PROBLEMAS RESUELTOS ESTATICA

CAPITULO 4 ESTRUCTURAS

Tercera y quinta edicion
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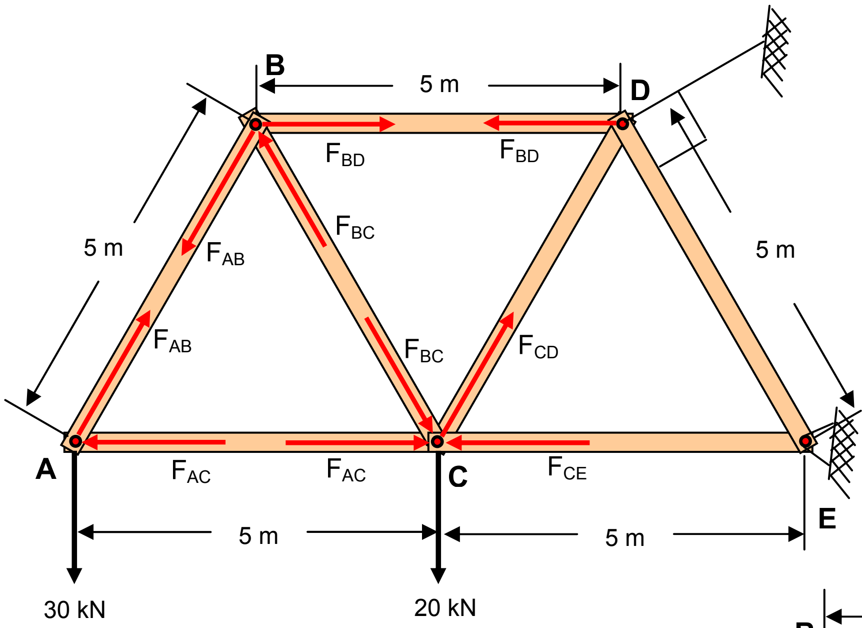
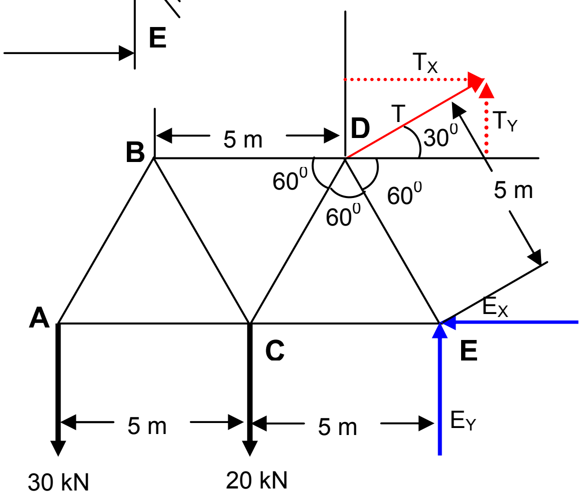
PROBLEMA ESTATICA MERIAM Edic 3.

Calcular, por el método de los nudos, la fuerza en los miembros del entramado en voladizo





Solución. Si no se deseara calcular las reacciones externas en *D* y *E*, el análisis de un entramado en voladizo podría iniciarse en el nudo del extremo en que se aplica la carga. Sin embargo, este entramado lo analizaremos por completo, por lo que el primer paso será calcular las fuerzas exteriores en *D* y *E* empleando el diagrama de sólido libre del entramado en conjunto. Las ecuaciones de equilibrio dan

$\Sigma M_E = 0$

$- T (5) + 30 (5 + 5) + 20 (5) = 0$

$- 5 T + 30 (10) + 20 (5) = 0$

$- 5 T + 300 + 100 = 0$

$- 5 T + 400 = 0$

$5 T = 400$

$$T = \frac{400}{5} = 80 \text{ N}$$

T = 80 N

$$\cos 30 = \frac{T_X}{T}$$

T_X = T cos 30

Pero: T = 80 N

T_X = 80 (0,866)

T_X = 69,28 N

$$\text{sen } 30 = \frac{T_Y}{T}$$

T_Y = T sen 30

Pero: T = 80 N

T_Y = 80 (0,5)

T_Y = 40 N

$\sum F_Y = 0$

$T_Y + E_Y - 30 - 20 = 0$

$T_Y + E_Y - 50 = 0$

Pero: T_Y = 40 N

$40 + E_Y - 50 = 0$

$E_Y - 10 = 0$

E_Y = 10 KN

$\sum F_X = 0$

$T_X - E_X = 0$

Pero: T_X = 69,28 N

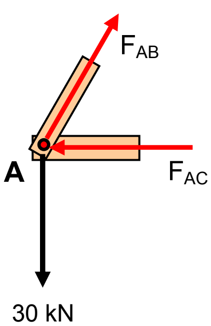
$T_X = E_X$

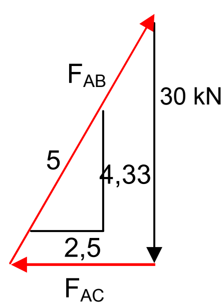
E_X = 69,28 N

A continuación, dibujamos los diagramas de sólido libre que muestren las fuerzas actuantes en cada nudo. La exactitud de los sentidos asignados a las fuerzas se comprueba al considerar cada nudo en el orden asignado. No debe haber dudas acerca de la exactitud del sentido asignado a las fuerzas actuantes en el nudo A. El equilibrio exige

NUDO A

$$\frac{F_{AB}}{5} = \frac{30}{4,33} = \frac{F_{AC}}{2,5}$$





Hallar F_{AB}

$$\frac{F_{AB}}{5} = \frac{30}{4,33}$$

$$F_{AB} = \frac{(30)5}{4,33} = 34,64 \text{ KN}$$

F_{AB} = 34,64 kN (tensión)

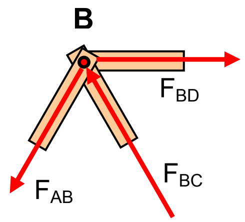
Se halla F_{AC}

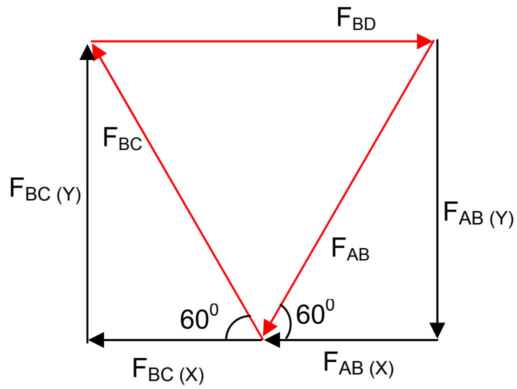
$$\frac{30}{4,33} = \frac{F_{AC}}{2,5}$$

$$F_{AC} = \frac{(30)2,5}{4,33} = 17,32 \text{ KN}$$

F_{AC} = 17,32 kN (compresion)

NUDO B





$$\text{sen } 60 = \frac{F_{BC(Y)}}{F_{BC}}$$

$F_{BC(Y)} = F_{BC} \text{ sen } 60$

$$F_{BC(Y)} = F_{BC}\left(\frac{\sqrt{3}}{2}\right)$$

$$F_{BC(Y)} = \left(\frac{\sqrt{3}}{2}\right)F_{BC}$$

Para abreviar los cálculos

$$\text{sen } 60 = \frac{\sqrt{3}}{2} \quad \cos 60 = \frac{1}{2}$$

$$\cos 60 = \frac{F_{BC(X)}}{F_{BC}}$$

$F_{BC(X)} = F_{BC} \cos 60$

$$F_{BC(x)} = F_{BC}\left(\frac{1}{2}\right)$$

$$F_{BC(x)} = \left(\frac{1}{2}\right)F_{BC}$$

$$\text{sen } 60 = \frac{F_{AB(Y)}}{F_{AB}}$$

$F_{AB(Y)} = F_{AB} \text{ sen } 60$

$$F_{AB(Y)} = F_{AB}\left(\frac{\sqrt{3}}{2}\right)$$

$$F_{AB(Y)} = \left(\frac{\sqrt{3}}{2}\right)F_{AB}$$

$$\cos 60 = \frac{F_{AB(X)}}{F_{AB}}$$

$F_{AB(X)} = F_{AB} \cos 60$

$$F_{AB(x)} = F_{AB}\left(\frac{1}{2}\right)$$

$$F_{AB(x)} = \left(\frac{1}{2}\right)F_{AB}$$

$\sum F_Y = 0$

$F_{BC(Y)} - F_{AB(Y)} = 0$

$F_{BC(Y)} = F_{AB(Y)}$

$$\cancel{\left(\frac{\sqrt{3}}{2}\right)}F_{BC} = \cancel{\left(\frac{\sqrt{3}}{2}\right)}F_{AB}$$

$F_{BC} = F_{AB}$

PERO: F_{AB} = 34,64 kN

F_{BC} = 34,64 kN (compresión)

$$F_{AB(x)} = \left(\frac{1}{2}\right)F_{AB}$$

PERO: F_{AB} = 34,64 kN

$$F_{AB}(x) = \left(\frac{1}{2}\right)(34{,}64) = 17{,}32\ \text{KN}$$

$F_{AB(x)}$ = 17,32 KN

$$F_{BC}(x) = \left(\frac{\sqrt{3}}{2}\right) F_{BC}$$

PERO: **F_{BC} = 34,64 kN**

$$F_{BC}(x) = \left(\frac{1}{2}\right)(34{,}64) = 17{,}32\ \text{KN}$$

$F_{BC(x)}$ = 17,32 KN

$\sum F_X = 0$

$- F_{AB(x)} - F_{BC(x)} + F_{BD} = 0$

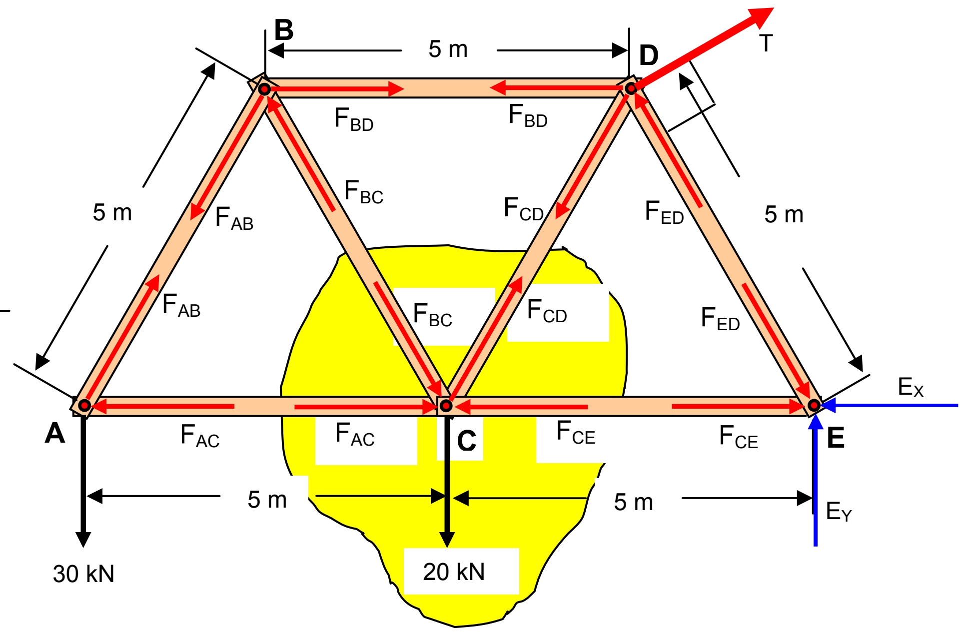
PERO:
$F_{AB(x)} = 17{,}32$ KN
$F_{BC(x)} = 17{,}32$ KN

$- F_{AB(x)} - F_{BC(x)} + F_{BD} = 0$

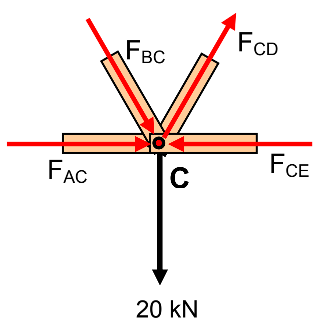
$-17{,}32 - 17{,}32 + F_{BD} = 0$

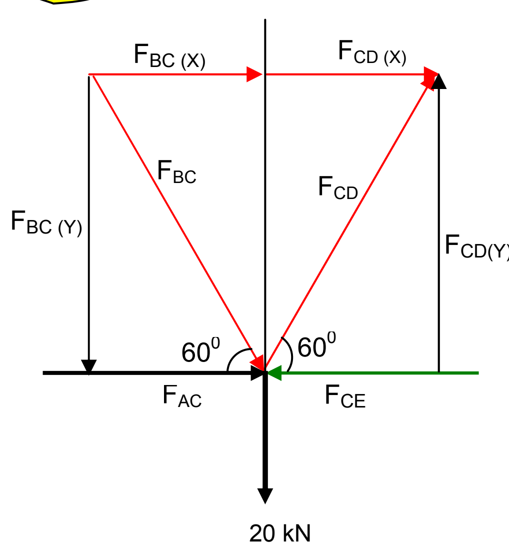
$- 34{,}64 + F_{BD} = 0$

F_{BD} = 34,64 KN (tensión)



NUDO C





PERO:
F_{AC} = 17,32 kN (compresion)
F_{BC} = 34,64 kN (compresión)
$F_{BC(x)}$ = 17,32 KN

$$F_{BC}(Y) = \left(\frac{\sqrt{3}}{2}\right) F_{BC}$$

$$F_{BC}(Y) = \left(\frac{\sqrt{3}}{2}\right)(34{,}64) = 30\ \text{KN}$$

$F_{BC(Y)}$ = 30 KN

$$\cos 60 = \frac{F_{CD}(X)}{F_{CD}}$$

$F_{CD(X)} = F_{CD} \cos 60$

$\sum F_X = 0$

$F_{CD(x)} + F_{BC(x)} + F_{AC} – F_{CE} = 0$

PERO:
F_{AC} = 17,32 kN (compresión)
$F_{BC(x)}$ = 17,32 KN

$F_{CD(x)} + \cancel{17,32} + \cancel{17,32} – F_{CE} = 0$

$\mathbf{F_{CD(x)} + 34,64 – F_{CE} = 0}$

$$\left(\frac{1}{2}\right) F_{CD} - F_{CE} = -34,64 \quad \textbf{(Ecuación 1)}$$

$$F_{CD(Y)} = \left(\frac{\sqrt{3}}{2}\right) F_{CD}$$

$$F_{CD} = \left(\frac{2}{\sqrt{3}}\right) F_{CD(Y)}$$

PERO: $\mathbf{F_{CD(Y)}}$ **= 50 KN**

$$F_{CD} = \left(\frac{2}{\sqrt{3}}\right) 50 = 57,73 \text{ KN}$$

F_{CD} = 57,73 kN (Tensión)

