Name. ANSWER KEY

Signature _____

ID _____

GEN_ENG_205-2

Engineering Analysis II

Midterm 1

Tuesday April 30, 2019

A. Alarcón

Instructions. Closed book and notes.

NCEES Calculators allowed. No other electronic device allowed even if it is used as a calculator.

Do not ask for clarification of the questions. If you think that there is an ambiguity, clearly state your assumption and continue to answer the question.

Show all your work, FBD, units and **box your final answer**. You can use the left blank pages for scratch calculations. If you need more paper, we will provide some more. There are 4 problems and 2 bonus questions (last page).

Problem	Points	
1	12	
2	12	
3	6	
4	6	
Bonus	2	
Total	36	

Name_____

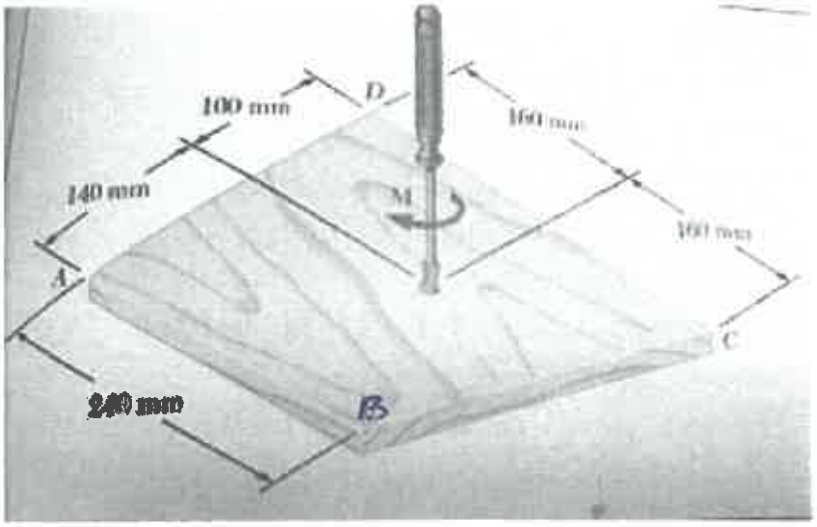
Problem 1 (12 points)

A couple M of magnitude 18 N · m is applied to the handle of a screwdriver to tighten a screw into a block of wood. Determine the magnitudes of the two smallest horizontal forces that are equivalent to M if they are applied

(a) at corners A and D,

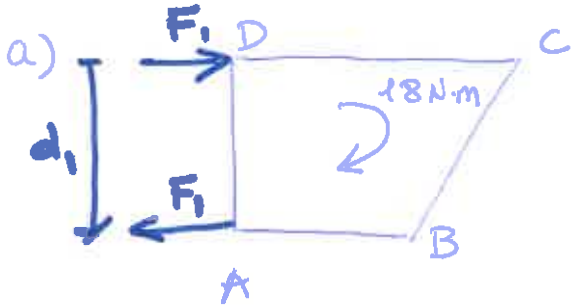
(b) at corners B and C,

(c) anywhere on the block



Draw a sketch for each case

a)

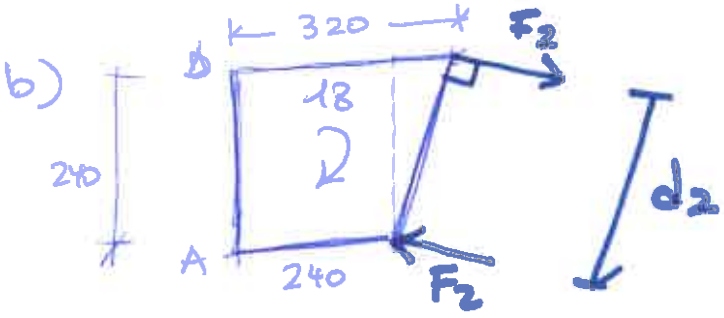


$\curvearrowright 18 = F_1 d_1 = F_1 (140+100)\,10^{-3}$

$F = \frac{18}{240\times10^{-3}} = 75\ N$

$\boxed{F_1 = 75\ N}$

b)



