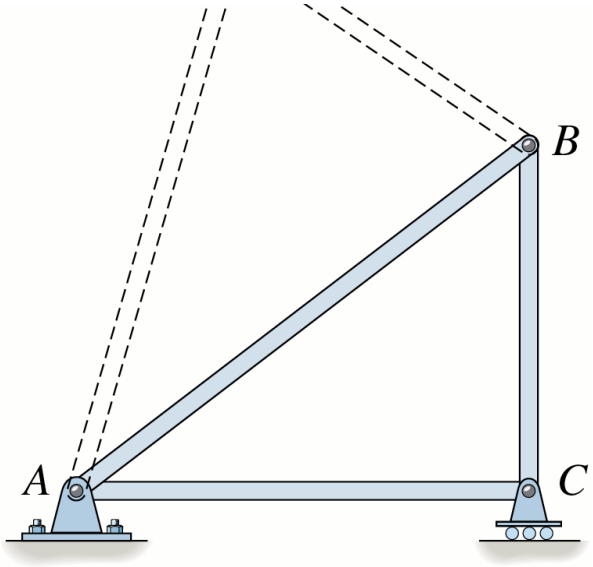
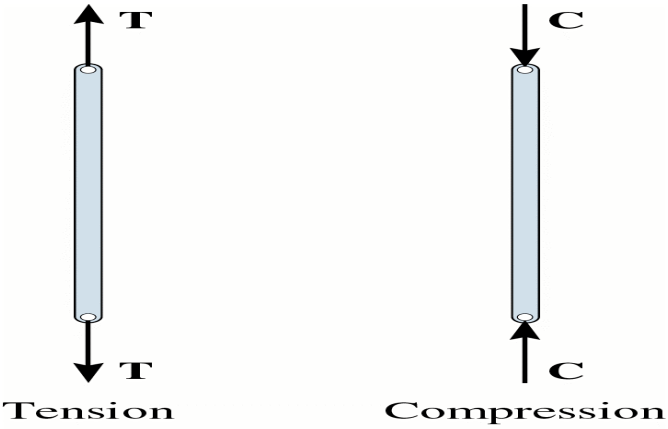
STATİK

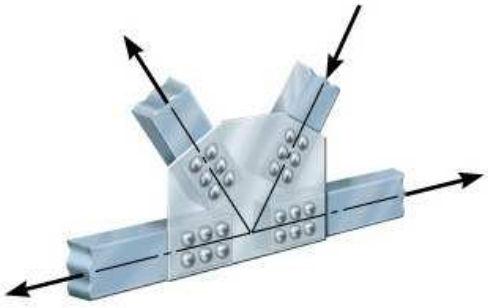
Kafes Kirişler:

Düzlem Kafes Sistem

Kafes system: bütün çubuklar mafsal ile birleşmiş taşıyıcı sistemdir

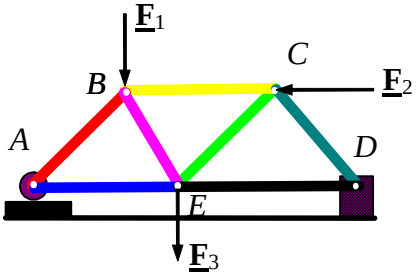






(a)

(b)



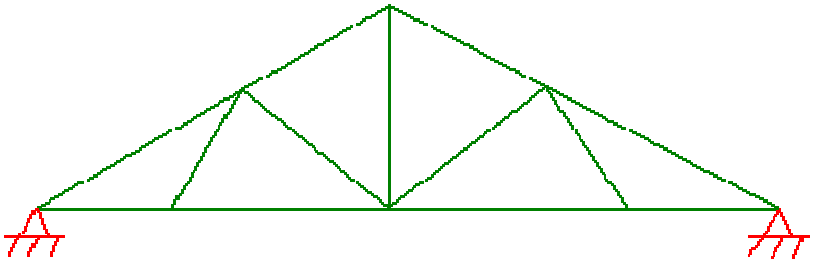
Rijitlik koşulu
c=2d-m gerek şart yeterli değil
c:toplam çubuk sayısı
d: düğüm noktası sayısı
m:mesnet tepkisi sayısı
(m=3)

-hem içten hem dıştan tam bağlı
-içten tam bağlı dıştan eksik bağlı
-İçten tam bağlı dıştan fazla bağlı
-içten fazla bağlı dıştan tam bağlı
-içten fazla bağlı dıştan eksik bağlı
-hem içten hem dıştan fazla bağlı
-içten eksik bağlı dıştan tam bağlı
-içten eksik bağlı dıştan fazla bağlı
-hem içten hem dıştan eksik bağlı