Reemplazar en la ecuación 1

$$\left(\frac{1}{2}\right) F_{CD} - F_{CE} = -34,64 \quad \textbf{(Ecuación 1)}$$

$$\left(\frac{1}{2}\right) 57,73 - F_{CE} = -34,64$$

28,86 – F_{CE} = - 34,64

– F_{CE} = - 34,64 - 28,86

– F_{CE} = - 63,5 (-1)

F_{CE} = 63,5 KN (compresión)

$$\text{sen } 60 = \frac{F_{CD(Y)}}{F_{CD}}$$

$F_{CD(Y)} = F_{CD}$ sen 60

$$F_{CD(Y)} = F_{CD}\left(\frac{\sqrt{3}}{2}\right)$$

$$F_{CD(Y)} = \left(\frac{\sqrt{3}}{2}\right) F_{CD}$$

$\sum F_Y = 0$

$- F_{BC(Y)} + F_{CD(Y)} – 20 = 0$

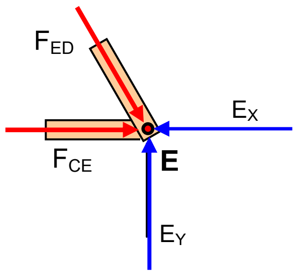
PERO:
$F_{BC(Y)}$ = 30 KN

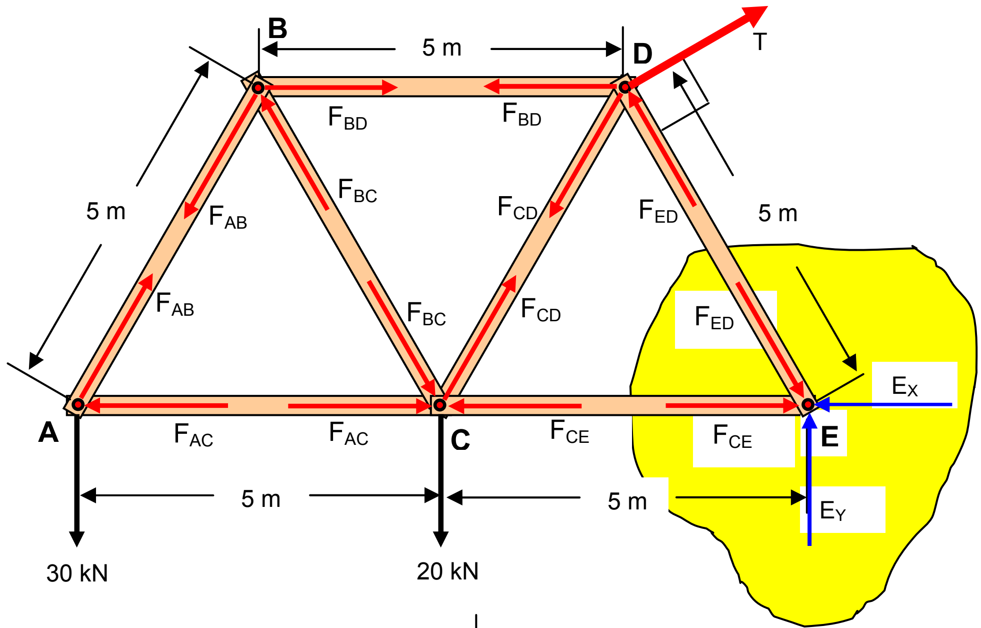
$- 30 + F_{CD(Y)} – 20 = 0$

$- 50 + F_{CD(Y)} = 0$

$\mathbf{F_{CD(Y)}}$ **= 50 KN**

NUDO E





$\sum F_Y = 0$

$E_Y - F_{ED\,(Y)} = 0$

$F_{ED\,(Y)} = E_Y$

PERO:
E_Y = 10 KN

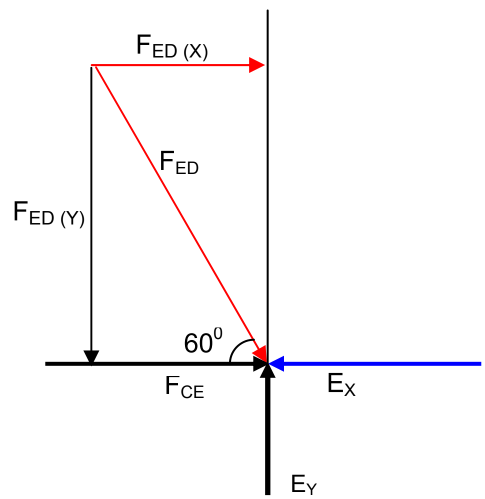
$F_{ED\,(Y)}$ = 10 KN

$$\text{sen } 60 = \frac{F_{ED(Y)}}{F_{ED}}$$

$F_{ED\,(Y)}$ = F_{ED} sen 60

$$F_{ED} = \frac{F_{ED(Y)}}{\text{sen } 60} = \frac{10}{0{,}866} = 11{,}54 \text{ kN}$$

F_{ED} = 11,54 KN (compresión)



T = 80 N **E_X = 69,28 N** **E_Y = 10 KN**

F_{AB} = 34,64 kN (tensión) **F_{AC} = 17,32 kN (compresión)**

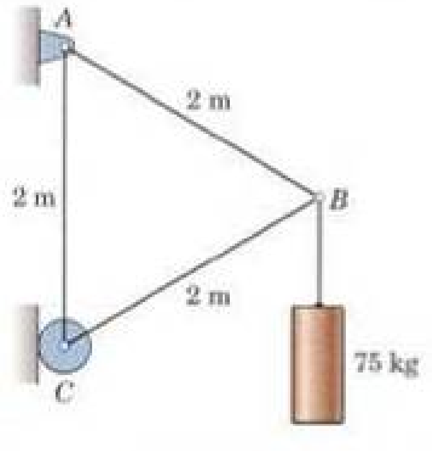
F_{BC} = 34,64 kN (compresión) **F_{BD} = 34,64 KN (tensión)**

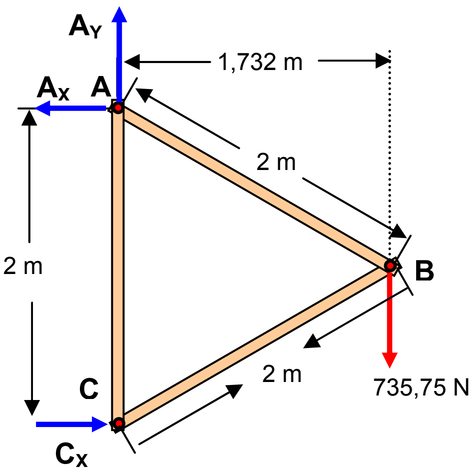
F_{CD} = 57,73 kN (Tensión) **F_{CE} = 63,5 KN (compresión)**

F_{ED} = 11,54 KN (compresión)

Problema 4.1 Estática Meriam edición cinco; Problema 4.2 Estática Meriam edición tres

Hallar la fuerza en cada miembro de la armadura simple equilátera





$\Sigma M_A = 0$

$+$ $C_X (2) - 735,75 (1,732) = 0$

$C_X (2) = 1274,31$

$$C_X = \frac{1274,31}{2} = 637,15\ \text{N}$$

C_X = 637,15 Newton

W = m x g

$$w = 75\ \text{kg} \left(9,81 \frac{\text{m}}{\text{seg}^2} \right) = 735,75\ \text{Newton}$$

W = 735,75 Newton

$\sum F_X = 0$

$C_X - A_X = 0$

$C_X = A_X$

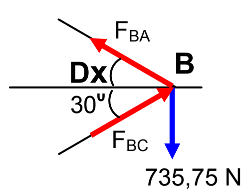
A_X = 637,15 Newton

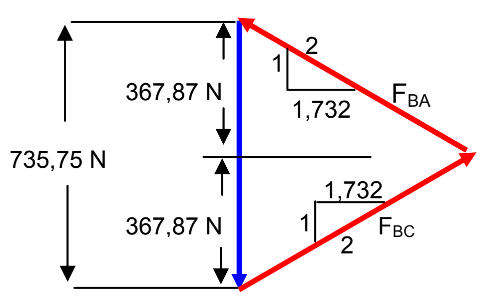
$\sum F_Y = 0$

$A_Y – 735,75 = 0$

A_Y = 735,75 Newton

Nudo B





$$\frac{F_{BA}}{2} = \frac{367,87}{1}$$

F_{BA} = 2 X 367,87

F_{BA} = 735,75 Newton

$$\frac{F_{BC}}{2} = \frac{367,87}{1}$$

F_{BC} = 2 X 367,87

F_{BC} = 735,75 Newton

Nudo C

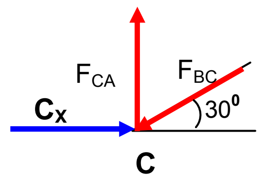
$$\frac{F_{BC}}{2} = \frac{F_{CA}}{1} = \frac{C_X}{1,732}$$

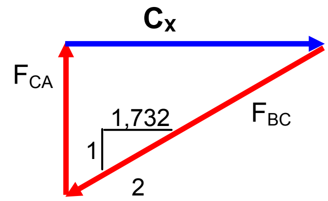
F_{BC} = 735,75 Newton (compresión)

$$\frac{735{,}75}{2} = \frac{F_{CA}}{1}$$

$$F_{CA} = \frac{735{,}75}{2}$$

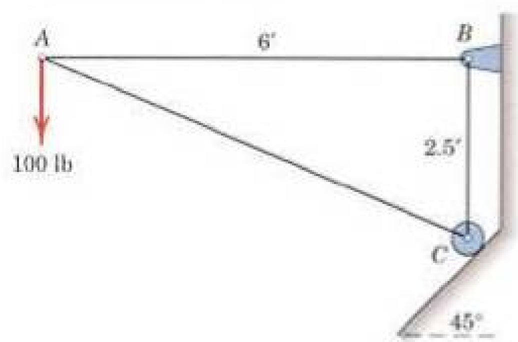
F_{CA} = 367,87 **Newton (tensión)**

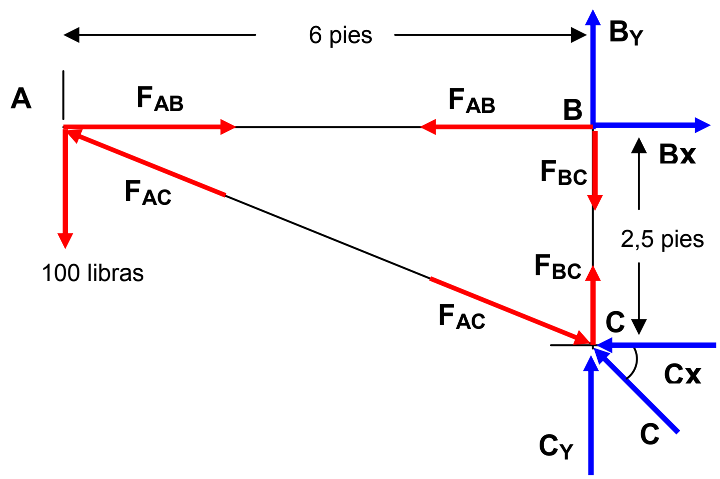




Problema 4.2 Estática Meriam edición cinco

Determine the force in each member of the loaded truss.Discuss the effects of varying the angle of the 45^0 support surface at C.





$\Sigma M_C = 0$

$100\ (6) - B_X\ (2{,}5) = 0$

$600 - 2{,}5\ B_X = 0$

$2{,}5\ B_X = 600$

$$B_X = \frac{600}{2{,}5} = 240 \text{ libras}$$

B_X = 240 libras

$\Sigma M_B = 0$

$100\ (6) - C_X\ (2{,}5) = 0$

$600 - 2{,}5\ C_X = 0$

$2{,}5\ C_X = 600$

$$C_X = \frac{600}{2{,}5} = 240 \text{ libras}$$

C_X = 240 libras

$$\cos 45 = \frac{C_X}{C}$$

$$C = \frac{C_X}{\cos 45} = \frac{240}{0{,}7071} = 339{,}41 \text{ libras}$$

C = 339,41 libras

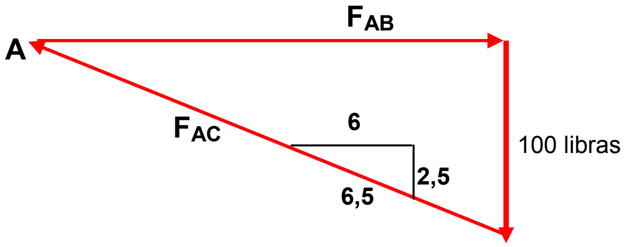
$$\text{sen } 45 = \frac{C_Y}{C}$$

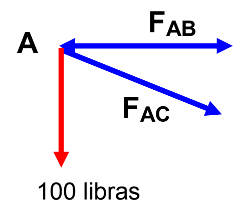
C_Y = C sen 45

C_Y = (339,41) 0,7071

C_Y = 240 libras

Nudo A





Las ecuaciones de equilibrio para la junta A son:

$$\frac{F_{AC}}{6{,}5} = \frac{100}{2{,}5} = \frac{F_{AB}}{6}$$

Hallar F_{AC}

$$\frac{F_{AC}}{6{,}5} = \frac{100}{2{,}5}$$

$$F_{AC} = \frac{(100)6{,}5}{2{,}5} = 260 \text{ libras}$$

F_{AC} = 260 libras (compresión)