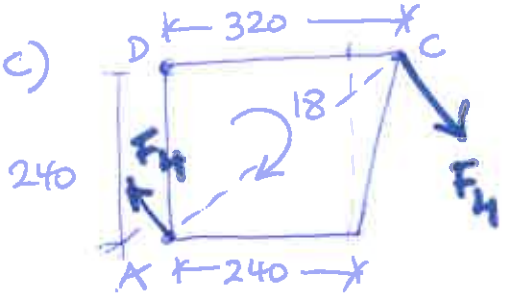
$320 - 240 = 80$

$240 \rightarrow \sqrt{80^2+240^2}$

$d_2 = 252.98$

$F_2 = \frac{18}{252.98\times10^{-3}} \Rightarrow \boxed{F_2 = 71.15\ N}$

c)



If I choose DC $\rightarrow F_3 = \frac{18}{320\times10^{-3}} = 56.25$

$d_4 = \overline{AC} = \sqrt{0.32^2+0.24^2} = 0.4$

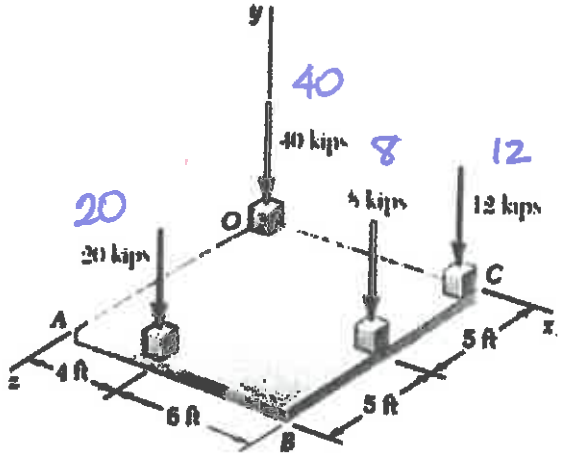
Smallest

$\boxed{F_4 = \frac{18}{0.4} = 45\ N}$

Name_____

Problem 2 (12 points)

A square foundation mat supports the four columns shown. Determine the magnitude and direction of the resultant force and point of application of the resultant force.



F = ?

(x, y) = ?

The final force since they are all vertical is also vertical

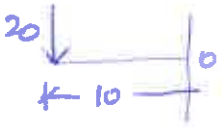
$+\downarrow \Sigma F_y = 0 \rightarrow 20+40+8+12 = 80 \text{ kips} \quad (\downarrow)$

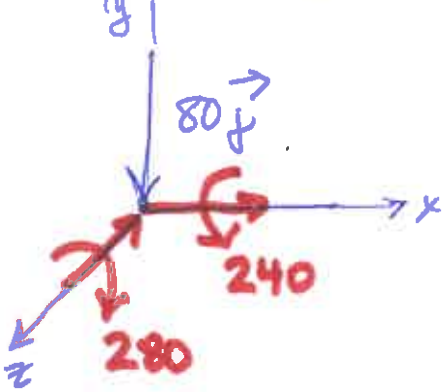
$$\boxed{F = -80\,j\ (\downarrow)}$$

1st Calculate moments @ O

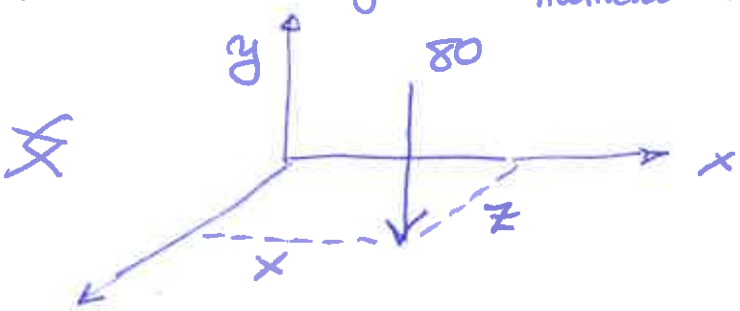
$+\circlearrowleft \Sigma M_O = -12(6+4) - 8(6+4) - 20(4) = -280$ in the $\vec{k}$ direction

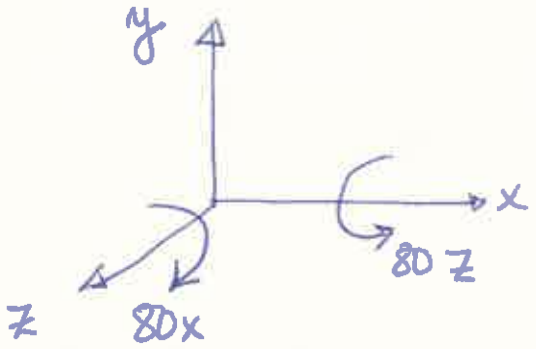
$\circlearrowright \Sigma M_O = 8 \times 5 + 20(5+5) = 240\ \vec{i}$





