القوى Ex Ey تمر كذلك لعدم مركبات T



$M_E = ?$

$$M_E + M_{(all\ other\ forces)} = 0$$ at any point

because M is free vector

بما انه العزم ناقل

$M_E + -T_y * 4.8 + 20 * 1.8 + 20 * 3.6 + 20 * 5.4 + 20 * 7.2$

$ME + -120 * 4.5 + 20(18)$

$M_E - 120 * 4.5 + 360 = 0$

$M_E = 120 * 4.5 - 360$

$M_E = +180$ kN.m counter clockwise

اشياء مهمة في هذا المثال :-

1- احياناً يصعب ايجاد القوى بالعزم مثل اول مثال

ظاهراً انه هنالك عزم غير معلوم عند الsupport

Principle of transability

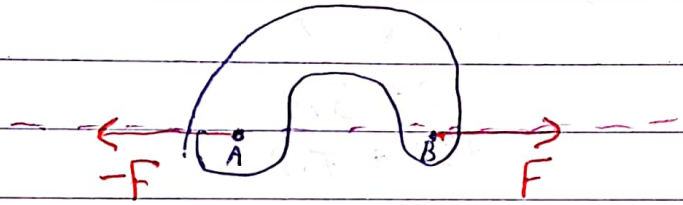
3- العزم Free vector يمكن نقل M_E عند D

4) القوى الداخلية لا تؤثر على الـ support

Equilibrium of Two Force member

when two forces act on a member ~~[illegible]~~ what ever its shape look like

and these forces are (A) equal in magnitude (B) and opposite in direction ~~[illegible]~~ (C) on the same line of action then they make no moment / ~~[illegible]~~ $\Sigma F = 0$



$\Sigma F = 0$

$\Sigma M = 0$

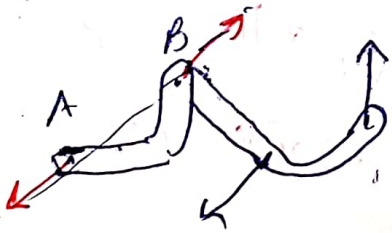
and if you saw a member such that

1) the member is acted on at Two Points only

2) the member is under equilibrium

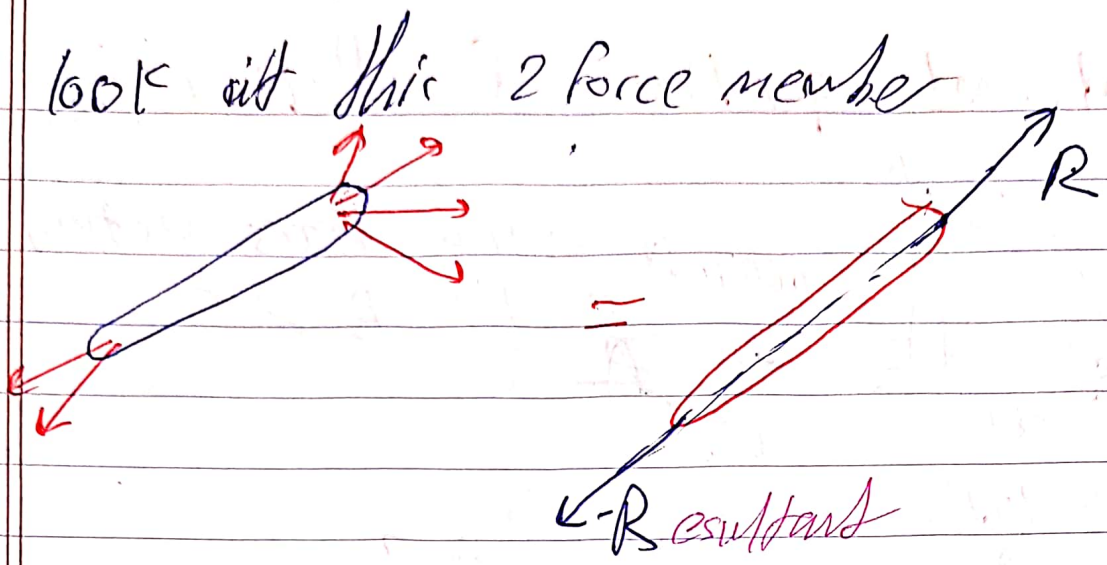
3) there is no external force or moment or couple

then the member is 2 Force member



∴ by this way you know the direction and line of Act.

look at this 2 force member



not exactly or totaly 2 forces

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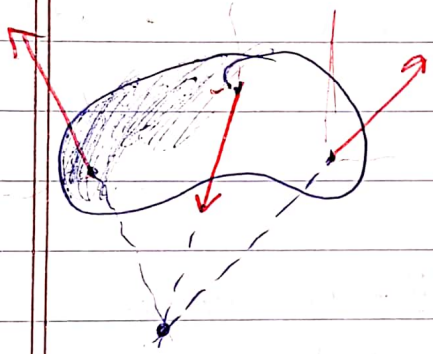
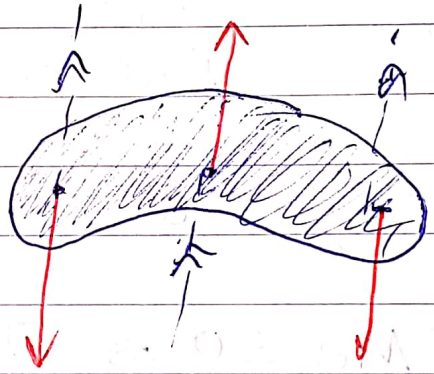
3 Force Body



concurent forces

then M = 0



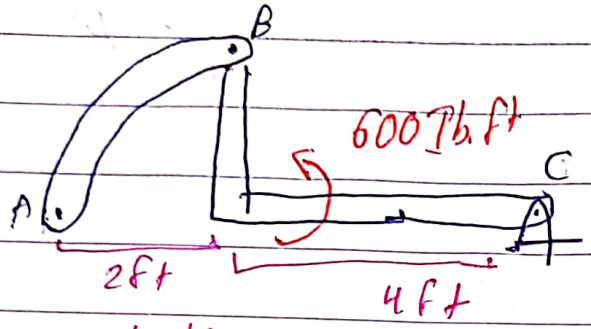
colinear forces

تتشابه نفس الاتجاه
والواقع على خط

عكس اتجاه موقع
نقطة التقاطع
وبالتالي نعرف
الزاوية

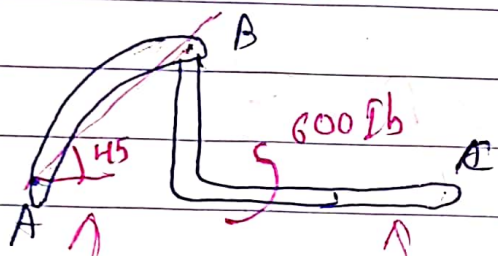
او نحل على
Fx/Fy
عادي جدا

External questions From (Pr. Kiza)



