Alexandria Higher Institute of Engineering & Technology (AIET)		
Department of: General	Preparatory Year	0th Year
ME001	Mechanics I	Final, Jan., 15, 2014
Examiners:	Dr. Raafat Ayad and Dr. Rola Afify	Time: 3 hours

Answer the following questions:

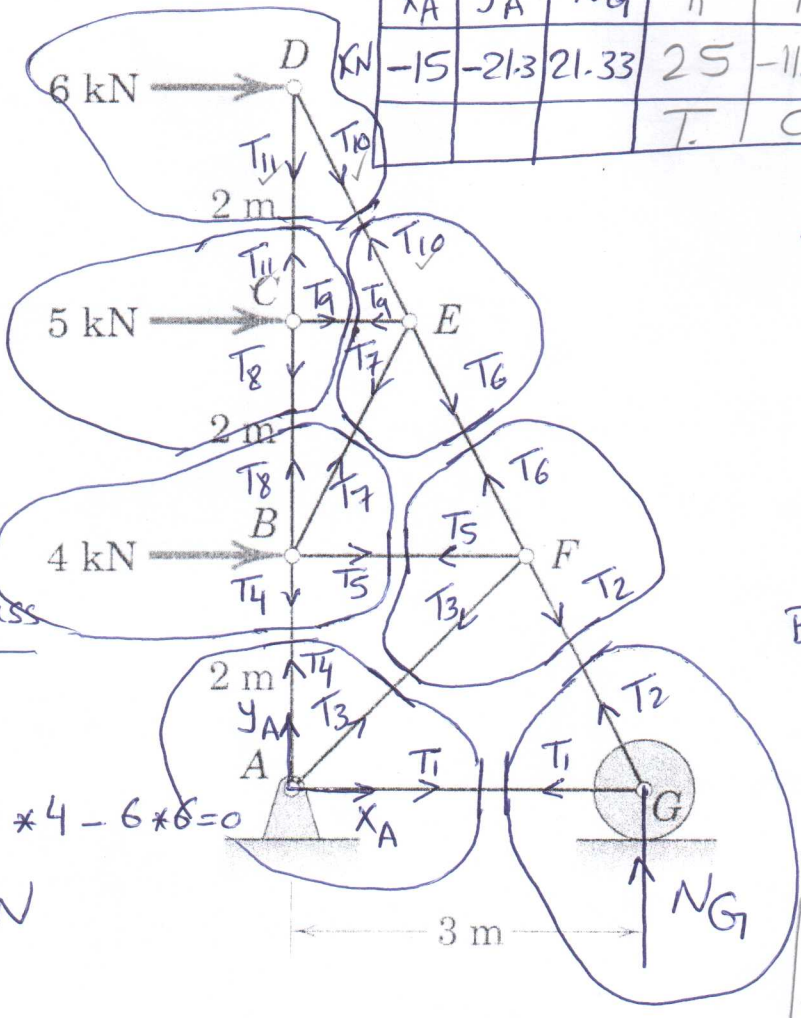
Question one: (10 marks)

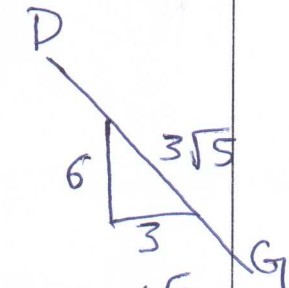
Determine the force in each member of the truss and state if the members are in tension or in compression.

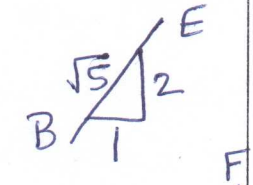
T_5	−6.5	C.
T_6	−19	C.
T_7	5.59	T.
T_8	−12	C.
T_9	−5	Comp.
T_{10}	$-6\sqrt{5}$ = 13.63	Comp.
T_{11}	12	T.