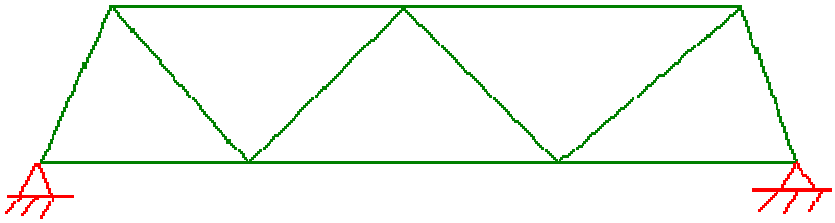
Trusses consist of straight members connected at joints by pins. Members (bars) exist from joint to joint (pin -- pin).

Typical examples:

Roof truss on a house.



R.R.bridge



Assumptions:

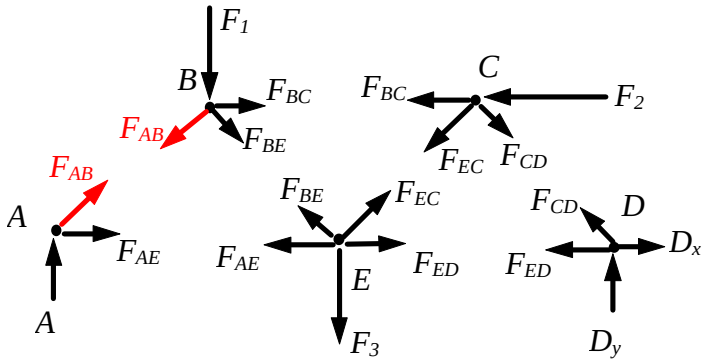
(1). All loads applied at joints including weight.
(2). All joints are pinned.

5.2 Kafes Sistemlerde denge:

Kafes sistemlerin çözüm yöntemi
-Düğüm noktaları yöntemi
-Kesim yöntemi (Ritter Yöntemi)
-Çubuk değiştirme (Henneberg) yöntemi

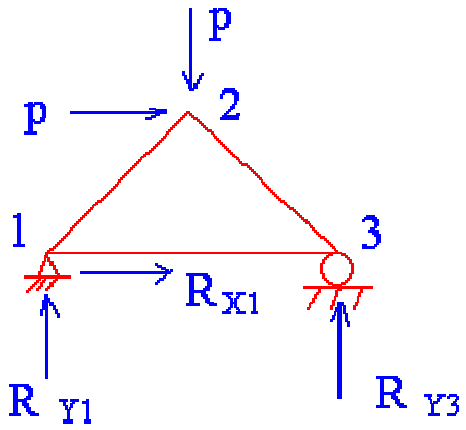
Düğüm noktası yöntemi
Her düğüm noktasına 2 denklem yazılarak hesaplanabilir

$$\sum F_x = 0, \sum F_y = 0$$

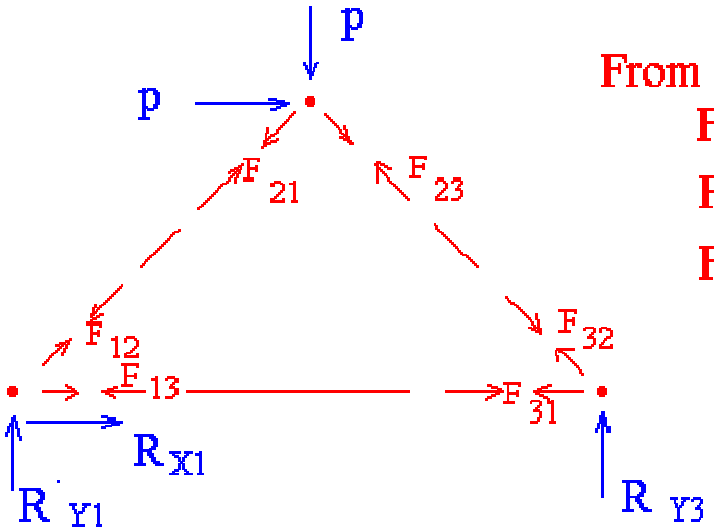

F1
B
FBC
FAB
FBE
C
FBC
F2
FEC
FCD
FAB
A
FAE
A
FBE
FEC
FAE
FED
E
F3
FCD
D
Dx
FED
Dy

A truss is rigid when it is formed from a triangle and is added to by 2 members and a joint.