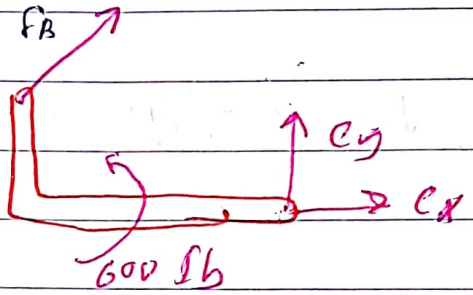
Find forces acting on Pins B & C

Solution:



force member

can be 2 force membe



hard to determine directions it's OK

~~$\Sigma F_y = 0$~~

free vector

$$\Sigma M_{(C)} = 0 \Rightarrow F_B \sin 45 * 4 + F_B \cos 45 * 2 - 600 = 0$$

$$\frac{F_B}{\sqrt{2}}(6) = 600$$

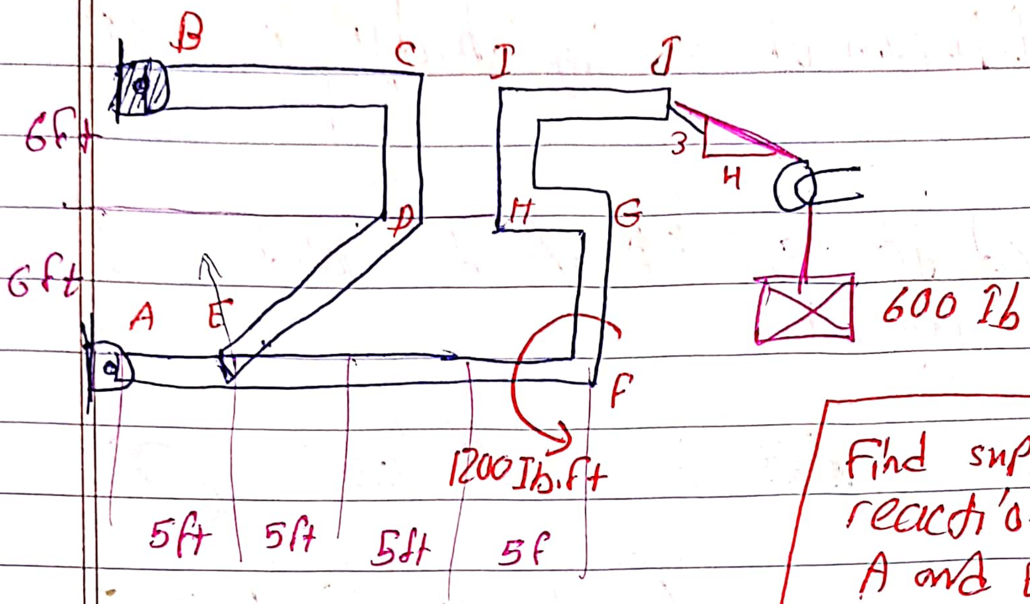
$$F_B = 100\sqrt{2} \text{ lb with angle 45 over } x^+$$

$$\Sigma F_y = 0 \rightarrow C_y + \frac{F_B}{\sqrt{2}} = 0$$

$$C_y = -100 \uparrow \text{ lb}$$

$$\Sigma F_x = 0 \rightarrow C_x + \frac{100\sqrt{2}}{\sqrt{2}} = 0$$

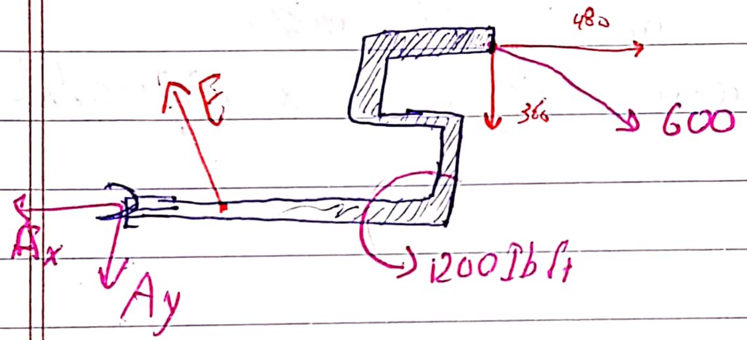
$$C_x = -100$$



Find suports reaction at A and E

solution

BCDE = Two force member
then we now draw FBD for (AEFGHIJ)



first find moment around A

$$= 1200 + E * \frac{12}{13} * 5 - 360 * 20 - 480 * 12 = 0$$

$E = 2548$ ← كل هاذا زي قلة الحش لانه ماطلب E عرفنا طرق اسرع

مثلا

moment at E / $-A_y * 5 + 1200 - 360 * 15 - 480 * 12$

$A_y = -1992$ lb

طلع الى قبل مش زي قلة الحش لانك رح تحتاجه لحساب Ax
واصلا FBD طالب E هو 2548 يا تافه يا حقالة

$A_x = E_x - T_x = 500$ lb

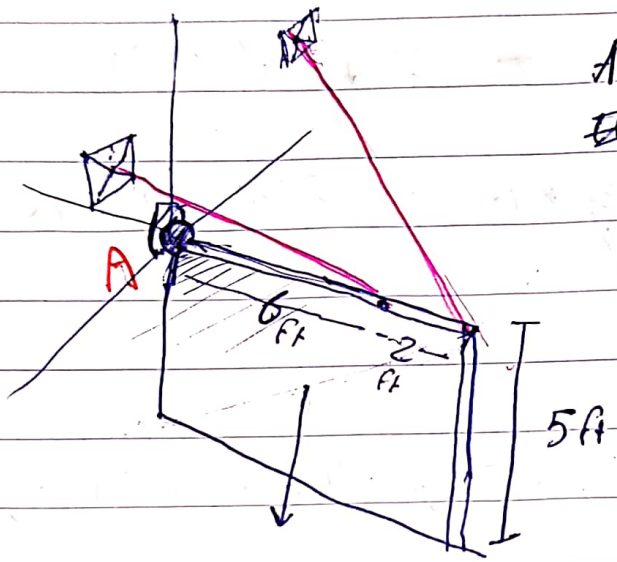
Equilibrium of a Rigid body in 3D

no need to split upon kinds of supports!

But: Here we have 6 Equations. And ability for 6 reactions

but that does not mean that it's necessary to find 6 equations

Sample problem 3D



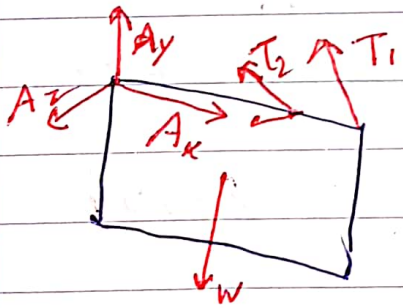
A sign of uniform density ~~weight~~ weighs 270 lb & is supported by a ball-and socket joint at A and 2 cables

Determine Tension in each cable and reaction at A

thinking:- Tension ~~of~~ in each cable are known in direction / ~~weight~~ weight is in centroid

equations $\Sigma F_x = 0$ / $\Sigma F_y = 0$ / $\Sigma F_z = 0$

$\Sigma M_x = 0$ / $\Sigma M_y = 0$ / $\Sigma M_z = 0$



$$\vec{T_2} = T_2\left(\frac{-6\hat{i} + 3\hat{j} + 2\hat{k}}{7}\right)$$

$$\vec{T_1} = T_1\left(\frac{-8\hat{i} + 4\hat{j} - 8\hat{k}}{12}\right)$$

My solution: find Moment around (AD) must be zero

$$\lambda_{AD} = \frac{4\hat{j} - 8\hat{k}}{\sqrt{80}}$$

$$r_W = (4\hat{i} - 2.5\hat{j})$$

$$\frac{T_2}{\sqrt{88}*7}\begin{vmatrix} 0 & 4 & -8 \\ 6 & 0 & 0 \\ -6 & +3 & +2 \end{vmatrix} + \begin{vmatrix} 0 & 4 & -8 \\ 4 & -2.5 & 0 \\ 0 & -270 & 0 \end{vmatrix} * \frac{1}{\sqrt{80}} \rightarrow T_2 = 316.9$$