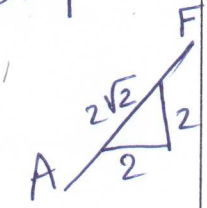
KN

X_A	Y_A	N_G	T_1	T_2	T_3	T_4
−15	−21.3	21.33	25	−11.178	−9.89	17
			T.	C	C.	T.









for the whole truss

$\Sigma M_A = 0 \quad (+\circlearrowleft)$

$3N_G - 4*2 - 5*4 - 6*6 = 0$

$N_G = 21.33$ KN

$\Sigma F_x = 0$

$X_A + 4 + 5 + 6 = 0 \quad \therefore X_A = -15$ KN

$\Sigma F_y = 0 \quad Y_A + N_G = 0 \quad Y_A = -N_G = -21.33$ KN

for check $\Sigma F_y = N_G + T_2 * \frac{2}{\sqrt{5}} = 0$

for joint G

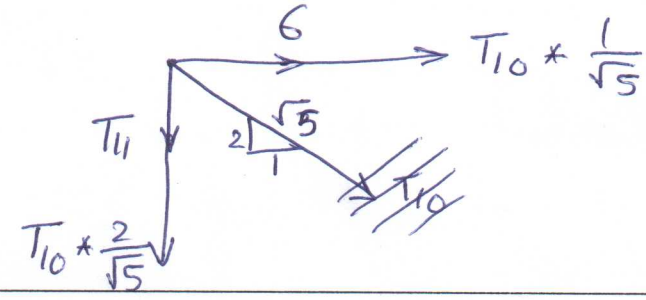
$\Sigma F_x = 0$

$-T_1 - T_2 * \frac{1}{\sqrt{5}} = 0$

$T_1 = +11.178\sqrt{5}$

$= 25$ KN

for joint (D)

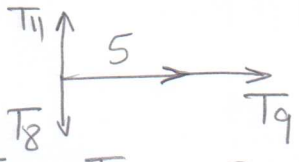


$\pm\rightarrow \Sigma F_x = 0 \qquad 6 + T_{10} * \frac{1}{\sqrt{5}} = 0 \qquad \therefore T_{10} = -6\sqrt{5}$ KN

$+\uparrow \Sigma F_y = 0 \qquad -T_{11} - T_{10} * \frac{2}{\sqrt{5}} = 0$

$T_{11} = +6\sqrt{5} * \frac{2}{\sqrt{5}} = 12$ KN

for joint (C)

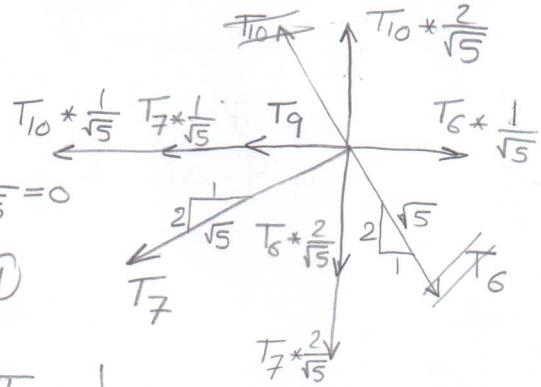


$\Sigma F_x = 0 \qquad 5 + T_9 = 0$

$T_9 = -5$ KN

$+\uparrow \Sigma F_y = 0 \qquad T_{11} - T_8 = 0 \qquad \therefore T_8 = +T_{11} = +12$ KN

for joint (E)



$+\uparrow \Sigma F_y = 0 \qquad T_{10} * \frac{2}{\sqrt{5}} - T_6 * \frac{2}{\sqrt{5}} - T_7 * \frac{2}{\sqrt{5}} = 0$

$T_6 + T_7 = -6\sqrt{5} \longrightarrow (1)$

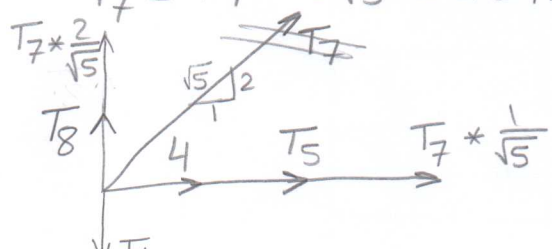
$\pm\rightarrow \Sigma F_x = 0 \qquad T_6 * \frac{1}{\sqrt{5}} - T_9 - T_7 * \frac{1}{\sqrt{5}} - T_{10} * \frac{1}{\sqrt{5}} = 0$