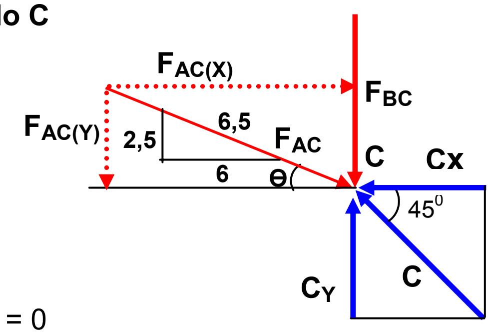
Hallar F_{AB}

$$\frac{100}{2{,}5} = \frac{F_{AB}}{6}$$

$$F_{AB} = \frac{(100)6}{2{,}5} = 240 \text{ libras}$$

F_{AB} = 240 libras (Tensión)

Nudo C



$\Sigma F_Y = 0$

$C_Y - F_{BC} - F_{AC(Y)} = 0$

Pero:
C_Y = 240 libras
$F_{AC(Y)}$ = 100 libras

$C_Y - F_{AC(Y)} = F_{BC}$

F_{BC} = 240 – 100 = 140 libras

F_{BC} = 140 libras (compresión)

$$\operatorname{sen}\theta = \frac{2{,}5}{6{,}5}$$

$$\operatorname{sen}\theta = \frac{F_{AC(Y)}}{F_{AC}}$$

$F_{AC(Y)}$ = sen Θ F_{AC}

$$F_{AC(Y)} = \frac{2{,}5}{6{,}5} F_{AC}$$

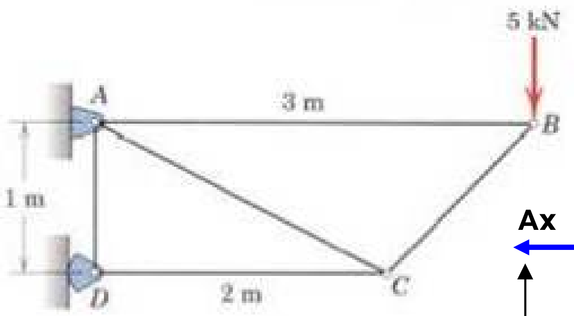
Pero: F_{AC} = 260 libras

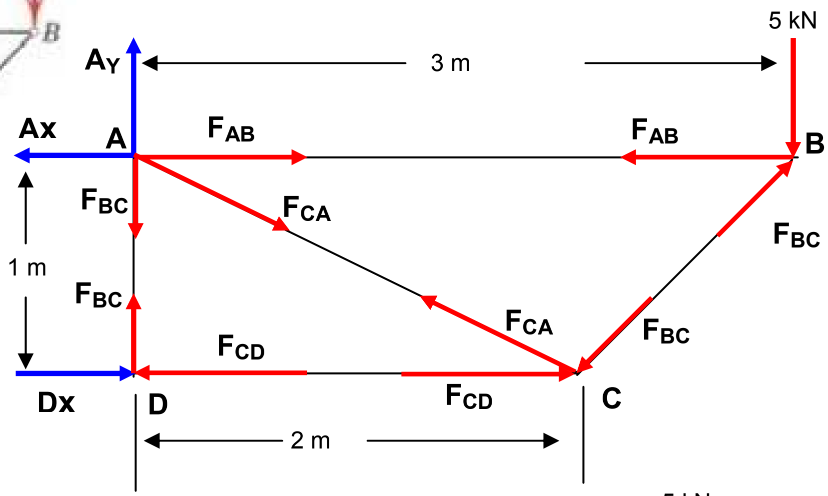
$$F_{AC(Y)} = \frac{2{,}5}{6{,}5}(260) = 100 \text{ libras}$$

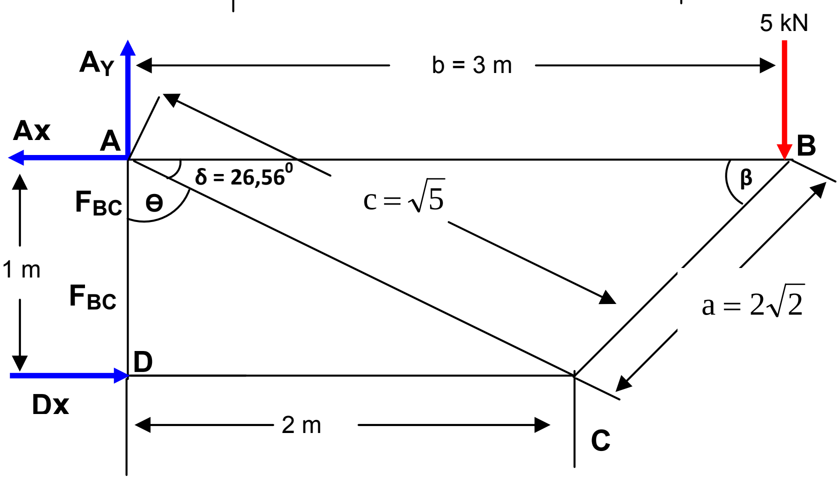
$F_{AC(Y)}$ = 100 libras

Problema 4.3 Estática Meriam edición cinco

Determine the force in each member of the truss. Note the presence of any zero-force members.







$\Sigma M_A = 0$

$+$ $D_X (1) - 5 (3) = 0$

$D_X - 15 = 0$

$D_X = 15$ KN

$\Sigma F_X = 0$

$D_X - A_X = 0$

$D_X = A_X$

PERO: $D_X = 15$ KN

$A_X = 15$ KN

$\Sigma F_Y = 0$

$A_Y - 5 = 0$

$A_Y = 5$ KN

$$\text{tg}\,\theta = \frac{2}{1}$$

$\Theta = \text{arc tg}(2)$

$\Theta = 63{,}43^0$

$\Theta + \delta = 90^0$

$\delta = 90^0 - \Theta$

$\delta = 90^0 - 63{,}43$

$\delta = 26{,}56^0$

ley de cosenos

$a^2 = b^2 + c^2 - 2\,b\,c\,\text{sen}\,\delta$

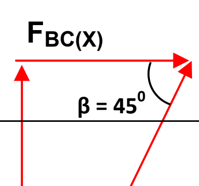
$$a^2 = (3)^2 + \left(\sqrt{5}\right)^2 - 2\,(3)\left(\sqrt{5}\right)\text{sen}\,26{,}56$$

$$a^2 = 9 + 5 - 6\left(\sqrt{5}\right)(0{,}4471)$$

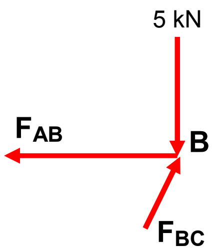
$$a^2 = 14 - 2{,}68\left(\sqrt{5}\right)$$

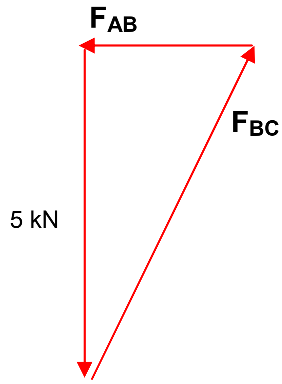
$$a^2 = 14 - 6 \qquad a^2 = 8$$

$$a = \sqrt{8} = 2\sqrt{2}$$



NUDO B





ley de cosenos

$c^2 = a^2 + b^2 – 2\ a\ b\ \text{sen}\ \beta$

$$\left(\sqrt{5}\right)^2 = \left(2\sqrt{2}\right)^2 + (3)^2 - 2\left(2\sqrt{2}\right)(3)\,\text{sen}\ \beta$$

$$5 = 8 + 9 - 12\left(\sqrt{2}\right)\text{sen}\ \beta$$

$$5 = 8 + 9 - 16{,}97\ \text{sen}\ \beta$$

$$5 = 17 - 16{,}97\ \text{sen}\ \beta$$

$$16{,}97\ \text{sen}\ \beta = 17 - 5 = 12$$

$$\text{sen}\ \beta = \frac{12}{16{,}97} = 0{,}7071$$

β = arc tg 0,7071

$\beta = 45^0$

cos β = cos 45 = 0,7071

sen β = sen 45 = 0,7071

$F_{BC(X)} = F_{BC}$ cos 45

Pero:
F_{BC} = 7,071 KN

$F_{BC(X)} = F_{BC}$ cos 45

$$\cos 45 = \frac{F_{BC(X)}}{F_{BC}}$$

$F_{BC(X)} = F_{BC}$ cos 45

$\Sigma F_Y = 0$
$F_{BC(Y)} – 5 = 0$

$F_{BC(Y)}$ = 5 kN

$$F_{BC} = \frac{F_{BC(Y)}}{\text{sen}\ 45} = \frac{5}{0{,}7071} = 7{,}071\ \text{kN}$$

F_{BC} = 7,071 KN

$F_{BC(X)} = F_{BC}$ cos 45

Pero:
F_{BC} = 7,071 KN

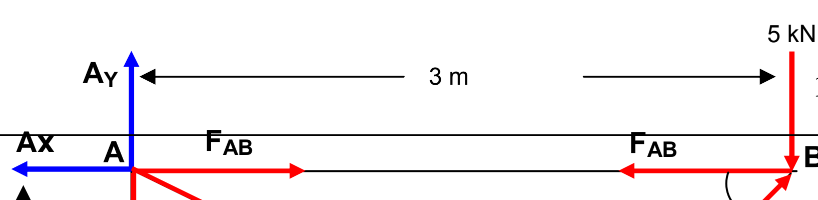
$F_{BC(X)} = F_{BC}$ cos 45

$F_{BC(X)}$ = (7,071) (0,7071)

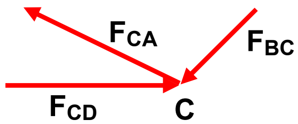
$F_{BC(X)}$ = 5 kN

$\Sigma F_X = 0$
$F_{BC(X)} – F_{AB} = 0$

$F_{AB} = F_{BC(X)}$ **F_{AB} = 5 kN**



NUDO C



$$\cos 26{,}56 = \frac{F_{CA(X)}}{F_{CA}}$$

$F_{CA(X)} = F_{CA} \cos 26{,}56$

$F_{CA(X)} = 0{,}8944\ F_{CA}$

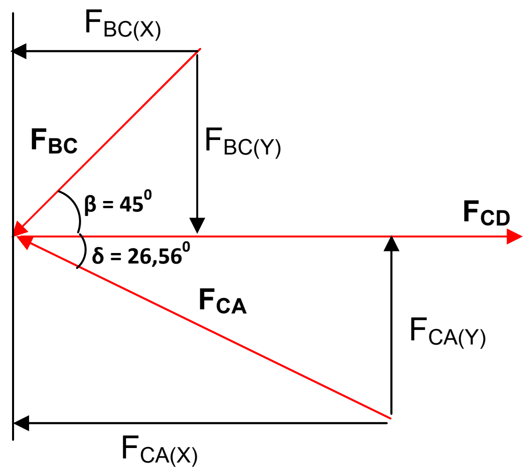
$\Sigma F_Y = 0$

$F_{CA(Y)} - F_{BC(Y)} = 0$

$F_{CA(Y)} = F_{BC(Y)}$

Pero: $F_{BC\ (Y)} = 5$ kN

$F_{CA(Y)} = 5$ kN



$$\text{sen } 26{,}56 = \frac{F_{CA(Y)}}{F_{CA}}$$

$$F_{CA} = \frac{F_{CA(Y)}}{\text{sen } 26{,}56} = \frac{5}{0{,}4471} = 11{,}18 \text{ kN}$$

$F_{CA} = 11{,}18$ kN (tensión)

Reemplazando la ecuación 1

$F_{CD} - 0{,}8944\ F_{CA} = 5$ (Ecuación 1)

Pero: $F_{CA} = 11{,}18$ kN

$F_{CD} - 0{,}8944\ (11{,}18) = 5$

$F_{CD} - 10 = 5$

$F_{CD} = 5 + 10 = 15$ kN

$F_{CD} = 15$ Kn (compresión)

$\Sigma F_X = 0$

$- F_{BC(X)} + F_{CD} - F_{CA(X)} = 0$

Pero:

$F_{BC(X)} = 5$ kN

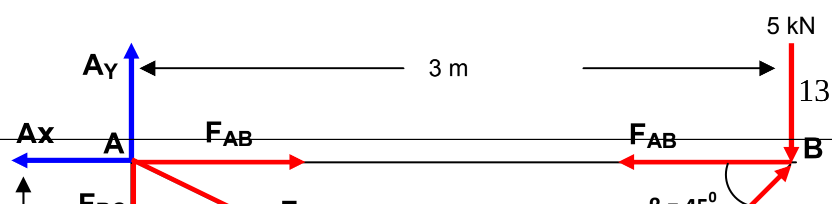
$- 5 + F_{CD} - F_{CA(X)} = 0$

$F_{CD} - F_{CA(X)} = 5$

$F_{CA(X)} = 0{,}8944\ F_{CA}$

$F_{CD} - 0{,}8944\ F_{CA} = 5$ (Ecuación 1)

NUDO D



$\Sigma F_X = 0$

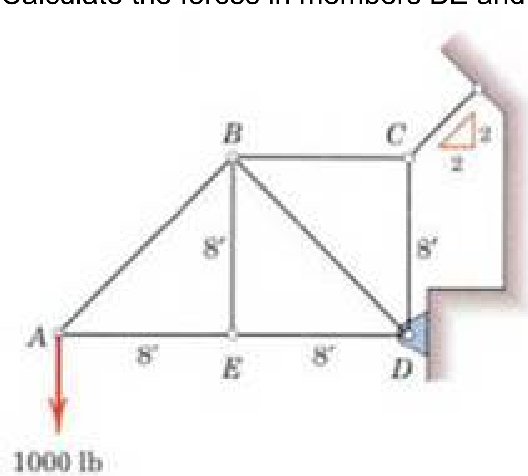
$D_X - F_{CD} = 0$

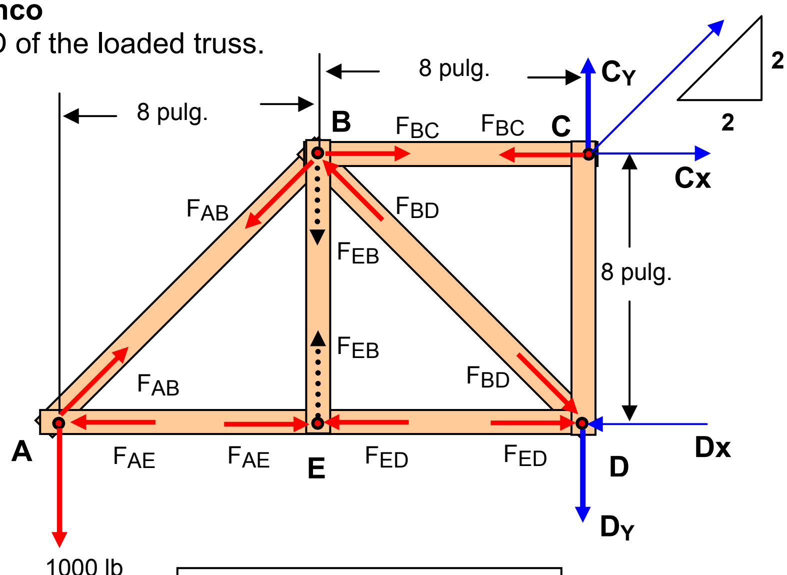
$D_X = F_{CD}$

Pero:
F_{CD} = 15 Kn

$\Sigma F_y = 0$
$F_{BC} = 0$

Problema 4.4 Estática Meriam edición cinco
Calculate the forces in members BE and BD of the loaded truss.