$\Sigma M_x = 0$

$T_{1y} * 8 + T_{2y} * 6 - W * 4 = 0$

$\frac{1}{3} T_1 * 8 + 315 * \frac{3}{7} * 6 - 270 * 4 = 0$

$T_1 = 101.25$

$\Sigma F_y = 0 \rightarrow T_{1y} + T_{2y} - W + A_y = 0$

$A_y = 101.25$

$\Sigma F_x = 0 \rightarrow A_x - T_{1x} - T_{2x} = 0$

$A_x = 337.5$

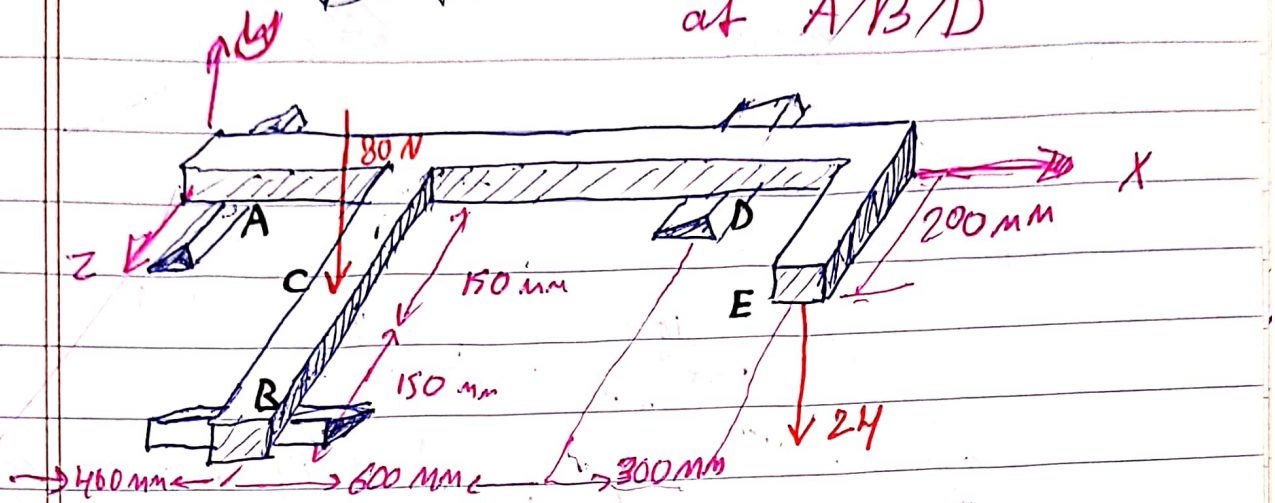
$\Sigma F_z = 0 \rightarrow T_{2z} - T_{1z} + A_z = 0$

$\frac{2}{7} * 315 - \frac{2}{3} * 101.25 + A_z = 0$

$A_z = -22.5$

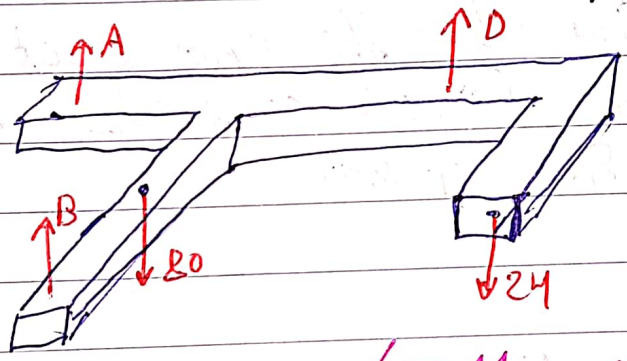
يمكن ايضاً ايجاد عدة معادلات
بعدة طرق

External Rizal — determine reactions at A/B/D



First notic you dont need all the 6 eq.

all forces are in y direction so so there is no Moment around y (also reactions in y)



no forces in other direction even if reaction exist

$\Sigma F_y = 0$ / $\Sigma M_x = 0$ / $\Sigma M_z = 0$

~~$\Sigma F_x = 0$~~ ~~$\Sigma F_z = 0$~~ / ~~$\Sigma M_y = 0$~~

معادلات 6 مش دايما

لانه عندي 2 supports

$\Sigma M_x = 0$ $\quad 24 * 200 + 80 * 150 - B_y * 300 \rightarrow \boxed{B_y = 56}$

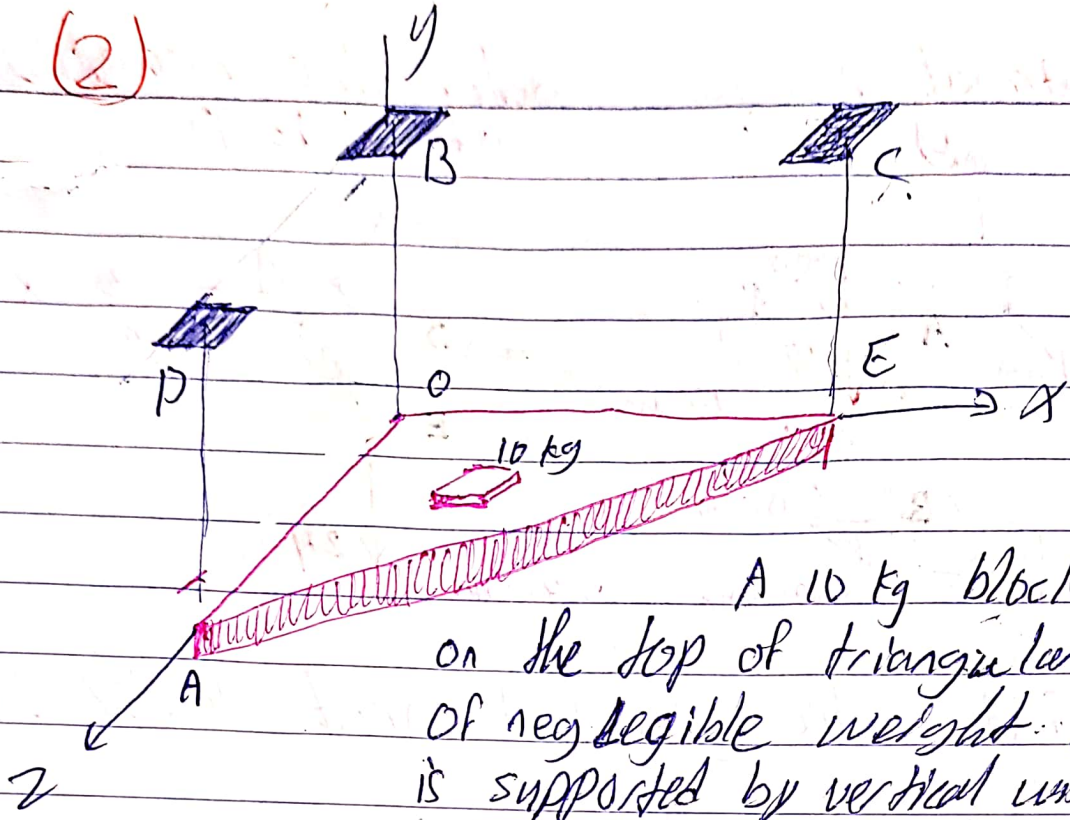
$\Sigma M_z = 0 \quad -24 * 1300 + D * (1000 - 80) * 400 + 56 * 400$