$T_6 - T_7 = T_9\sqrt{5} + T_{10} = -5\sqrt{5} - 6\sqrt{5} = -11\sqrt{5} \longrightarrow$

$(1) + (2) \qquad 2T_6 = -17\sqrt{5} \qquad \therefore T_6 = \frac{-17}{2}\sqrt{5} = -8.5\sqrt{5} = -19$ KN

sub. in (1) $\qquad -19 + T_7 = -6\sqrt{5} \qquad \therefore T_7 = 19 - 6\sqrt{5} = 5.59$ K

for joint (B)



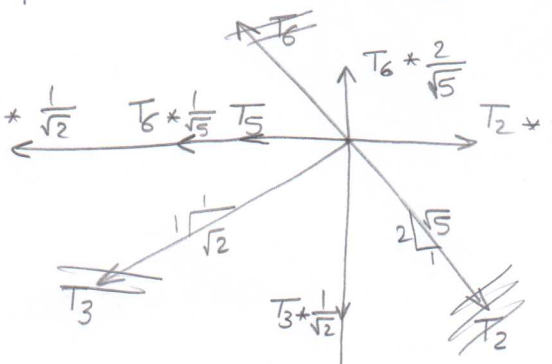
$\pm\rightarrow \Sigma F_x = 0 \qquad 4 + T_5 + T_7 * \frac{1}{\sqrt{5}} = 0$

$T_5 = -4 - 5.59 * \frac{1}{\sqrt{5}}$

$= -6.5$ KN

$+\uparrow \Sigma F_y = 0 \qquad T_7 * \frac{2}{\sqrt{5}} + T_8 - T_4 = 0 \qquad \therefore T_4 = +12 + 5.59 * \frac{2}{\sqrt{5}} = 17$

for joint (F)



$+\uparrow \Sigma F_y = 0 \qquad T_6 * \frac{2}{\sqrt{5}} - T_3 * \frac{1}{\sqrt{2}} - T_2 * \frac{2}{\sqrt{5}} = 0$

$T_3 * \frac{\sqrt{5}}{\sqrt{2}} + 2T_2 = 2T_6 = -38 \longrightarrow (3)$

$\pm\rightarrow \Sigma F_x = 0 \qquad T_2 * \frac{1}{\sqrt{5}} - T_5 - T_6 * \frac{1}{\sqrt{5}} - T_3 * \frac{1}{\sqrt{2}} = 0$

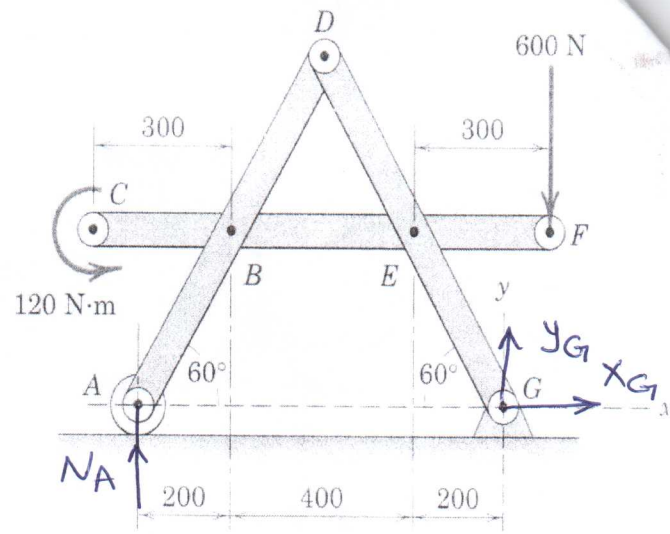
$-T_3 * \frac{\sqrt{5}}{\sqrt{2}} + T_2 = T_5 * \sqrt{5} - T_6 = -6.5 * \sqrt{5} + 19 = 4.4656 \longrightarrow (4)$