$\Sigma M_C = 0$

$$+\quad 1000\,(8 + 8) - D_X\,(8) = 0$$

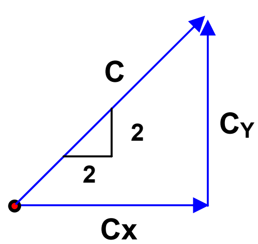
$1000\,(16) - 8\,D_X = 0$

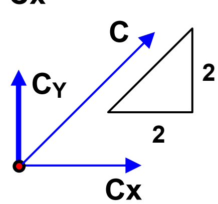
$16000 - 8\,D_X = 0$

$8\,D_X = 16000$

$$D_X = \frac{16000}{8} = 2000\text{ lb.}$$

D_X = 2000 lb.





$\sum F_X = 0$

$C_X - D_X = 0$

$C_X = D_X$

PERO: D_X = 2000 lb.

C_X = 2000 lb.

Las ecuaciones de equilibrio para la fuerza C son:

$$\frac{C_Y}{\cancel{2}} = \frac{C_X}{\cancel{2}}$$

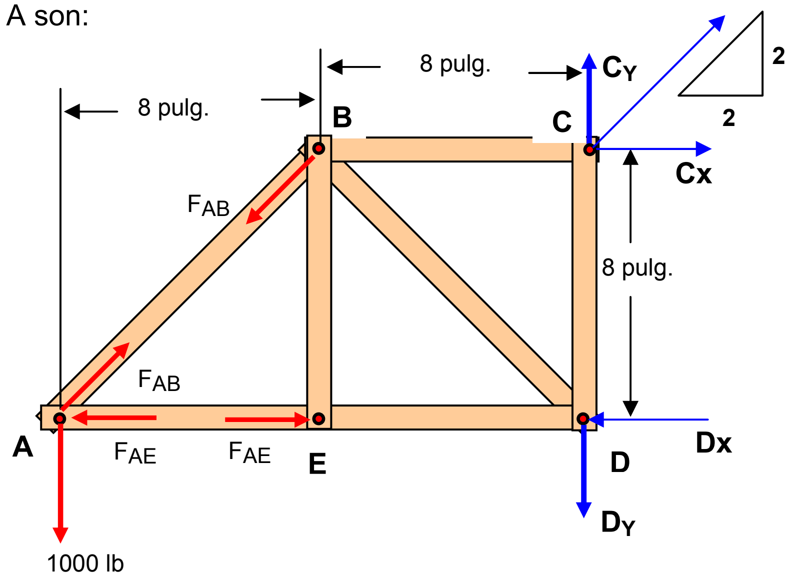
Cancelando términos semejantes

$C_Y = C_X$

PERO: C_X = 2000 lb.
C_Y = 2000 lb.

NUDO A
Las ecuaciones de equilibrio para la junta A son:

$$\frac{F_{AB}}{\cancel{8}\sqrt{2}} = \frac{1000}{\cancel{8}} = \frac{F_{AE}}{\cancel{8}}$$



Cancelando términos semejantes

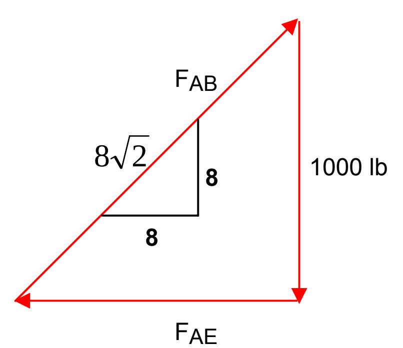
$$\frac{F_{AB}}{\sqrt{2}} = 1000 = F_{AE}$$

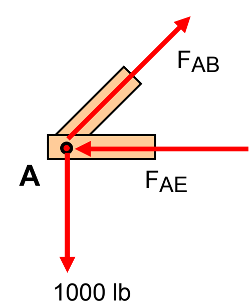
Hallar F_{AB}

$$\frac{F_{AB}}{\sqrt{2}} = 1000$$

$$F_{AB} = 1000\left(\sqrt{2}\right)$$

F_{AB} = 1414,21libras (tensión)



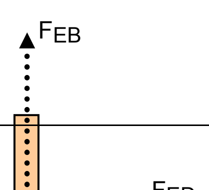


Hallar F_{AE}

$1000 = F_{AE}$

F_{AE} = 1000 lb. (Compresión)

NUDO E



$\sum F_Y = 0$

$F_{EB} = 0$

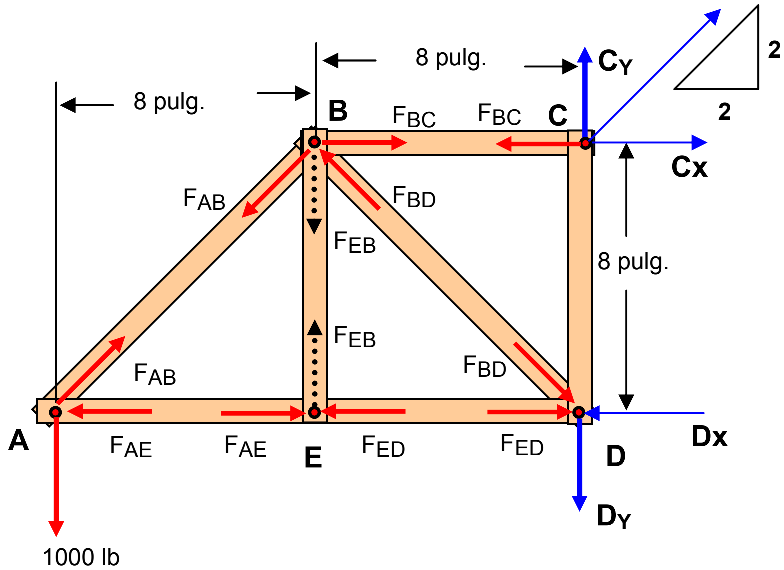
$\sum F_X = 0$

$F_{AE} - F_{ED} = 0$

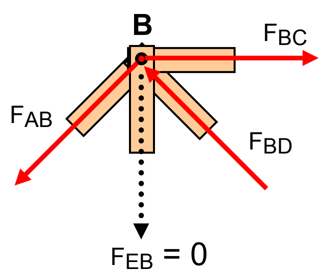
$F_{AE} = F_{ED}$

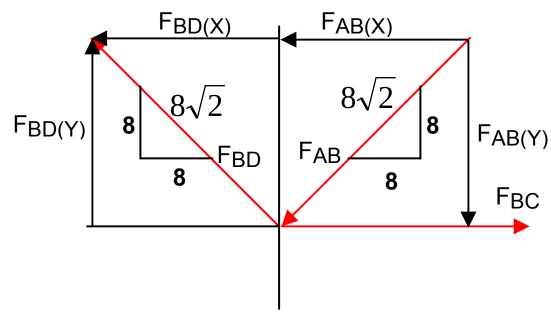
PERO: F_{AE} = 1000 lb.

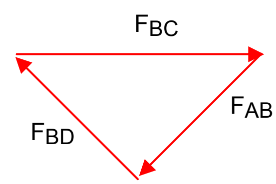
F_{ED} = 1000 lb. (Compresión)



NUDO B







Las ecuaciones de equilibrio para la junta B son:

$$\frac{F_{AB}}{\cancel{8}\sqrt{2}} = \frac{F_{AB(Y)}}{\cancel{8}} = \frac{F_{AB(X)}}{\cancel{8}}$$

Cancelando términos semejantes

$$\frac{F_{AB}}{\sqrt{2}} = F_{AB(Y)} = F_{AB(X)}$$

PERO: **F_{AB} = 1414,21libras**

Hallar $F_{AB(Y)}$

$$\frac{F_{AB}}{\sqrt{2}} = F_{AB(Y)}$$

Hallar $F_{AB(X)}$

$$\frac{F_{AB}}{\sqrt{2}} = F_{AB(X)}$$

$$\frac{1414{,}2}{\sqrt{2}} = F_{AB(X)}$$

$F_{AB(X)}$ = 1000 lb.

$\sum F_X = 0$

$F_{BC} - F_{BD(X)} - F_{AB(X)} = 0$

PERO: $F_{AB(X)}$ = 1000 lb.

$$\frac{1414{,}2}{\sqrt{2}} = F_{AB(Y)}$$

$F_{AB(Y)}$ = 1000 lb.

$\Sigma F_Y = 0$

$F_{BD\,(Y)} - F_{AB\,(Y)} = 0$

$F_{BD\,(Y)} = F_{AB\,(Y)}$

Pero: $F_{AB\,(Y)}$ = 1000 lb.

$F_{BD\,(Y)}$ = 1000 lb.

Las ecuaciones de equilibrio para la junta B son:

$$\frac{F_{BD}}{\cancel{8}\sqrt{2}} = \frac{F_{BD(Y)}}{\cancel{8}} = \frac{F_{BD(X)}}{\cancel{8}}$$

Cancelando términos semejantes

$$\frac{F_{BD}}{\sqrt{2}} = F_{BD(Y)} = F_{BD(X)}$$

Pero: $F_{BD\,(Y)}$ = 1000 lb.

$$F_{BD(Y)} = F_{BD(X)}$$

$F_{BD\,(X)}$ = 1000 lb.

$$\frac{F_{BD}}{\sqrt{2}} = F_{BD(Y)}$$

Pero: $F_{BD\,(Y)}$ = 1000 lb.

$$F_{BD} = \left(\sqrt{2}\right) F_{BD(Y)}$$

$$F_{BD} = \left(\sqrt{2}\right) 1000$$

F_{BD} = 1414,2 libras (compresión)

Hallar F_{BC}

$F_{BC} - F_{BD(X)}$ = 1000 ECUACION 1

PERO:

$F_{BD\,(X)}$ = 1000 lb.

F_{BC} - 1000 = 1000

F_{BC} = 1000 + 1000

F_{BC} = 2000 lb. (tracción)

D_X = 2000 lb.

F_{AB} = 1414,21libras (tensión)

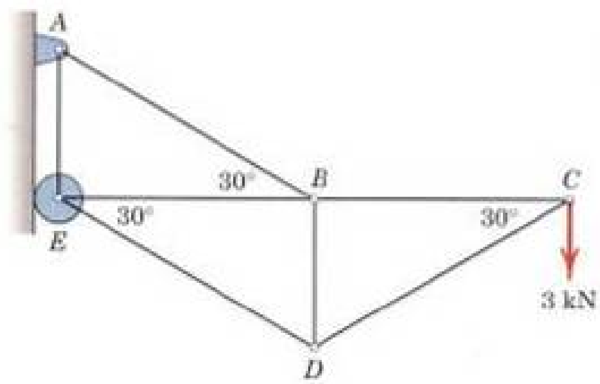
F_{AE} = 1000 lb. (Compresión)

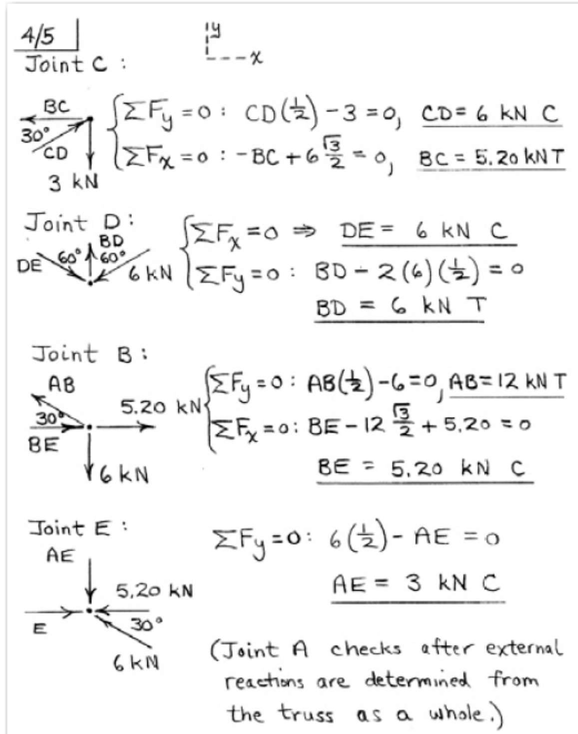
F_{ED} = 1000 lb. (Compresión)

F_{EB} = 0

F_{BC} = 2000 lb. (tracción)

Problema 4.5 Estática Meriam edición cinco
Determine the force in each member of the loaded truss





4/5

Joint C:

$$\Sigma F_y = 0: \quad CD\left(\tfrac{1}{2}\right) - 3 = 0, \quad \underline{CD = 6 \text{ kN C}}$$

$$\Sigma F_x = 0: \quad -BC + 6\tfrac{\sqrt{3}}{2} = 0, \quad \underline{BC = 5.20 \text{ kN T}}$$