$\boxed{D_y = 40.8}$

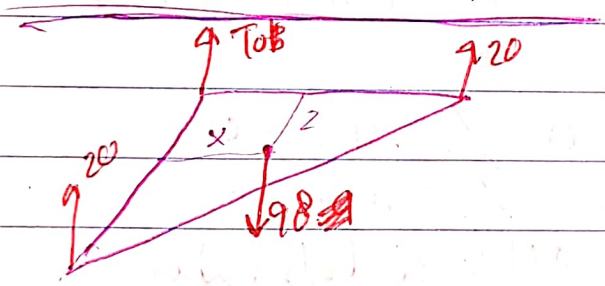
$\Sigma F_y = 0 \rightarrow 40.8 + 56 + A_y - 24 - 80$

$\boxed{A_y = 7.2}$

(2)



A 10 kg block rests on the top of triangular plate of negligible weight. The plate is supported by vertical wires DA, OB, CE. both AD & CE are same tension = 20 N
Find wher the 10kg Block should be (x, z) coordinates and Find T (OB)



$\Sigma F_y = 0 \rightarrow T_{OB} = 58$ ✓

$M_x = 0 \rightarrow 98 * z = 20 * 300$

$z = 61.2$

$M_z = 0 \rightarrow 20 * 400 = 98 x$

$x = 81.6$

External

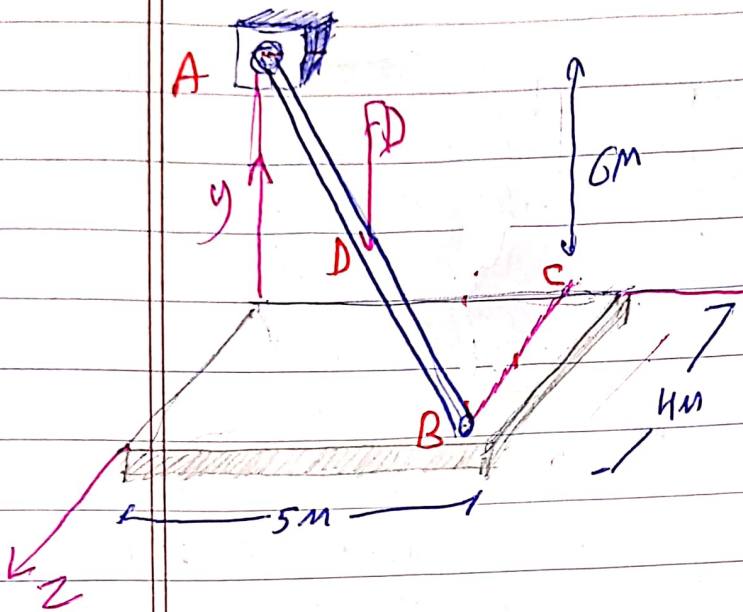
$F_D = 20\hat{i} - 40\hat{j} + 30\hat{k}$

D = mid point

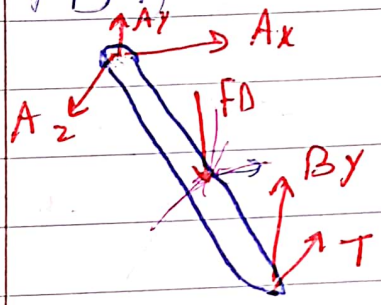
B rests on smooth plate

$\overline{BC}$ is a rod

Find T_{BC} / reactions of A / reactions of B



FBD



$\Sigma M_{z(A)} = 0$

$-F_{Dy} * 2.5 + F_{Dx} * 3 + 5 * B_y = 0$

$-40 * 2.5 + 5 * B_y + 60 = 0$

$\frac{40}{5} = B_y \rightarrow B_y = 8N$

$\Sigma M_{y(A)} = 0$

$0 = T * 5 + 20 * 2 - 30 * 2.5$

$T * 5 = 35$

$T = 7\ N$

$\Sigma F_x = 0$

$8 + A_y - 40 = 0$

$40 - 8 = A_y$

$A_y = 32\ N$

$\Sigma F_x = 0$

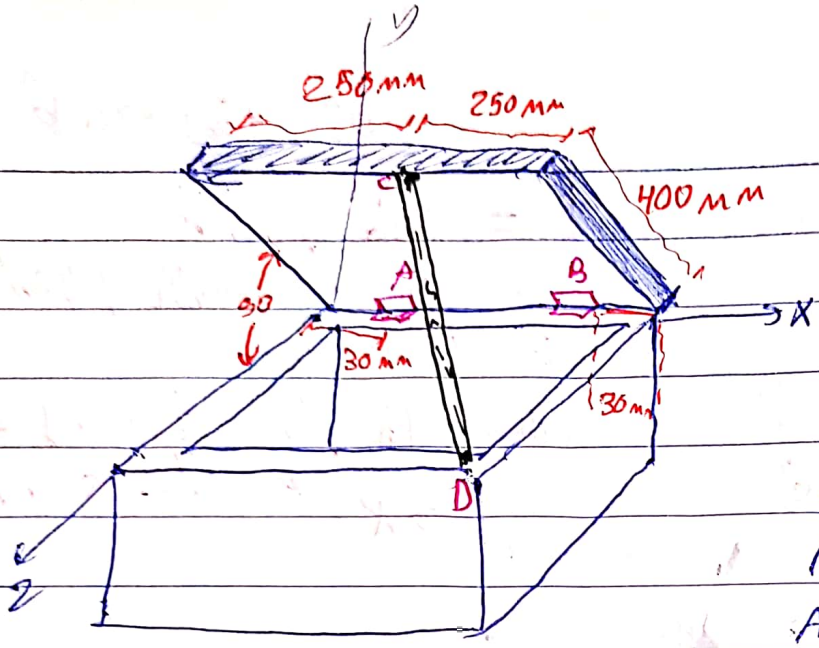
$A_x + 20 = 0$

$A_x = -20\ N \uparrow$

$\Sigma F_z = 0$

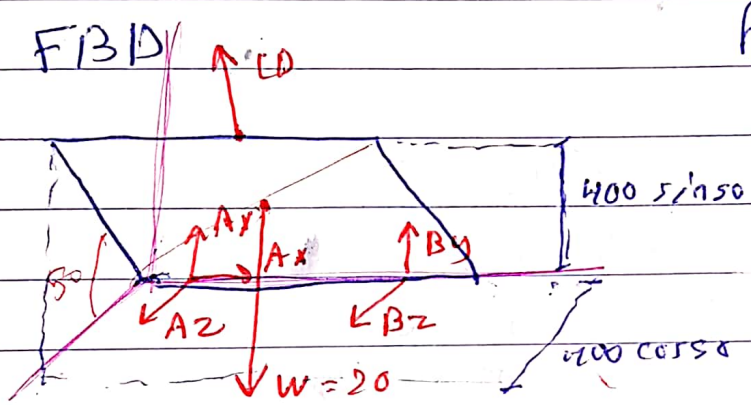
$-T + 30 + A_z = 0$

$A_z = -23\ N$

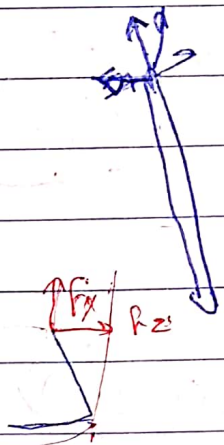


The uniform 20 lb lid of the Box is supported by a stick CD And short hinges At A & B Assume that B transmits no axial force Find reactions at A/B/ and force in the stick