To be able to get a ~~force~~ moment ⇒





$+80x = +280 \rightarrow x = 280/80 = 3.5$

$80z = 240 \rightarrow z = 3$

$x = 3.5$
$z = 3$

OPTION 2 Using vector products

r (ft)	F (kip)	$M = r \times F$
0	$-40\bar{j}$	0
$10\bar{i}$	$-12\bar{j}$	$-120\bar{k}$
$10\bar{i}+5\bar{k}$	$-8\bar{j}$	$40\bar{i} - 80\bar{k}$
$4\bar{i}+10\bar{k}$	$-20\bar{j}$	$200\bar{i} - 80\bar{k}$
	$R = -80\bar{j}$	$M = 240\bar{i} - 280\bar{k}$

$r \times R = M_O^R$

$(x\bar{i} + z\bar{k}) \times (-80\bar{j}) = 240\,\bar{i} - 280\,\bar{k}$

$-80x\bar{k} + 80z\,\bar{i} = 240\bar{i} - 280\,\bar{k}$

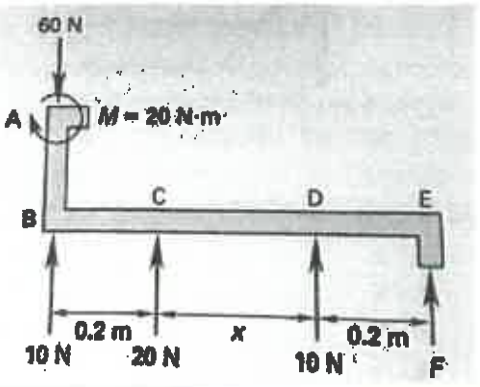
$-80x = -280$
$80z = 240$

$x = 3.5$
$z = 3$

Name_____

Problem 3 (~~10~~ 6 points)

A bent beam is acted upon by a moment and several concentrated forces, as shown. Find the missing force F and distance x that will maintain equilibrium on the member shown.



F = ?

x = ?

$\uparrow \Sigma F_y = 0$ $\quad 10 + 20 + 10 + F - 60 = 0 \rightarrow$ **$F = 20$ N** $(\uparrow)$

$+\circlearrowleft \Sigma M_A = 0$ $\quad -20 + 20(0.2) + 10(x + 0.2) + F(0.4 + x) = 0$

$-20 + 4 + 10x + 2 + 20(0.4) + 20x = 0$

$30x = 20 - 14$

$x = 6/30 = 1/5 = 0.2$

$x = 0.2$

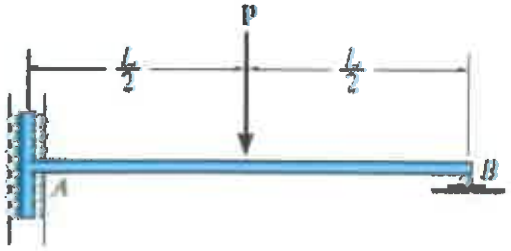
Name_____

Problem 4 (6 points)

Given beam AB subjected to the loading shown

a) Draw the FBD

b) Determine the reactions at supports A and B clearly showing their direction. A is a support that consists of a wall with rollers inside and B is a roller support.



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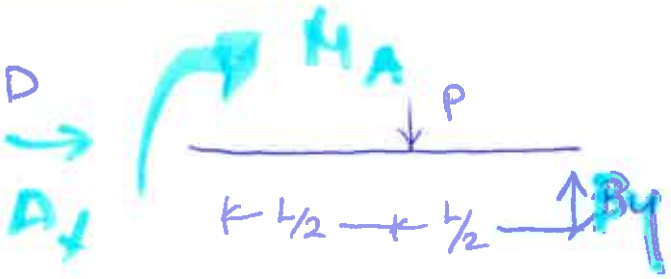
a) FBD



3 unknowns MA, Ax, By

3 eq eq in 2D

b) EQ EQ

$\pm\rightarrow \Sigma F_x = 0$ $\quad \boxed{A_x = 0}$

$+\uparrow \Sigma F_y = 0$ $\quad B_y - P = 0 \rightarrow \boxed{B_y = P}$ (↑)

$+\circlearrowleft \Sigma M_A = 0$ $\quad -M_A - P\frac{L}{2} + PL = 0$

$\boxed{M_A = \frac{PL}{2}}$ (↺)

sign ok as shown