Joint D:

$$\Sigma F_x = 0 \Rightarrow \underline{DE = 6 \text{ kN C}}$$

$$\Sigma F_y = 0: \quad BD - 2(6)\left(\tfrac{1}{2}\right) = 0$$

$$\underline{BD = 6 \text{ kN T}}$$

Joint B:

$$\Sigma F_y = 0: \quad AB\left(\tfrac{1}{2}\right) - 6 = 0, \quad \underline{AB = 12 \text{ kN T}}$$

$$\Sigma F_x = 0: \quad BE - 12\tfrac{\sqrt{3}}{2} + 5.20 = 0$$

$$\underline{BE = 5.20 \text{ kN C}}$$

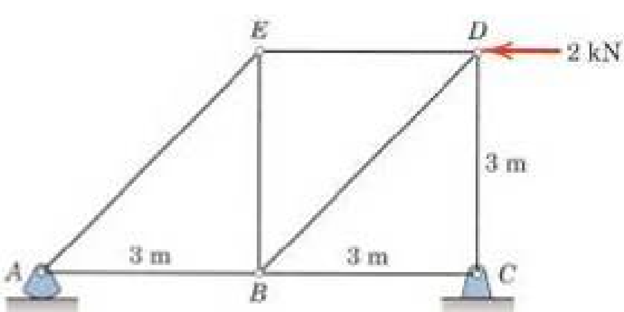
Joint E:

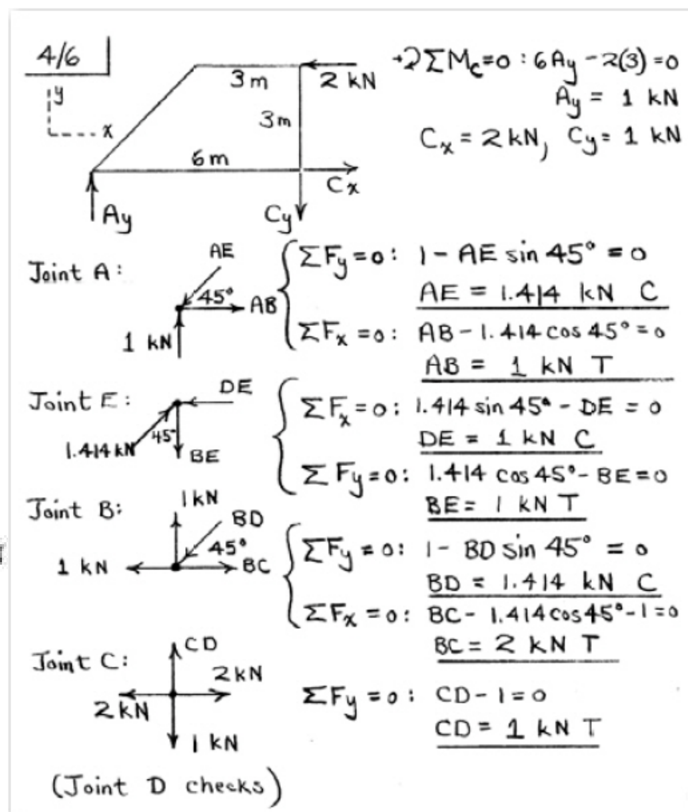
$$\Sigma F_y = 0: \quad 6\left(\tfrac{1}{2}\right) - AE = 0$$

$$\underline{AE = 3 \text{ kN C}}$$

(Joint A checks after external reactions are determined from the truss as a whole.)

Problema 4.4 Estática Meriam edición tres; Problema 4.6 Estática Meriam edición cinco;
Hallar la fuerza en cada miembro de la armadura cargada





4/6

$$\circlearrowleft \Sigma M_C = 0: \quad 6A_y - 2(3) = 0$$

$$A_y = 1 \text{ kN}$$

$$C_x = 2 \text{ kN}, \quad C_y = 1 \text{ kN}$$

Joint A:

$$\Sigma F_y = 0: \quad 1 - AE \sin 45° = 0$$

$$\underline{AE = 1.414 \text{ kN C}}$$

$$\Sigma F_x = 0: \quad AB - 1.414 \cos 45° = 0$$

$$\underline{AB = 1 \text{ kN T}}$$

Joint E:

$$\Sigma F_x = 0: \quad 1.414 \sin 45° - DE = 0$$

$$\underline{DE = 1 \text{ kN C}}$$

$$\Sigma F_y = 0: \quad 1.414 \cos 45° - BE = 0$$

$$\underline{BE = 1 \text{ kN T}}$$

Joint B:

$$\Sigma F_y = 0: \quad 1 - BD \sin 45° = 0$$

$$\underline{BD = 1.414 \text{ kN C}}$$

$$\Sigma F_x = 0: \quad BC - 1.414 \cos 45° - 1 = 0$$

$$\underline{BC = 2 \text{ kN T}}$$

Joint C:

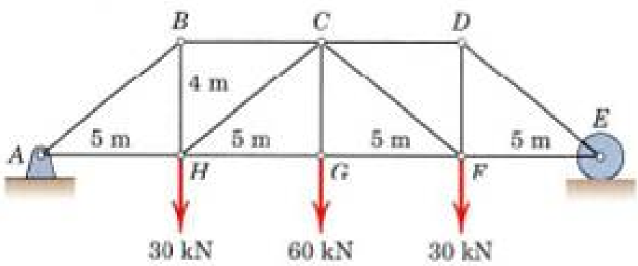
$$\Sigma F_y = 0: \quad CD - 1 = 0$$

$$\underline{CD = 1 \text{ kN T}}$$

(Joint D checks)

4/7 Determine the force in each member of the loaded truss. Make use of the symmetry of the truss and of the loading.

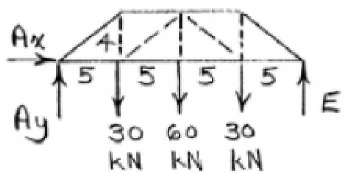
Ans. $AB = DE = 96.0$ kN C
$AH = EF = 75$ kN T, $BC = CD = 75$ kN C
$BH = CG = DF = 60$ kN T
$CH = CF = 48.0$ kN C, $GH = FG = 112.5$ kN T



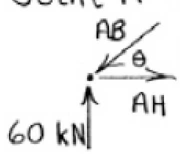
Problem 4/7

4/7 As a whole: $\Sigma F_x = 0 \Rightarrow A_x = 0$

(Dim. in m) $A_y = E = 60$ kN by $\Sigma F_y = 0$ and symmetry.



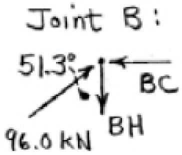
Joint A: $\left(\theta = \tan^{-1}\left(\frac{4}{5}\right) = 38.7^\circ\right)$



$\Sigma F_y = 0$: $60 - AB\sin\theta = 0$, $\underline{AB = 96.0 \text{ kN } C}$

$\Sigma F_x = 0$: $AH - 96.0\cos\theta = 0$, $\underline{AH = 75 \text{ kN } T}$

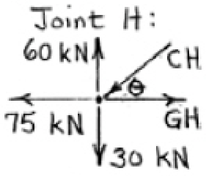
Joint B:



$\Sigma F_x = 0$: $-BC + 96.0\sin 51.3^\circ = 0$, $\underline{BC = 75 \text{ kN } C}$

$\Sigma F_y = 0$: $-BH + 96.0\cos 51.3^\circ = 0$, $\underline{BH = 60 \text{ kN } T}$

Joint H:

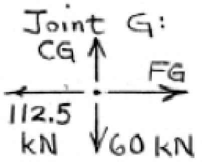


$\Sigma F_y = 0$: $-CH\sin\theta + 30 = 0$, $\underline{CH = 48.0 \text{ kN } C}$

$\Sigma F_x = 0$: $-48.0\cos\theta + GH - 75 = 0$

$\underline{GH = 112.5 \text{ kN } T}$

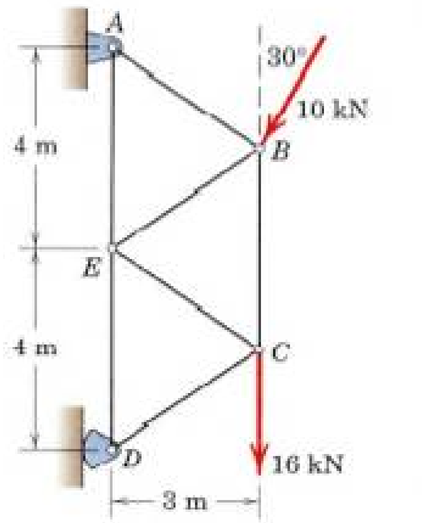
Joint G:



$\Sigma F_y = 0 \Rightarrow \underline{CG = 60 \text{ kN } T}$

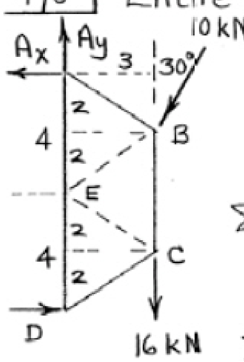
By symmetry:
FG = 112.5 kN T, CF = 48.0 kN C
CD = 75 kN C, DF = 60 kN T
EF = 75 kN T, DE = 96.0 kN C

4/8 Determine the force in each member of the loaded truss. All triangles are isosceles.



Problem 4/8

4/8 Entire truss:



$\circlearrowleft + \Sigma M_A = 0: -10\cos 30°(3) - 10\sin 30°(2) - 16(3) + D(8) = 0$

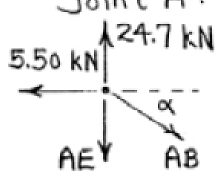
$D = 10.50$ kN

$\Sigma F_x = 0: -A_x - 10\left(\frac{1}{2}\right) + 10.50 = 0$

$A_x = 5.50$ kN

$\Sigma F_y = 0: -10\frac{\sqrt{3}}{2} - 16 + A_y = 0, \; A_y = 24.7$ kN

Joint A:



$\left(\alpha = \tan^{-1}\left(\frac{2}{3}\right) = 33.7°\right)$

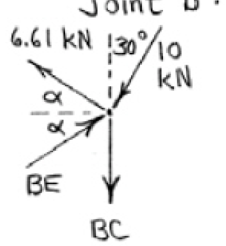
$\Sigma F_x = 0: AB\cos 33.7° - 5.50 = 0$

$\underline{AB = 6.61 \text{ kN T}}$

$\Sigma F_y = 0: 24.7 - AE - 6.61\sin 33.7° = 0$

$\underline{AE = 21.0 \text{ kN T}}$

Joint B:

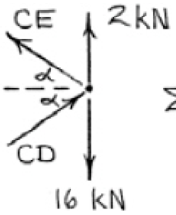


$\Sigma F_x = 0: -6.61\cos 33.7° - 10\sin 30° + BE\cos 33.7° = 0, \; \underline{BE = 12.62 \text{ kN C}}$

$\Sigma F_y = 0: 6.61\sin 33.7° - 10\cos 30° + 12.62\sin 33.7° - BC = 0$

$\underline{BC = 2.00 \text{ kN T}}$

Joint C :



$\Sigma F_x = 0 : -CE \cos\alpha + CD \cos\alpha = 0$

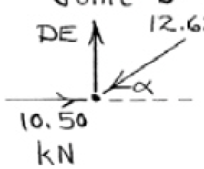
$CE = CD$

$\Sigma F_y = 0 : 2 - 16 + (CE + CE)\sin 33.7° = 0$

$\underline{CE = 12.62 \text{ kN } T}$

$\underline{CD = 12.62 \text{ kN } C}$

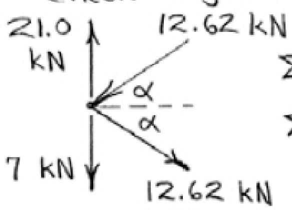
Joint D:



$\Sigma F_y = 0 : DE - 12.62 \sin 33.7° = 0$

$\underline{DE = 7 \text{ kN } T}$

Check on joint E :



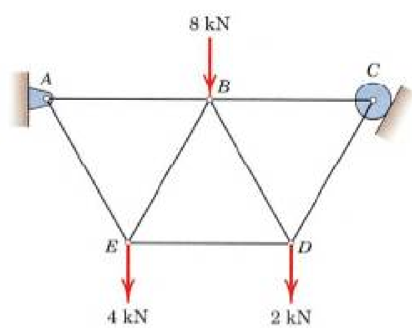
$\Sigma F_x = 0$ ✓

$\Sigma F_y = 21 - 7 - 2(12.62)\sin 33.7°$

$= 0$ ✓

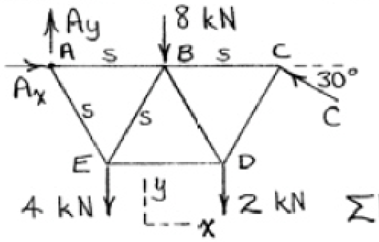
4/9 Determine the force in each member of the loaded truss. All triangles are equilateral.

Ans. $AB = 9\sqrt{3}$ kN C, $AE = 5\sqrt{3}$ kN T
$BC = \frac{26}{3}\sqrt{3}$ kN C, $BD = 3\sqrt{3}$ kN C, $BE = \frac{7}{3}\sqrt{3}$ kN C
$CD = \frac{13}{3}\sqrt{3}$ kN T, $DE = \frac{11}{3}\sqrt{3}$ kN T



Problem 4/9

4/9 As a whole: $\circlearrowleft \Sigma M_A = 0: -8s - 4\frac{s}{2} - 2\frac{3s}{2} + C\frac{1}{2}(2s) = 0, \quad C = 13 \text{ kN}$



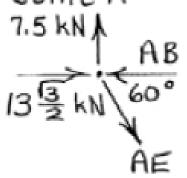
$\Sigma F_x = 0: A_x - 13\frac{\sqrt{3}}{2} = 0$

$A_x = 13\frac{\sqrt{3}}{2}$ kN

$\Sigma F_y = 0: A_y + 13\left(\frac{1}{2}\right) - 14 = 0$

$A_y = 7.5$ kN

Joint A:

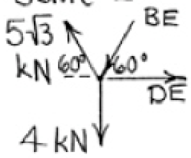


$\Sigma F_y = 0: 7.5 - AE\frac{\sqrt{3}}{2} = 0, \quad AE = 5\sqrt{3}$ kN T

$\Sigma F_x = 0: 13\frac{\sqrt{3}}{2} - AB + 5\sqrt{3}\left(\frac{1}{2}\right) = 0$

$AB = 9\sqrt{3}$ kN C

Joint E:



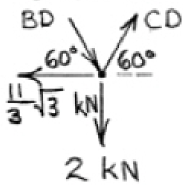
$\Sigma F_y = 0: 5\sqrt{3}\frac{\sqrt{3}}{2} - 4 - BE\frac{\sqrt{3}}{2} = 0$

$BE = \frac{7}{3}\sqrt{3}$ kN C

$\Sigma F_x = 0: -5\sqrt{3}\left(\frac{1}{2}\right) - \frac{7}{3}\sqrt{3}\left(\frac{1}{2}\right) + DE = 0$

$DE = \frac{11}{3}\sqrt{3}$ kN T

Joint D:

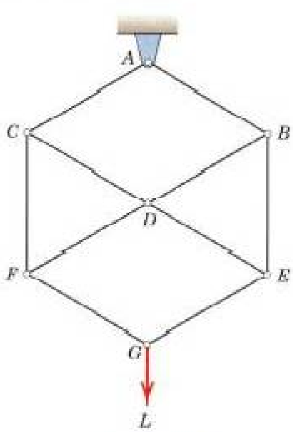


$\Sigma F_x = 0: BD\left(\frac{1}{2}\right) + CD\left(\frac{1}{2}\right) - \frac{11}{3}\sqrt{3} = 0$

$\Sigma F_y = 0: -BD\frac{\sqrt{3}}{2} + CD\frac{\sqrt{3}}{2} - 2 = 0$

$\Rightarrow \begin{cases} CD = \frac{13}{3}\sqrt{3} \text{ kN} & T \\ BD = 3\sqrt{3} \text{ kN} & C \end{cases}$

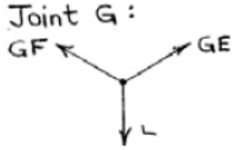
4/10 Solve for the forces in members *BE* and *BD* of the truss which supports the load *L*. All interior angles are 60° or 120°.