FBD



$$C = \left(\frac{-250\hat{i} + 306.4\hat{j}}{420.5} - \frac{142.9\hat{k}}{420.5}\right) C$$



$$M_x = 0 = 20 * 128.6 - C_y * 257.1 - C_z * 306.4$$

$$2572 = C\left(\frac{306.4}{420} * 257.1 + \frac{142.9 * 306.4}{420.5}\right)$$

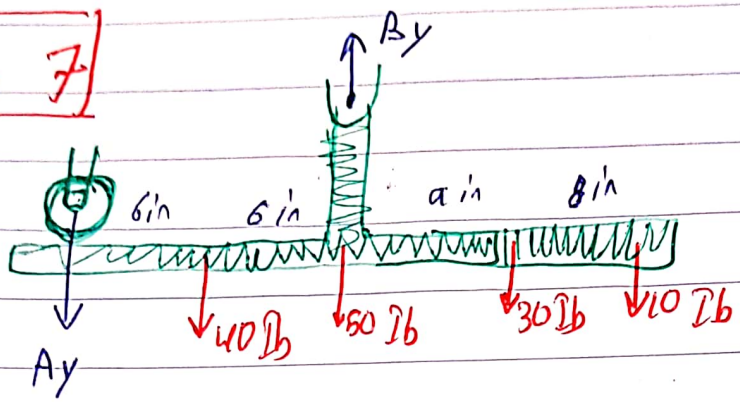
$$C = 8.824$$

$$\Sigma F_x = 0 \rightarrow A_x = -C_x$$

Naseem Hamed # 1200502

Home Work 3

Problem 7



(a)

$M_B = 0 = A_y * 12 + 40*6 + 30*a + 10*(8+a)$

$= 12A_y + 240 = 300 + 180$

$A_y = -20\ lb\ (\downarrow)$ ✓

$\sum F_y = 0$

$-(A_y + 40 + 50 + 30 + 10) + B_y = 0$

$B_y = +150\ lb\ (\uparrow)$ ✓

(b) For $a = 7$

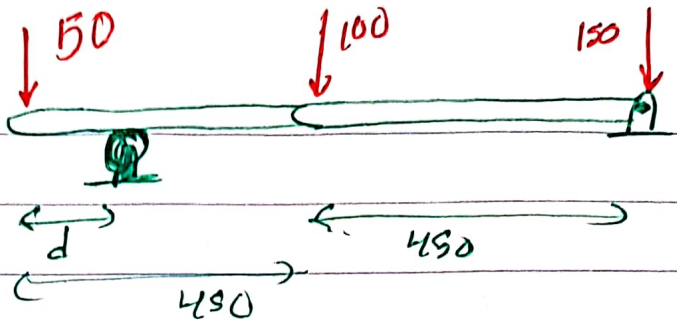
$12A_y + 240 = 210 + 150$

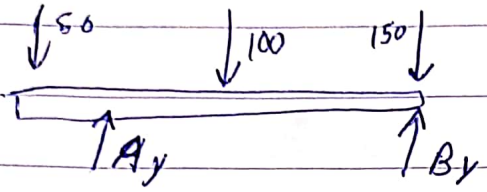
$A_y = -10\ lb\ (\downarrow)$ ✓

$B_y = A_y + 40 + 50 + 30 + 10$

$= +140\ lb\ (\uparrow)$ ✓

Prob. 13





$$0 = M_B = 50 * 0.9 + 100 * 0.45 - Ay * (0.9 - d)$$

$$Ay(0.9 - d) = 90$$

$$Ay = \frac{90}{0.9 - d}$$

Answer is $150 \le d \le 400$ in mm

$$Ay \le 180 \rightarrow \frac{90}{0.9 - d} \le 180$$

$$90 \le 162 - 180d$$

$$72 \ge 180d$$

$$0.4 \ge d$$

$$400\ mm \ge d$$

This is for A

For B $M_A = 0$

$$50 * d + By * (0.9 - d) + 100 * (0.45 - d) = 150(0.9 - d)$$

$$50d + 0.9By - Byd - 45 + 100d = 135 + 150d$$

$$300d + (0.9 - d)By - 180 = 0$$

$$(0.9 - d)By = 180 - 300d$$

$$By = \frac{180 - 300d}{0.9 - d}$$

$$\frac{180 - 300d}{0.9 - d} \le 180$$

$$162 - 180d \ge 180 - 300d$$

$$120d \ge 18 \rightarrow d \ge 0.15 = 150\ mm$$

or easily we can say

another way

$$A_x = \frac{90}{0.9 - d}$$

and $\sum F_y = 0$

$$B_y + A_y = 300$$

$$B_y + \frac{90}{0.9 - d} = 300$$

$$B_y = 300 - \frac{90}{0.9 - d}$$

$$\frac{300 - 90}{0.9 - d} \leq 180$$

$$120 \leq \frac{90}{0.9 - d}$$

$$108 - 120d \leq 90$$

$$120d \geq 18$$

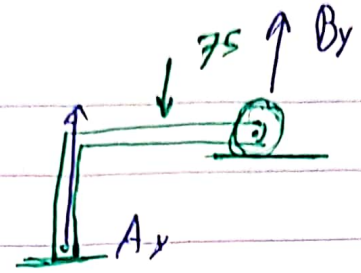
$$d \geq 0.15$$

$$d \geq 150 \text{ mm}$$

and $d \leq 400$ mm

then $150 \leq d \leq 400$

Prob 37 (a)



$M_B = 0 \rightarrow 75 * 10 = 20 A_y$

$75 = 2 A_y$

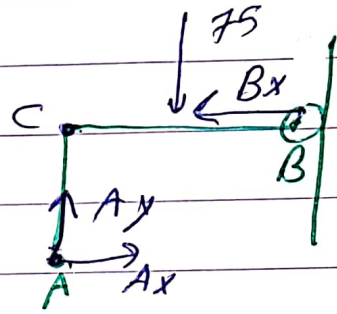
$A_y = 37.5 \uparrow$ lb ✓

$\Sigma F = 0 \rightarrow B_x + A_y = 75$

$B_x = 75 - 37.5$

$B_x = 37.5 \uparrow$ ✓

(b)