$(3) + (4) \qquad \therefore 3T_2 = -38 + 4.4656 = -33.53 \qquad \therefore T_2 = -11.178$ KN

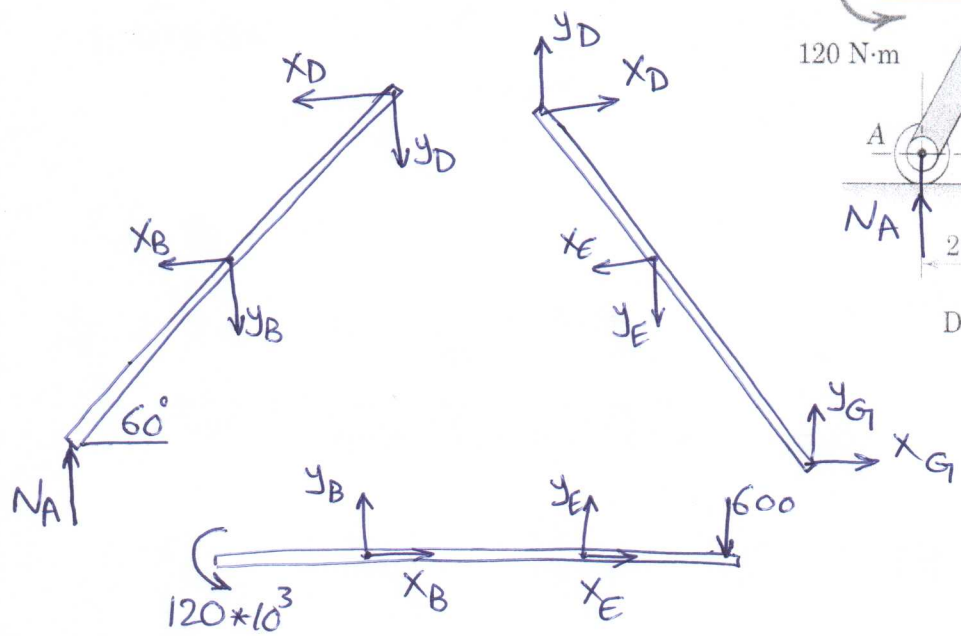
sub. in (3) $\qquad T_3 = -9.89$ KN

Question Two: (10 marks)

Determine the horizontal and vertical components of force at pins B, D, E and G.



Dimensions in millimeters



	N
x_G	0
y_G	525
N_A	75
x_D	173.2
y_D	225
x_E	173.2
y_E	750
x_B	-173.2
y_B	-150

for the whole frame

$(+\circlearrowleft)\ \Sigma M_G = 0$

$10^3*120 - N_A*800 - 600*100 = 0$

$N_A = 75$ Newton

$\xrightarrow{+}\ \Sigma F_x = 0 \qquad x_G = 0$

$+\uparrow\ \Sigma F_y = 0 \qquad N_A + y_G - 600 = 0$

$y_G = 600 - N_A$

$= 525\ N$

for member CBEF

$(+\circlearrowleft)\ \Sigma M_B = 0 \qquad 10^3*120 + y_E*400 - 600*700 = 0$

$y_E = +750$

$+\uparrow\ \Sigma F_y = 0 \qquad y_B + y_E - 600 = 0$

$y_B = 600 - y_E = 600 - 750 = -150\ N$

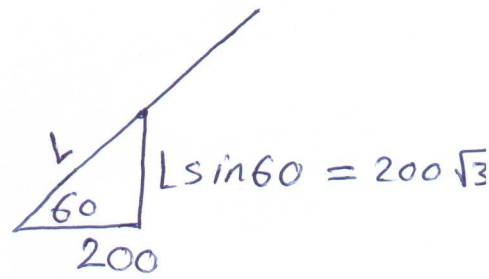
$\Sigma F_x = 0 \qquad X_B + X_E = 0$

$X_B = -X_E \longrightarrow (1)$

for member ABD

$L\cos 60 = 200$

$\therefore L = 400\ mm$



$(+\circlearrowleft) \quad \Sigma M_B = 0$

$Y_B * 200 - X_B * 200\sqrt{3} - N_A * 400 = 0$

$X_B = \dfrac{-150*200 - 75*400}{200\sqrt{3}} = +173.2$ Newton

$\therefore X_E = 173.2$ Newton from eqn (1)