Problem 4/10

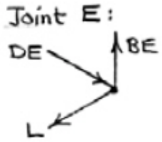
4/10

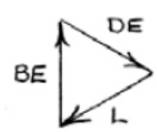
Joint G:



GE = GF = L C

Joint E:

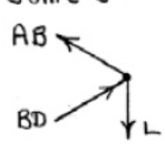


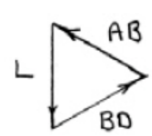


BE = L T

DE = L C

Joint B:



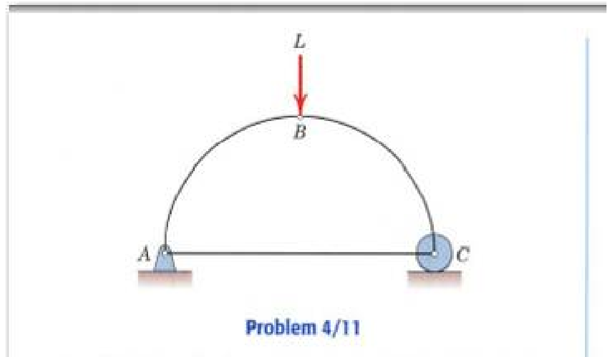


BD = L C

AB = L T

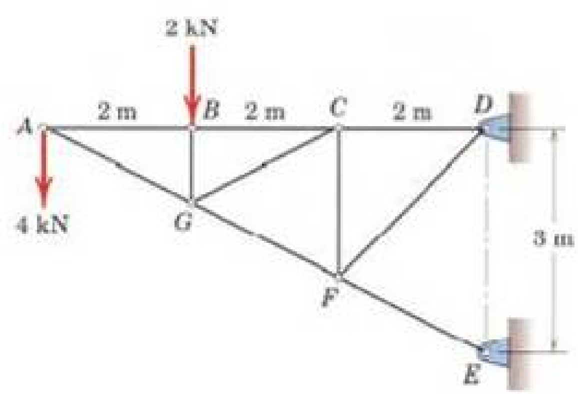
4/11 Determine the force in member AC of the loaded truss. The two quarter-circular members act as two-force members.

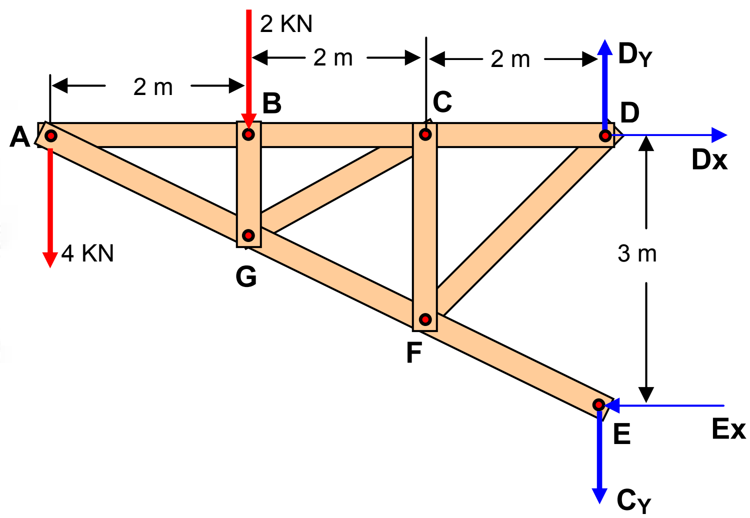
Ans. $AC = \frac{L}{2}T$



Problema 4.7 Estática Meriam edición tres; Problema 4.12 Estática Meriam edición cinco

Calcular las fuerzas en los miembros CG y CF de la armadura representada





$\Sigma M_E = 0$

$4\,(2 + 2 + 2) + 2\,(2 + 2) - D_X\,(3) = 0$

$4\,(6) + 2\,(4) - D_X\,(3) = 0$

$24 + 8 - 3\,D_X = 0$

$32 - 3\,D_X = 0$

$3\,D_X = 32$

$$D_X = \frac{32}{3} = 10{,}666\ \text{KN}$$

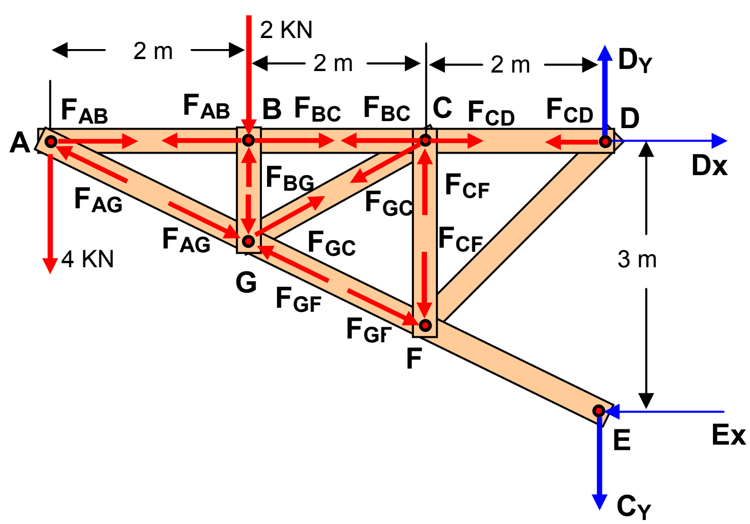
D_X = 10,666 KN

$\Sigma F_X = 0$

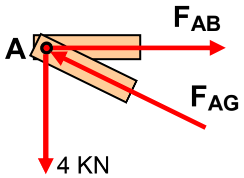
$D_X - E_X = 0$

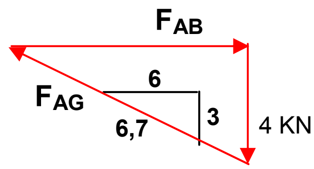
$E_X = D_X$

E_X =10,666 KN



NUDO A





Hallar F_{AG}

$$\frac{F_{AB}}{6} = \frac{F_{AG}}{6{,}7} = \frac{4}{3}$$

$$\frac{F_{AG}}{6{,}7} = \frac{4}{3}$$

$$F_{AG} = \frac{(6{,}7)4}{3} = 8{,}94 \text{ KN}$$

F_{AG} = 8,94 KN (compresion)

Las ecuaciones de equilibrio para la junta A son:

$$\frac{F_{AB}}{6} = \frac{F_{AG}}{6{,}7} = \frac{4}{3}$$

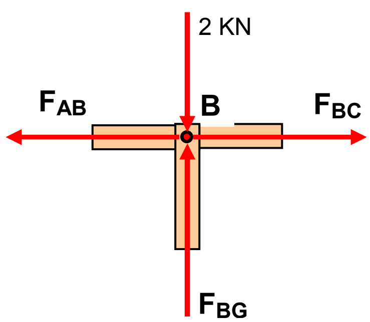
Hallar F_{AB}

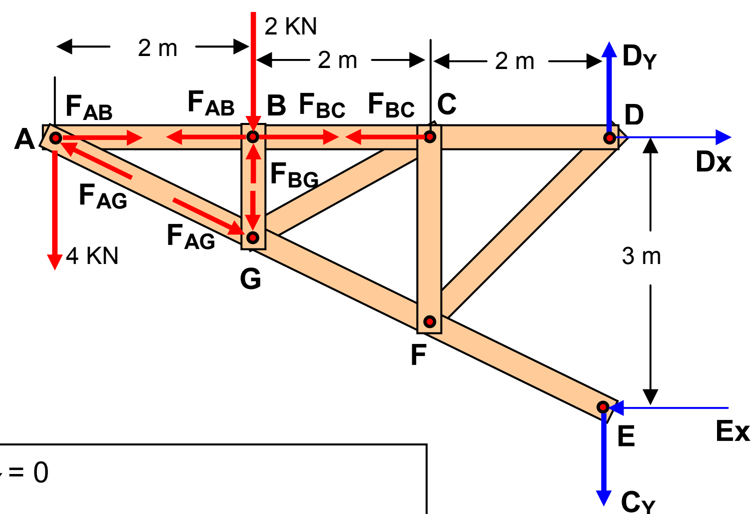
$$\frac{F_{AB}}{6} = \frac{4}{3}$$

$$F_{AB} = \frac{(4)6}{3} = 8 \text{ KN}$$

F_{AB} = 8 KN (tensión)

NUDO B





$\sum F_X = 0$

$F_{BC} - F_{AB} = 0$

$F_{BC} = F_{AB}$

PERO: F_{AB} = 8 KN (tensión)

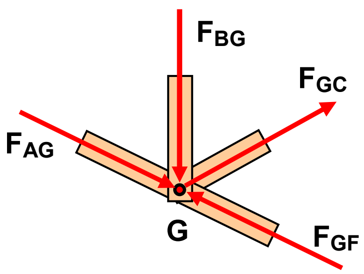
F_{BC} = 8 KN (tensión)

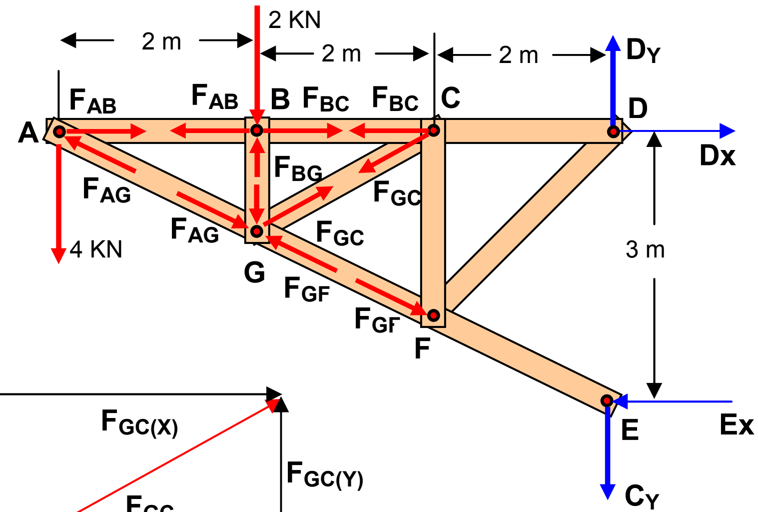
$\sum F_Y = 0$

$F_{BG} - 2 = 0$

F_{BG} = 2 KN (compresión)

NUDO G

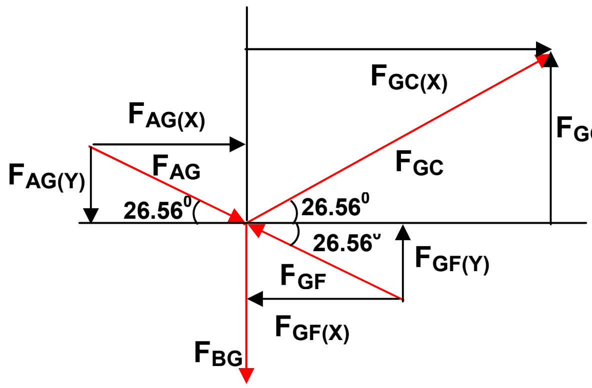




$$\mathrm{tg}\,\theta = \frac{3}{6} = 0{,}5$$

Ɵ = arc tg (0,5)

Ɵ = $26{,}56^{0}$



$$\mathrm{sen}\ 26{,}56 = \frac{F_{GF(Y)}}{F_{GF}}$$

$F_{GF(Y)} = F_{GF}$ sen 26,56

$$\mathrm{sen}\ 26{,}56 = \frac{F_{GC(Y)}}{F_{GC}}$$

$F_{GC(Y)} = F_{GC}$ sen 26,56

$$\mathrm{sen}\ 26{,}56 = \frac{F_{AG(Y)}}{F_{AG}}$$

$F_{AG(Y)} = F_{AG}$ sen 26,56

$$\cos 26{,}56 = \frac{F_{GF(X)}}{F_{GF}}$$

$F_{GF\,(X)} = F_{GF}$ cos 26,56

$$\cos 26{,}56 = \frac{F_{GC(X)}}{F_{GC}}$$

$F_{GC\,(X)} = F_{GC}$ cos 26,56

$$\cos 26{,}56 = \frac{F_{AG(X)}}{F_{AG}}$$

$F_{AG\,(X)} = F_{AG}$ cos 26,56

$\sum F_Y = 0$

$F_{GC\,(Y)} + F_{GF\,(Y)} - F_{AG\,(Y)} - F_{BG} = 0$

PERO:

$F_{GC(Y)} = F_{GC}$ sen 26,56

$F_{GF(Y)} = F_{GF}$ sen 26,56

F_{BG} = 2 KN (compresión)