$\Sigma F_y = 0$

$A_y \uparrow - 75 \uparrow = 0$

$A_y = +75 \uparrow$ ✓

$\Sigma M_C = 0$

$12 A_x - 75 * 10 = 0$

$A_x = \frac{750}{12} = 62.5$ lb

$A_x = +62.5$ lb $\uparrow$ ✓

$\Sigma F_x = 0 \rightarrow \vec{A_x} + \vec{B_x} = 0$

$|62.5| + |B_x| = 0$

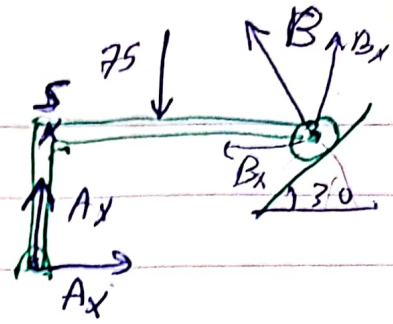
$|B_x| = 62.5$

$\vec{B_x} = -62.5 \uparrow$ ✓

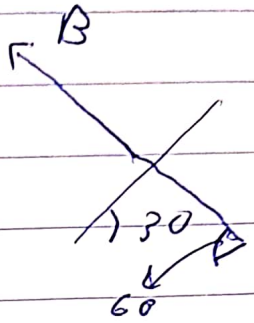
C at $\alpha = 30$

Next Page

(c)



4 reactions!
but we already know
the angle of B = 60



لأن عندي
3 concurrent forces

$\Sigma F_x = 0$

$M_S = 0$

$0 = B \sin 60 * 20 + 12 * A_x - 750$

$17.32 B + 12 A_x = 750$ --- (1)

$\Sigma F_x = 0 \rightarrow \overrightarrow{A_x} + \overrightarrow{B_x} = 0$

$|A_x| - |B_x| = 0$

$A_x = B \cos 60$

$2A_x = B$ - - - - (2)

solve eq 1 and 2

$17.32 * 2A_x + 12 A_x = 750$

$\rightarrow A_x = +16.1$ lb $A_x = 16.156 \uparrow$

$\rightarrow B = 32.16$ lb

angle 90 on surface
= 120 with x+

$B_y = B \sin 60 = 27.85$

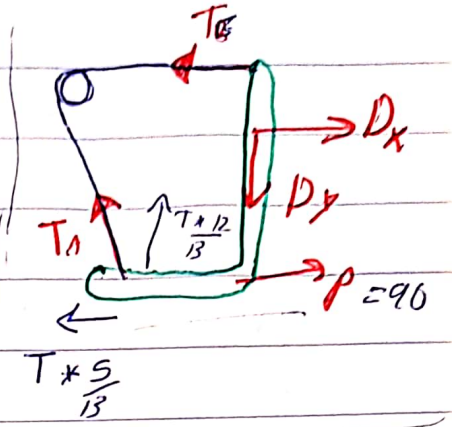
$\Sigma F_x = 0$

$\rightarrow A_x + B_x - 75 = 0$

$A_y + 27.85 = 75$

$\rightarrow A_x = 47.15$ lb $\uparrow$

Prob 33



$M_D = 0$

$T * 3 + 90 * 9 - T * \frac{5}{13} * 9 - T * \frac{12}{13} * 7$

$810 = 6.92\,T$

$T = 117$ lb

$\Sigma F_y = 0$

$T * \frac{12}{13} - D_y = 0$

$108 - D_y = 0$

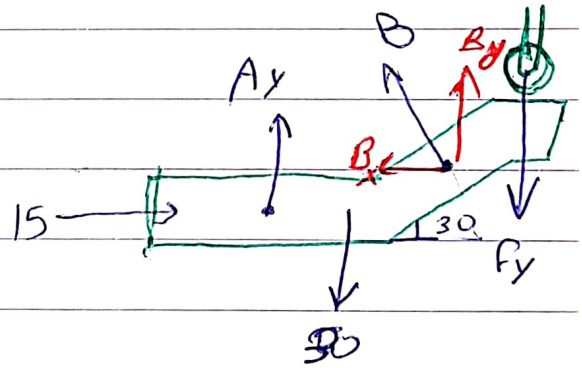
$D_y = -108$ lb ↑

$\Sigma F_x = 0$

$T * \frac{5}{13} + T - P - D_x = 0$

$D_x = -72$ ↑

Prob 41



$\Sigma F_x = 0$

$B_x - 15 = 0$

$B_x = 15$

$B_x = B \cos 60$

$B = 30$ lb $\theta = 60°$ ↗

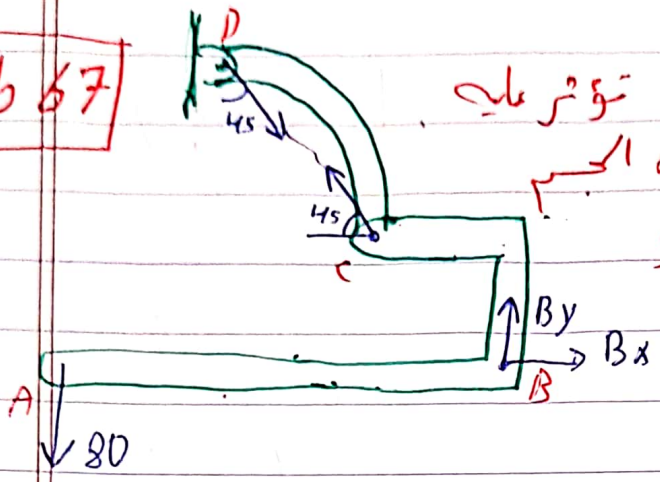
$\Sigma M_A = 0$

$30 * 4 + F_x * 13 - B \sin 60 * 11 - B \cos 60 * 3 = 0$

$F_x * 13 = 210.78 \rightarrow F_y = -16.2$ lb ↑

$\Sigma F_y = 0 \rightarrow A_y = F_y + 30 - B_y \rightarrow A_y = 20.2$ lb ↑

Prob 67



لاحظ انه القوس $\overset{\frown}{DC}$ تؤثر عليه قوة من الحائط وقوة من الجسم $\overset{\frown}{ABC}$ فوتيرته نقط وهو متزن اي انه مجموع القوتان متساويتان وتقعان على line of Action الواصل بين A , C