$\therefore X_D = -X_B = 173.2$ Newton

$\pm\rightarrow \Sigma F_x = 0 \qquad -X_B - X_D = 0$

$+\uparrow \Sigma F_y = 0 \qquad N_A - Y_B - Y_D = 0$

$Y_D = N_A - Y_B = 75 + 150 = 225$ Newto

use member DEG for check

$\rightarrow \Sigma F_x = X_D - X_E + X_G$

$= 173.2 - 173.2 + 0 = 0$

$\uparrow \Sigma F_y = Y_D - Y_E + Y_G$

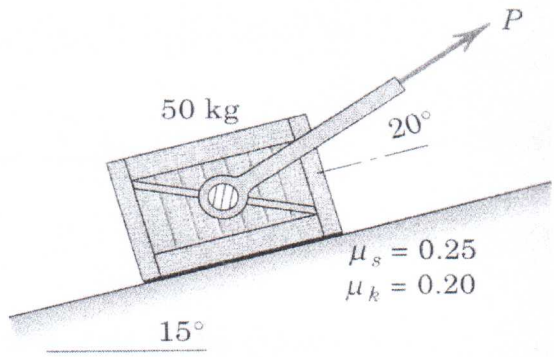
$= 225 - 750 + 525$

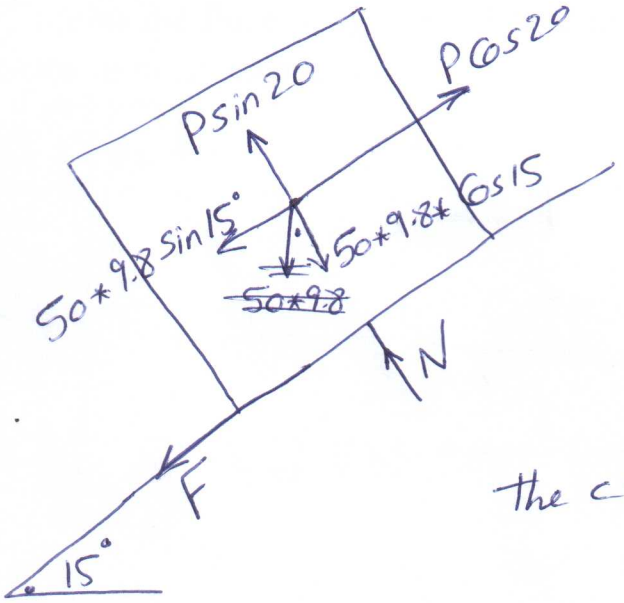
$= 0$

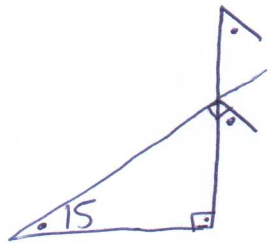
$\therefore$ O.K.

Question Three: (10 marks)

Determine the magnitude of force P so that the 50-kg crate will start moving up the inclined plane.







the crate will start moving

$F = \mu_s N = 0.25\,N$

$+\uparrow \Sigma F_y = 0$

$P\sin 20 + N - 50*9.8*\cos 15 = 0$

$N = 50*9.8\cos 15 - P\sin 20 \longrightarrow (1)$

$= 473.3 - 0.34P$

$\nearrow \Sigma F_x = 0$

$P\cos 20 - 50*9.8\sin 15 - 0.25N = 0$

from (1)

$P\cos 20 - 126.82 = 0.25(473.3 - 0.34P)$

$1.025P = 126.82 + 0.25*473.3$

$P = 239.167$ Newton $\longrightarrow$ 245 if $g = 10\,m/s^2$

sub. in (1)

$N = 473.3 - 0.34*239.167$

$= 392$ Newton