$F_{AG(Y)} = F_{AG}$ sen 26,56

F_{AG} = 8,94 KN (compresion)

$F_{AG\,(Y)}$ = (8,94) sen 26,56

$F_{AG\,(Y)}$ = (8,94) (0,4471)

$F_{AG\,(Y)}$ = 4 KN

$F_{GC\,(Y)} + F_{GF\,(Y)} - F_{AG\,(Y)} - F_{BG} = 0$

$F_{GC\,(Y)} + F_{GF\,(Y)} - 4 - 2 = 0$

$F_{GC\,(Y)} + F_{GF\,(Y)} - 6 = 0$

$F_{GC\,(Y)} + F_{GF\,(Y)} = 6$

$0{,}4471\ F_{GC} + 0{,}4471\ F_{GF} = 6$
(Ecuación 2)

$\sum F_X = 0$

$F_{GC\,(X)} + F_{AG\,(X)} - F_{GF\,(X)} = 0$

PERO:

$F_{GC\,(X)} = F_{GC}$ cos 26,56

$F_{GF\,(X)} = F_{GF} \cos 26{,}56$

$F_{AG\,(X)} = F_{AG} \cos 26{,}56$
$F_{AG} = 8{,}94$ KN (compresion)

$F_{AG\,(X)} = F_{AG} \cos 26{,}56$
$\mathbf{F_{AG\,(X)} = (8{,}94) \cos 26{,}56}$

$F_{GC\,(X)} + F_{AG\,(X)} - F_{GF\,(X)} = 0$

$F_{GC} \cancel{\cos 26{,}56} + (8{,}94) \cancel{\cos 26{,}56} - F_{GF} \cancel{\cos 26{,}56} = 0$

$F_{GC} + 8{,}94 - F_{GF} = 0$
$F_{GC} - F_{GF} = -\,8{,}94$ (Ecuación 1)

Resolver las ecuaciones

$F_{GC} - F_{GF} = -\,8{,}94 \quad (-0{,}4471)$
$0{,}4471\, F_{GC} + 0{,}4471\, F_{GF} = 6$

$\cancel{-0{,}4471\, F_{GC}} + 0{,}4471\, F_{GF} = 4$
$\cancel{0{,}4471\, F_{GC}} + 0{,}4471\, F_{GF} = 6$

$0{,}4471\, F_{GF} + 0{,}4471\, F_{GF} = 4 + 6$

$0{,}8942\, F_{GF} = 10$

$$F_{GF} = \frac{10}{0{,}8942} = 11{,}18 \text{ KN}$$

$F_{GF} = 11{,}18$ KN (compresion)

Reemplazar la ecuación 1

$F_{GC} - F_{GF} = -\,8{,}94$ (Ecuación 1)

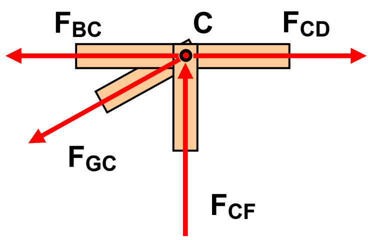
Pero: $F_{GF} = 11{,}18$ KN

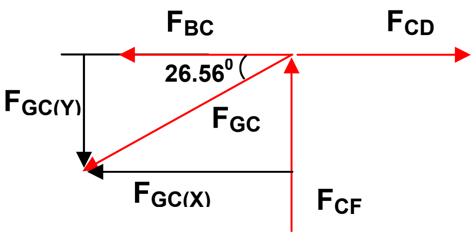
$F_{GC} - 11{,}18 = -\,8{,}94$

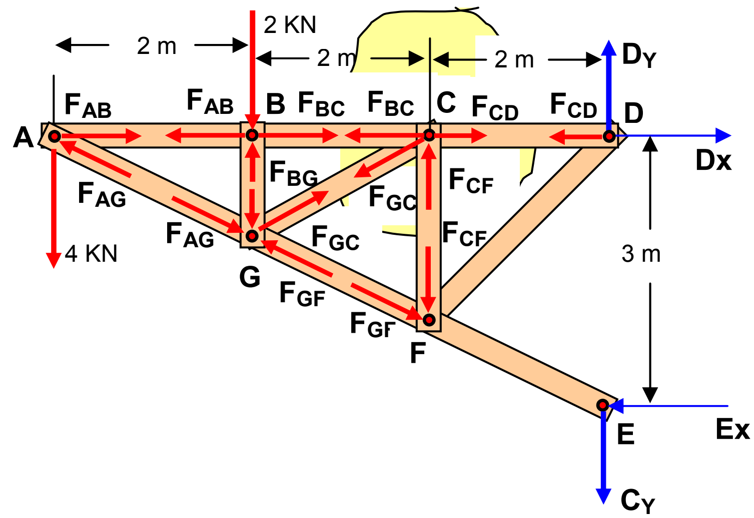
$F_{GC} = 11{,}18 - 8{,}94$

$F_{GC} = 2{,}24$ KN (tensión)

NUDO C







PERO:

F_{BC} = 8 KN

F_{GC} = 2,24 KN

$$\cos 26{,}56 = \frac{F_{GC}(X)}{F_{GC}}$$

$F_{GC\,(X)} = F_{GC} \cos 26{,}56$

$F_{GC\,(X)} = (2{,}24) \cos 26{,}56$

$F_{GC\,(X)} = (2{,}24)\ 0{,}8944$

$F_{GC\,(X)} = 2$ KN

$$\operatorname{sen} 26{,}56 = \frac{F_{GC}(Y)}{F_{GC}}$$

$F_{GC\,(Y)} = F_{GC} \operatorname{sen} 26{,}56$

$F_{GC\,(Y)} = (2{,}24) \operatorname{sen} 26{,}56$

$F_{GC\,(Y)} = (2{,}24)\ 0{,}4471$

$F_{GC\,(Y)} = 1$ KN

$\sum F_X = 0$

$F_{CD} - F_{BC} - F_{GC\,(X)} = 0$

PERO:

F_{BC} = 8 KN

$F_{GC\,(X)}$ = 2 KN

$F_{CD} - F_{BC} - F_{GC\,(X)} = 0$

$F_{CD} - 8 - 2 = 0$

$F_{CD} - 10 = 0$

F_{CD} = 10 kN (tensión)

$\sum F_Y = 0$

$F_{CF} - F_{GC\,(Y)} = 0$

$F_{CF} = F_{GC\,(Y)}$

PERO:

$F_{GC\,(Y)}$ = 1 KN

F_{CF} = 1 KN (compresión)

4/12 Joint A

$\theta = \tan^{-1} 1/2 = 26.57°$

$\sin\theta = 1/\sqrt{5}$, $\cos\theta = 2/\sqrt{5}$

$\Sigma F_y = 0$; $AG/\sqrt{5} - 4 = 0$

$AG = 4\sqrt{5}$ kN C

$\Sigma F_x = 0$; $AB - 4\sqrt{5}(2/\sqrt{5}) = 0$

$AB = 8$ kN T

Joint B: 8 kN, 2 kN, $BC = 8$ kN, $BG = 2$ kN

Joint G: 2 kN, $4\sqrt{5}$ kN, GC, GF

$\Sigma F_{y'} = 0$; $2\left(\frac{2}{\sqrt{5}}\right) - CG \sin 2\theta = 0$

$CG = \frac{4}{\sqrt{5}} \frac{1}{0.8} = 2.24$ kN T

$\Sigma F_{x'} = 0$; $2.24 \cos 2\theta + 2/\sqrt{5} + 4\sqrt{5} - GF = 0$

$GF = 5\sqrt{5} = 11.18$ kN C

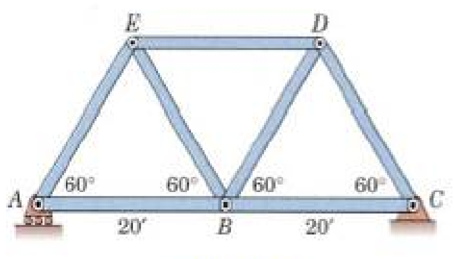
Joint C: 2 kN, CD, 2.24 kN, CF

$\Sigma F_y = 0$; $CF - 2.24 \sin\theta = 0$

$CF = 1.00$ kN C

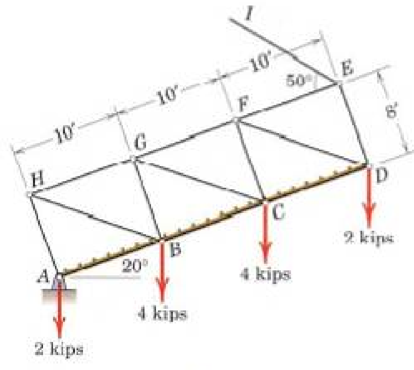
4/13 Each member of the truss is a uniform 20-ft bar weighing 400 lb. Calculate the average tension or compression in each member due to the weights of the members.

Ans. $AB = BC = 1000/\sqrt{3}$ lb T
$AE = CD = 2000/\sqrt{3}$ lb C
$BD = BE = 800/\sqrt{3}$ lb T
$ED = 1400/\sqrt{3}$ lb C



Problem 4/13

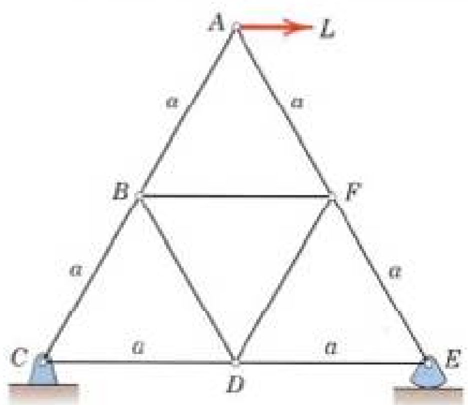
4/14 A drawbridge is being raised by a cable EI. The four joint loadings shown result from the weight of the roadway. Determine the forces in members EF, DE, DF, CD, and FG.



Problem 4/14

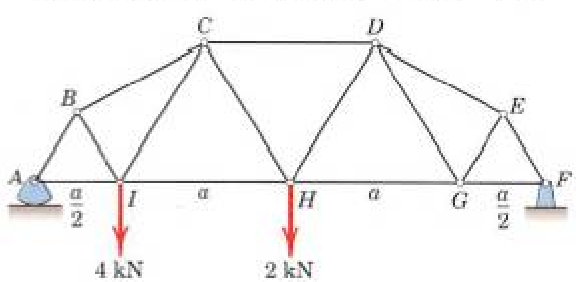
4/15 The equiangular truss is loaded and supported as shown. Determine the forces in all members in terms of the horizontal load L.

Ans. $AB = BC = L\ T$, $AF = EF = L\ C$
$DE = CD = L/2\ T$, $BF = DF = BD = 0$



Problem 4/15

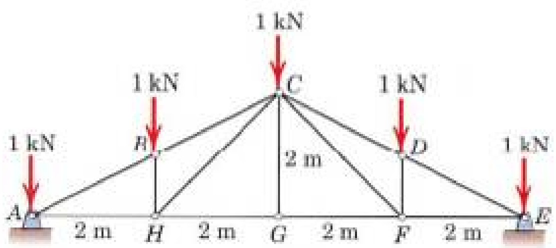
4/16 Determine the forces in members BI, CI, and HI for the loaded truss. All angles are 30°, 60°, or 90°.



Problem 4/16

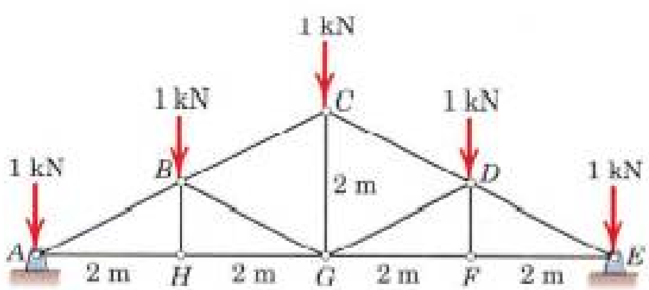
4/17 A snow load transfers the forces shown to the upper joints of a Pratt roof truss. Neglect any horizontal reactions at the supports and solve for the forces in all members.

Ans. $AB = DE = BC = CD = 3.35$ kN C
$AH = EF = 3$ kN T, $BH = DF = 1$ kN C
$CF = CH = 1.414$ kN T, $FG = GH = 2$ kN T



Problem 4/17

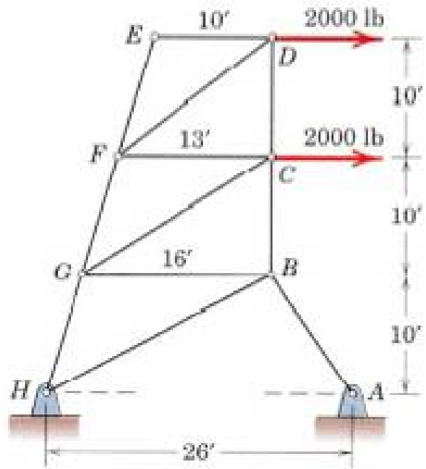
4/18 The loading of Prob. 4/17 is shown applied to a Howe roof truss. Neglect any horizontal reactions at the supports and solve for the forces in all members. Compare with the results of Prob. 4/17.



Problem 4/18

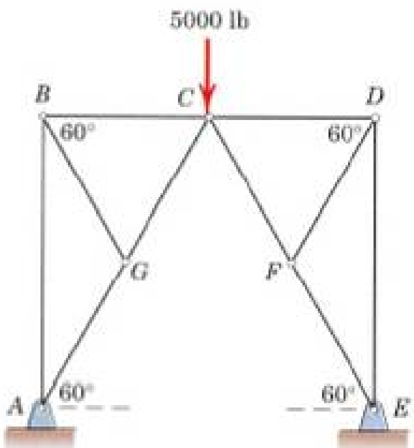
4/19 Calculate the forces in members *CF*, *CG*, and *EF* of the loaded truss.

Ans. $CF = 1538$ lb C, $CG = 4170$ lb T, $EF = 0$



Problem 4/19

4/20 Determine the force in each member of the pair of trusses which support the 5000-lb load at their common joint *C*.