$\overset{\frown}{DC}$ is under equilibrium we already know that

ABC is under equilibrium

then

$$M_B = 0 = 80 * 250 - F_c \sin 45 * 90 + F_c \sin 45 * 66$$

$$= 20000 = 30 * F_c \sin 45$$

$$F_c = 942.8 \text{ N}$$

$$\Sigma F_x = B_x - C_x$$

$$= B_x - F_c \sin 45$$

$$\boxed{B_x = 666.7 \text{ N}}$$

$$\Sigma F_y = C_y + B_y - 80 = 0$$

$$F_c \sin 45 + B_y - 80 = 0$$

$$666.6 - 80 + B_y = 0$$

$$B_y = -586.67$$

$$\boxed{B_y = -586.67 \text{ N} \downarrow}$$

reaction at D $= -F_c$

$$\boxed{D = 942.8 \text{ N} \text{ at angle } -45^\circ}$$

لاحظ

أننا نعمل

على

اسم

الفاعل

لوحده

لا نعمل

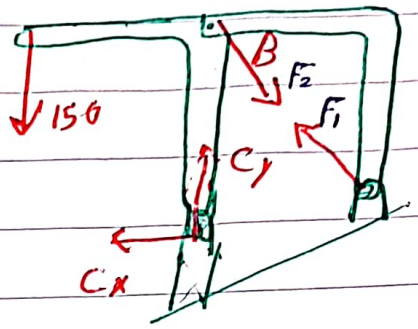
على الجمع

كاسم مستقل

68

F_1 & F_2 are colinear

Two force member



$M_B = 0$

$150 * 3 - C_x * 3$

$C_x = 150$ lb

$\Sigma F_x = 0$

$C_x - F_2 * \frac{3}{\sqrt{3^2 + 1.5^2}} = 0$

$150 = F_2 * 0.26666$

$F_2 = 1677$ lb

$\Sigma F_y = 0$

$C_y = 150 + F_2 * \frac{1.5}{\sqrt{3^2 + 1.5^2}}$

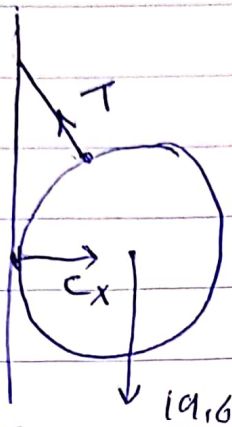
$C_y = 225 \uparrow$ lb

$F_C = (150 \uparrow + 225 \uparrow)$ lb

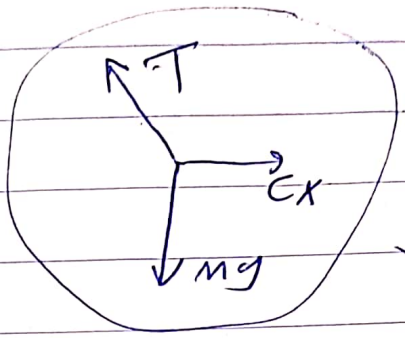
$F_D = -F_2$

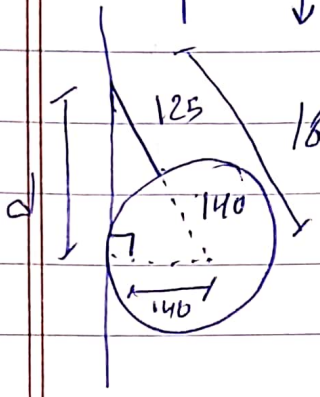
$= (-150 \uparrow + 225 \uparrow)$ lb

Prob 88



3 force → concurrent



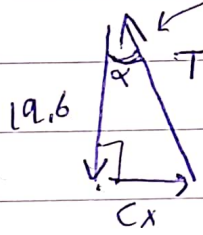


$$140^2 + d^2 = 265^2$$

$$d = \sqrt{265^2 - 140^2}$$

$$d = 225 \text{ mm}$$

$$\alpha = \sin^{-1}\left(\frac{140}{265}\right)$$



$$\frac{T}{\sin 90} = \frac{Cx}{\sin \alpha} = \frac{19.6}{\sin(90-\alpha)}$$

$$T = \frac{Cx}{\frac{140}{265}} = \frac{19.6}{\frac{225}{265}}$$

$$T = 23.1 \text{ N}$$

$$Cx = +12.2 \text{ N} \uparrow$$

3 un knowns

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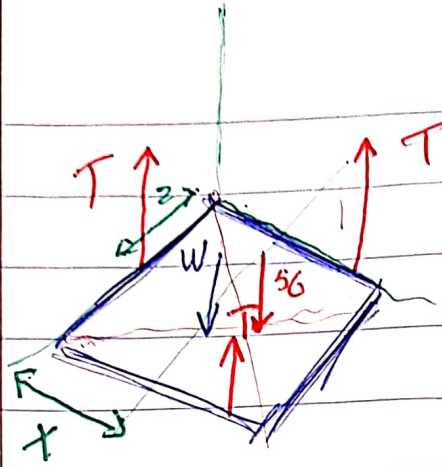

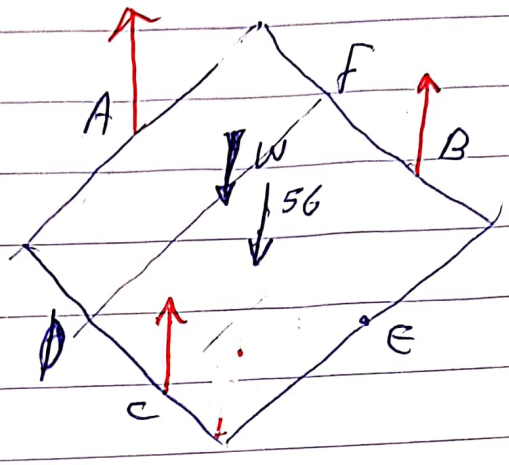

$\sum M_B = 0$

$-T*16 + W*(6-x) + 56*6 = 0$

$16T = W(6-x) + 336$

$M_{AE} = 0$

$= 0 + T*10 - T*10 + W*z - 10 + 0$

$W*(z-10) = 0 \rightarrow z = 10$

$\sum F_y = 0 \rightarrow 3T - 56 - W = 0$

$3T - 56 = W$

$M_{DE} = 0$

$0 = T*x + 56*(10-x) - 2T*(16-x)$

$2T*(16-x) - Tx = 56*(10-x)$

$32T - 2Tx - Tx = 560 - 56x$

$T(32-3x) = 560 - 56x$

$$T = \frac{560 - 56x}{32 - 3x}$$

$$\frac{1680 - 168x}{32 - 3x} - 56 = W$$

T بنعوض

Next Page

we need the smalest w

$$w' = -168(32-3x) + 3(1680 - 168x) \quad \text{مقام مربع}$$

$$= \frac{-6240 + 504x + 5040 - 504x}{(32-3x)^2}$$

$$= \frac{-1200}{(32-3x)^2} \quad \begin{cases} \to 0 \\ \to \text{DNE} \\ \to \text{or look at the ends} \end{cases}$$

w' can't be 0 or even DNE so we check interval ends

w' : $-$ | $+$

w : $0 \searrow$ $10.6 \searrow$ 20

check point 20 which is the only decision and

$$w(20) = \left(\frac{-560}{32-60}\right) * 3 - 56$$

$$= 4N$$

$w = 4.1\text{lb}$ at $x = 20$ in / at $z = 10$ in

$$T = \frac{w+56}{3} = \frac{4-65}{3} = 20\ N$$

فكرة السؤال حلوة !!!