Analysis by methods of joints:



Break out joints and members (bars).



From 2 forces body:

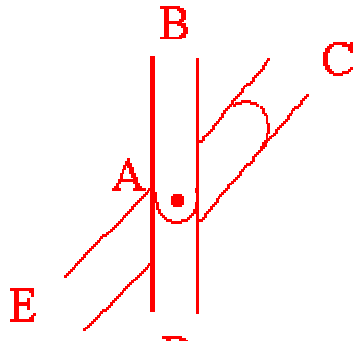
$$F_{21} = F_{12}$$
$$F_{13} = F_{31}$$
$$F_{23} = F_{32}$$

Now each joint must be in equilibrium

$$\sum F_x = 0 \quad \& \quad \sum F_y = 0$$

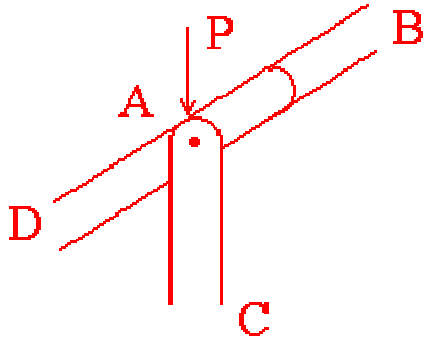
So, total EQNS =2n n = # of joints

5.3 Özel Durumlar



From examination

$F_{AC} = F_{AE}$ & $F_{AB} = F_{AD}$



$F_{AB} = F_{AD}$ & $F_{AC} = P$

If P=0, F_{AC}=0 and bar AC is called a zero-force member.

The total number of EQNS from $\sum F_X$ & $\sum F_Y$ =2j.

Total number of unknows = b + r

where b = # of bars

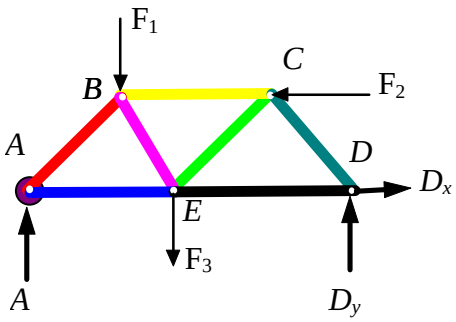
r = # of reactions

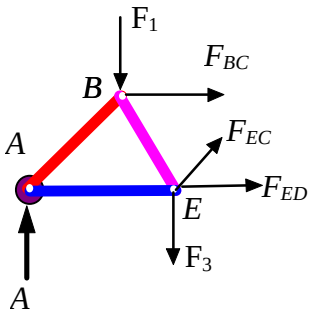
So, If 2j = b + r, we can solve the problem.

(Statically determinate)

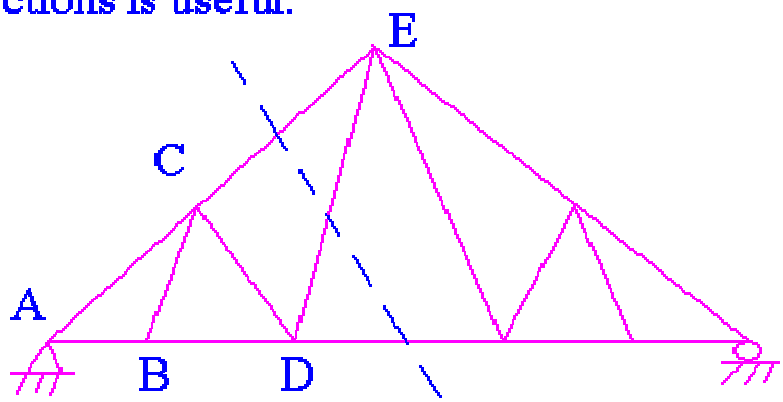
5.4 Kesim Yöntemiyle hesap :

Kesim Yöntemi:

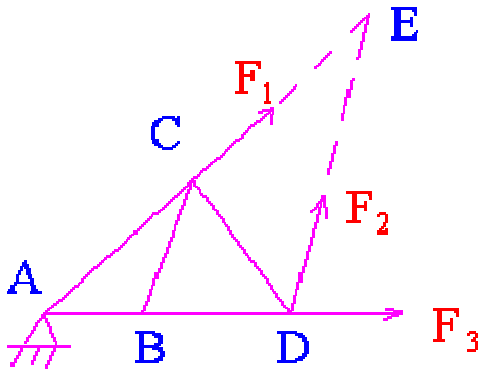




The method of joints is useful when every bar force must be determined. However, this method is very tedious if the forces of just a few bars are required in a large truss. This is where the method of sections is useful.