Problem 4/20

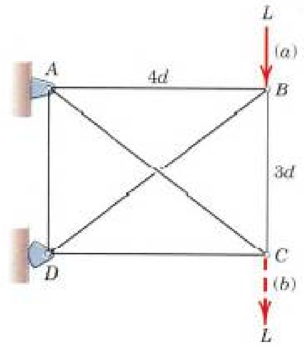
4/21 The rectangular frame is composed of four perimeter two-force members and two cables AC and BD which are incapable of supporting compression. Determine the forces in all members due to the load L in position (a) and then in position (b).

Ans. (a) $AB = AD = BD = 0$, $BC = L\ C$

$AC = \frac{5L}{3}\ T$, $CD = \frac{4L}{3}\ C$

(b) $AB = AD = BC = BD = 0$

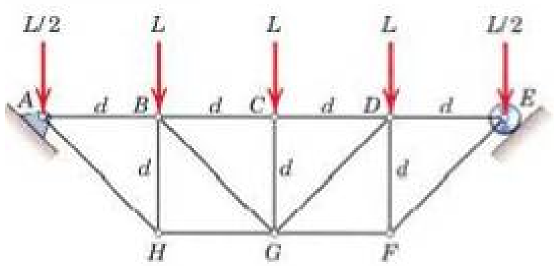
$AC = \frac{5L}{3}\ T$, $CD = \frac{4L}{3}\ C$



Problem 4/21

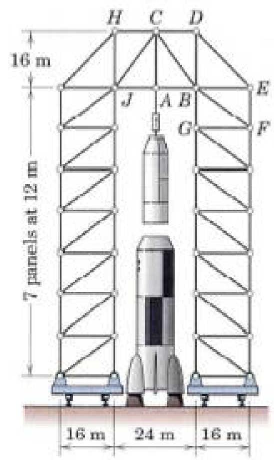
Problema 4.22 Estática Meriam edición cinco

Determine the forces in members AB, CG, and DE of the loaded truss



4/23 The movable gantry is used to erect and prepare a 500-Mg rocket for firing. The primary structure of the gantry is approximated by the symmetrical plane truss shown, which is statically indeterminate. As the gantry is positioning a 60-Mg section of the rocket suspended from A, strain-gage measurements indicate a compressive force of 50 kN in member AB and a tensile force of 120 kN in member CD due to the 60-Mg load. Calculate the corresponding forces in members BF and EF.

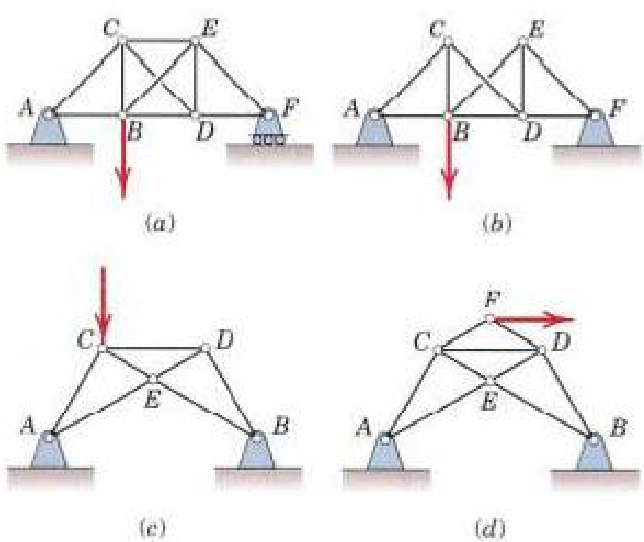
Ans. BF = 188.4 kN C, EF = 120 kN T



Problem 4/23

Problema 4.24 Estática Meriam edición cinco

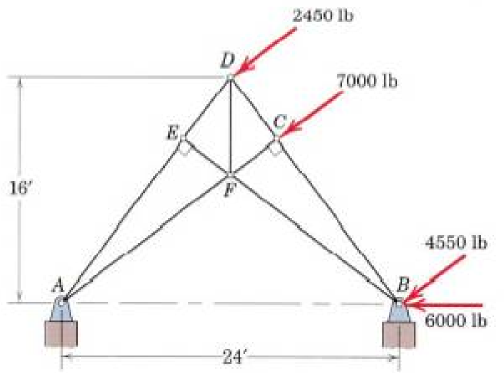
Verify the fact that each of redundancy and prpose two separate changes, either one of which would remove the redundancy and produce complete statical determinacy. All members can support compression as well as tension.



Problema 4.25 Estática Meriam edición cinco

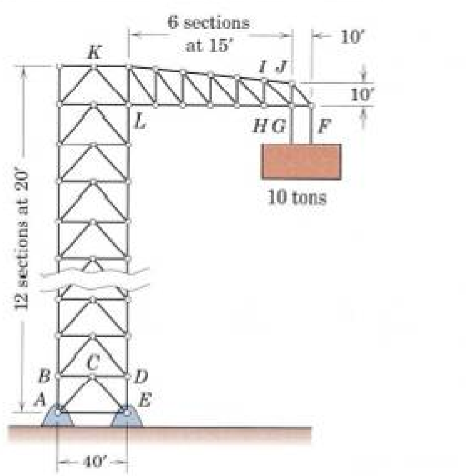
4/25 Analysis of the wind acting on a small Hawaiian church, which withstood the 165-mi/hr winds of Hurricane Iniki in 1992, showed the forces transmitted to each roof truss panel to be as shown. Treat the structure as a symmetrical simple truss and neglect any horizontal component of the support reaction at A. Identify the truss member which supports the largest force, tension or compression, and calculate this force.

Ans. FD = 24,500 lb T



Problem 4/25

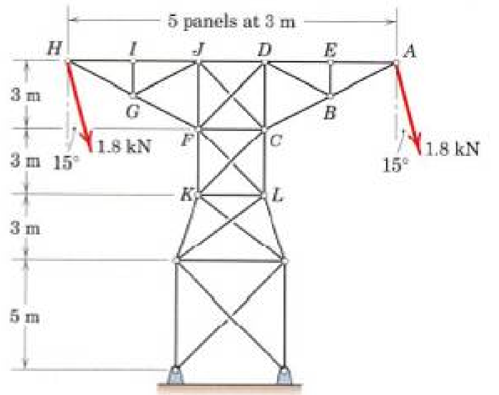
4/26 The 240-ft structure is used to provide various support services to launch vehicles prior to liftoff. In a test, a 10-ton weight is suspended from joints F and G, with its weight equally divided between the two joints. Determine the forces in members GJ and GI. What would be your path of joint analysis for members in the vertical tower, such as AB or KL?



Problem 4/26

▸ **4/27** The tower for a transmission line is modeled by the truss shown. The crossed members in the center sections of the truss may be assumed to be capable of supporting tension only. For the loads of 1.8 kN applied in the vertical plane, compute the forces induced in members *AB*, *DB*, and *CD*.

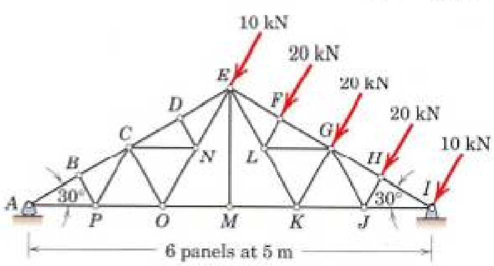
Ans. $AB = 3.89$ kN C, $DB = 0$, $CD = 0.932$ kN C



Problem 4/27

▸ **4/28** Find the forces in members *EF*, *KL*, and *GL* for the Fink truss shown.

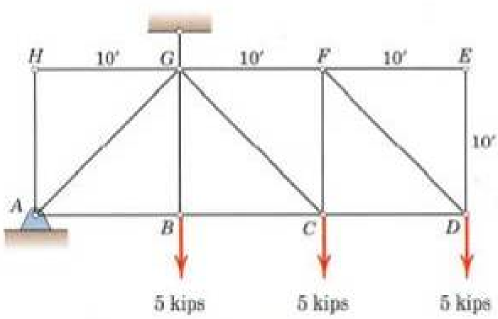
Ans. $EF = 75.1$ kN C, $KL = 40$ kN T
$GL = 20$ kN T



Problem 4/28

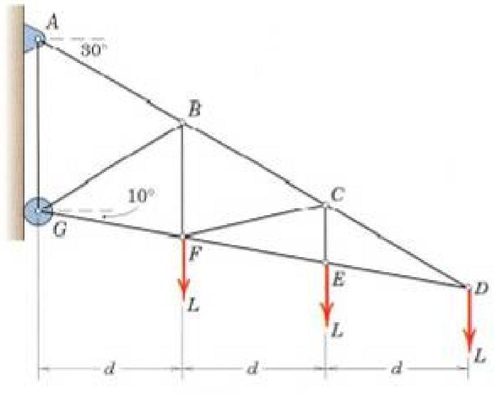
4/29 Determine the force in member *CG*.

Ans. $CG = 14.14$ kips T



Problem 4/29

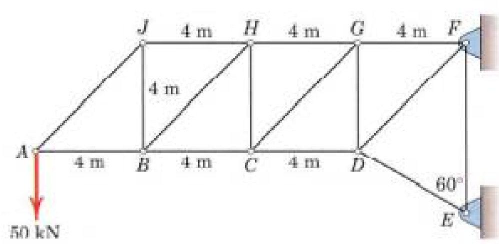
4/30 Determine the forces in members *BC*, *CF*, and *EF* of the loaded truss.



Problem 4/30

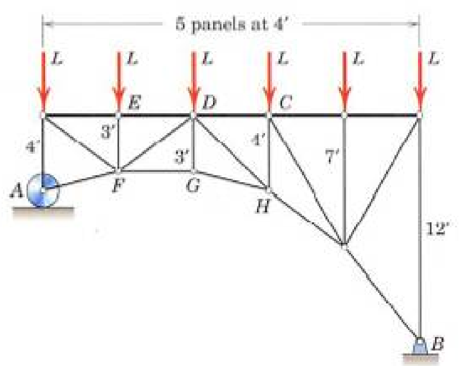
4/31 Determine the forces in members *GH* and *CG* for the truss loaded and supported as shown. Does the statical indeterminacy of the supports affect your calculation?

Ans. $CG = 70.7$ kN *T*, $GH = 100$ kN *T*, No



Problem 4/31

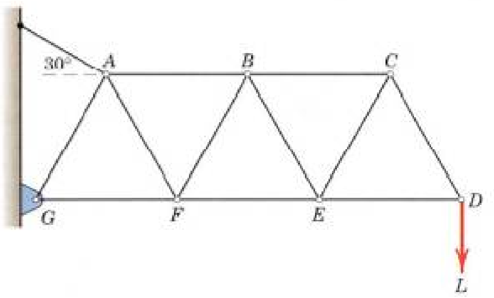
4/32 Determine the force in member *DG* of the loaded truss.



Problem 4/32

4/33 Determine the forces in members BC, BE, and BF. The triangles are equilateral.

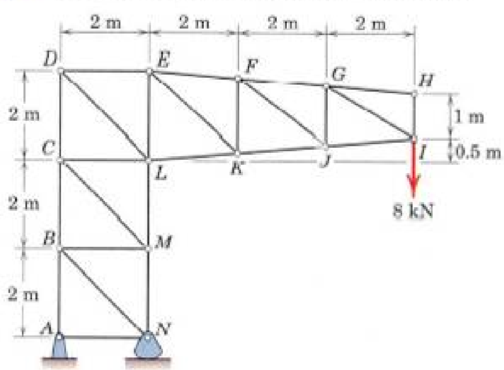
Ans. $BC = BE = \dfrac{2L}{\sqrt{3}}\ T,\ BF = \dfrac{2L}{\sqrt{3}}\ C$



Problem 4/33

Representative Problems

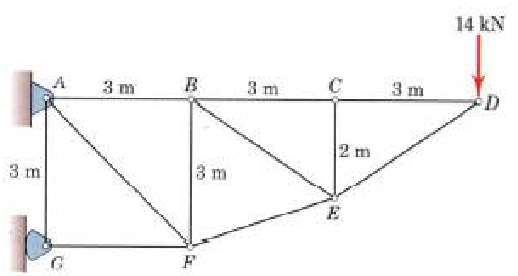
4/34 Determine the forces in members DE and DL.



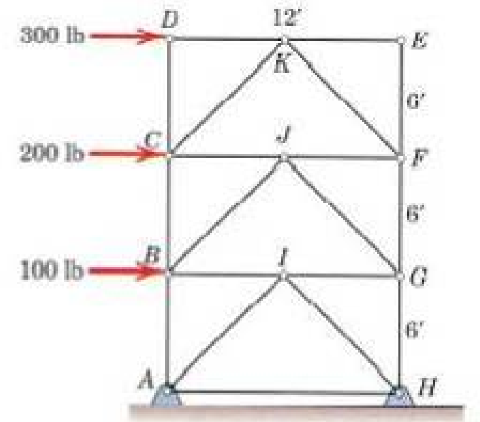
Problem 4/34

4/35 Calculate the forces in members BC, BE, and EF. Solve for each force from an equilibrium equation which contains that force as the only unknown.

Ans. $BC = 21$ kN T, $BE = 8.41$ kN T
$EF = 29.5$ kN C

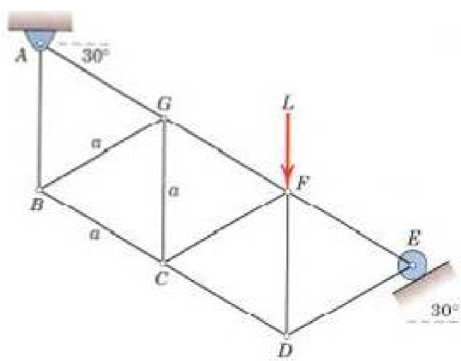


Problema 4.36 Estática Meriam edición cinco
Determine the forces in members BC and FG of the loaded symmetrical truss. Show that this calculation can be accomplished by using one section and two equations, each of wich contains only one of the two unknowns. Arc the results affected by the statical indeterminacy of the supports at the base?



Problema 4.37 Estática Meriam edición cinco

The truss is composed of equilateral triangles of side a and is supported and loaded as shown. Determine the forces in members BC and CG.



Problema 4.38 Estática Meriam edición cinco

The truss shown is composed of 45^0 right triangles. The crossed members in the center two panels are slender tie rods incapable of supporting compression. Retain the two rods wich are under tension and compute the magnitudes of their tensions. Also find the force in member MN.