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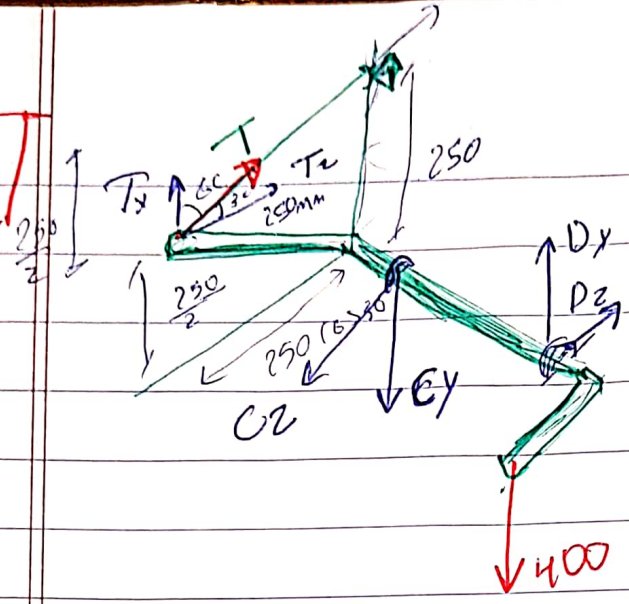


no forces at X axis

$\Sigma F_x = 0$

$\Sigma F_z = 0$

$\Sigma M_x = 0$

~~$\Sigma M_x = 0$~~ $\Sigma M_x = 0$

$\Sigma M_z = 0$

(a) $\Sigma M_x = 0$

$400 * 250 = T * 250 * \sin 60$

$T = \frac{400}{\sin 60} = 461.88\ N$ ✓

$\Sigma M_y = 0$ at Point C

$= Dz * 300 - Tz * 50 = 0$

$Dz * 300 = 50\ Tz \sin 60$

$Dz = \frac{5 * 400}{30}$

$Dz = 66.67 N$ ✓ $= -66.67 N\hat{k}$

$\Sigma F_z = 0$

$Cz - Dz - Tz = 0$

$Cz = |Dz| + |Tz|$

$= +66.67 + 400$

$Cz = +466.67\ \hat{k}$ ✓

ΣM_z at Point C $= 0$

$300 * Dx - 400 * 350 - Ty * 50$

$300\ Dz = 400 * 350 + 50 * 461.88 * \sin 30$

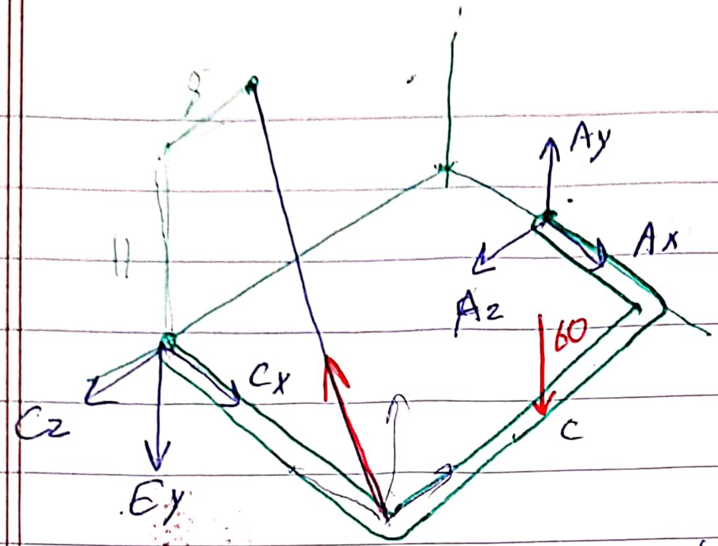
$Dx = 505.16\ \hat{j}\ N$ ✓

$\Sigma F_y = 0 \rightarrow Cy = Ty + Dy - 400 \rightarrow Cy = -336\ N$ ✓

Answer: $T = 461.88$ / $C = (-336\hat{j} + 466.7\hat{k})\ N$ / $D = (505\hat{j} - 66.7\hat{k})\ N$

نكزة رهيبة

135



مش بالضرورة الذي يكون المحور موازي لـ X/Y/Z

حاول دائماً اتجاه المحور الذي يمر بأكبر عدد من النقاط لتسهيل الحل وعدم حساب عزوم هذه النقاط ويستحسن أن تكون النقاط مجهولة القوى وإبعاد النقاط معلومة القوى

$\Sigma M_{AE} = 0$

$= F_1 \times r_{AC} \cdot \lambda + \vec{T} \times r_2 \cdot \lambda$

$F_1 = -60 \hat{j}$

$r_{AC} = 9\hat{i} + 10\hat{k}$

$r_2 = r_{ED} = 16\hat{i}$

$\vec{T} = \frac{-16\hat{i} + 11\hat{j} - 8\hat{k}}{21} |T|$

$-0.76|T|\hat{i} + 0.524\hat{j}|T| - 0.38T\hat{k}$

$\lambda_{EA} = \frac{\vec{EA}}{|EA|} = \frac{7}{25}\hat{i} - \frac{24}{25}\hat{k}$

$$\begin{vmatrix} \frac{7}{25} & 0 & -\frac{24}{25} \\ 16 & 0 & 0 \\ -0.76T & 0.524T & -0.38T \end{vmatrix} + \begin{vmatrix} \frac{7}{25} & 0 & -\frac{24}{25} \\ 9 & 0 & 10 \\ 0 & -60 & 0 \end{vmatrix} = 0$$

$\approx -0.524\left(\frac{24}{25} \times 16\right)T + 60\left(\frac{7}{25} \times 10 + \frac{9 \times 24}{25}\right)$

$T \approx 85$

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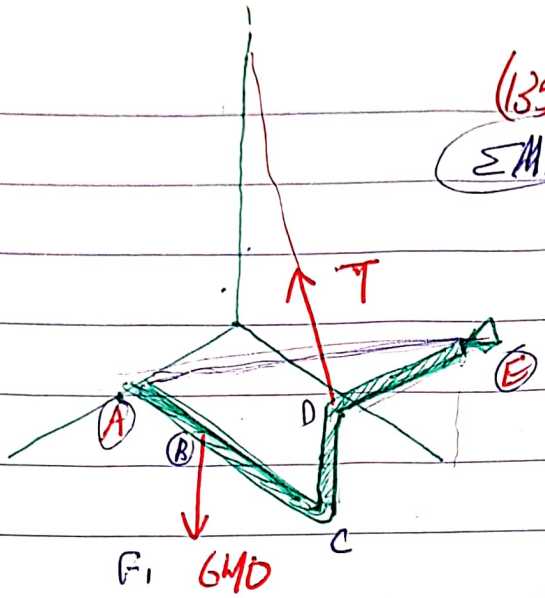
(135) نفس



$\Sigma M_{AE} = 0$

$(\vec{r}_{A\to B} \times \vec{F}_1) \cdot \lambda_{AE} + (\vec{r}_{E\to D} \times \vec{T}) \cdot \lambda_{AE} = 0$

$\vec{F}_1 = -640\,\hat{j}$

$\vec{T} = T\left(\frac{-480\,\hat{i} + 330\,\hat{j} - 240\,\hat{k}}{630}\right)$

$\vec{T} = T(-0.76\,\hat{i} + 0.524\,\hat{j} - 0.381\,\hat{k})$

$r_{A\to B} = +0.2\,m\,\hat{i}$

$r_{E\to D} = +0.24\,m\,\hat{k}$

$\lambda_{AE} = \frac{\vec{AE}}{|AE|}$

$= \frac{480\,\hat{i} + 160\,\hat{j} - 240\,\hat{k}}{560}$

$$\frac{1}{560}\begin{vmatrix} 480 & 160 & -240 \\ -0.2 & 0 & 0 \\ 0 & -640 & 0 \end{vmatrix} \frac{-T}{(630\times 560)} \begin{vmatrix} 480 & 160 & -240 \\ -0 & +0 & -0.24 \\ -480 & 330 & -240 \end{vmatrix} = 0$$

$$\frac{0.2 * -153600}{560} + \frac{0.24 * 235200 * T}{630 * 560}$$

$T = 342.86\ N$