Find forces in bars 1,2,3.(Hard by method of joints.)



Now this body must be in equil.

$\sum F_X = 0 \qquad \sum F_Y = 0 \qquad \sum F_Z = 0$

For this problem I would use

$$\sum M_E = 0 \Rightarrow F_3$$

$$\sum M_A = 0 \Rightarrow F_2$$

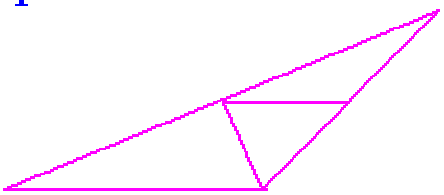
$$\sum M_D = 0 \Rightarrow F_1$$

5.5 Kafes sistemin sınıflandırılması :

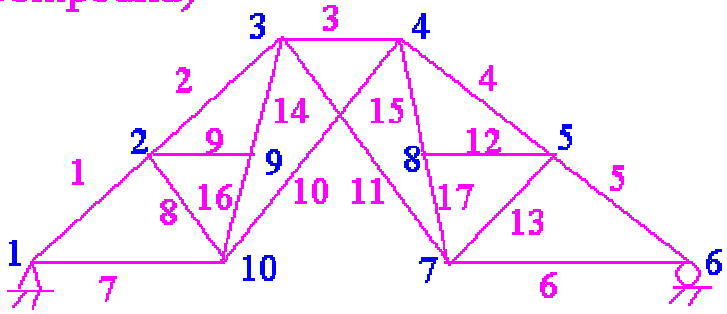
-Basit Kafes sistemler
-Bileşik kafes sistemler
-Karmaşık kafes sistemler

A truss made of triangles as discussed before is known as a simple truss. Simple trusses combined by 3 bars or a bar & a joint are still rigid and are known as a compound trusses.

Ex. (Simple)



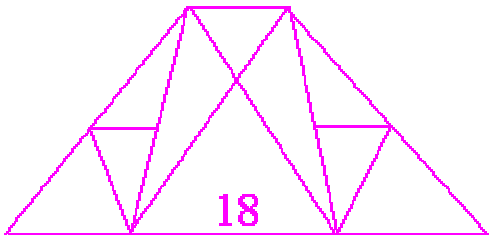
Ex. (Compound)



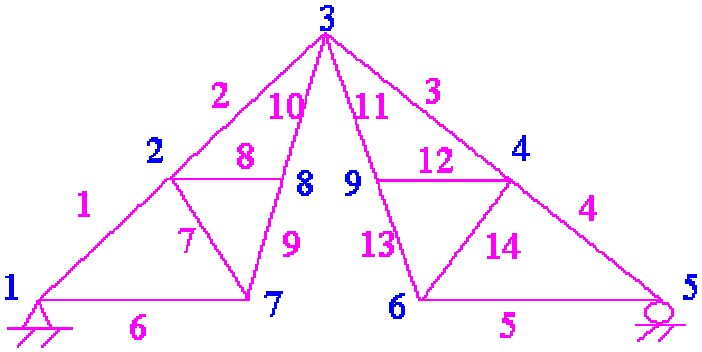
Again total EQNS = $2j = 2(10) = 20$
unknowns $= b + r = 17 + 3 = 20$ } DET

Now if $2j = b + r$ statically determinate
$2j < b + r$ statically indeterminate
$2j > b + r$ unstable

Ex. (Statically indet.)

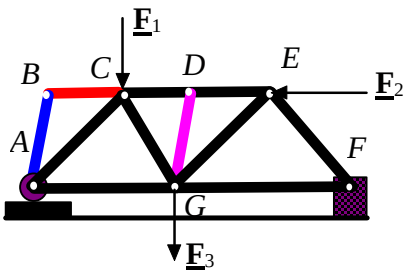


$2j = 20$
$b + r = 21$ } Stat. indet.

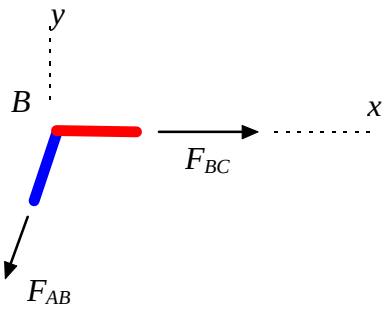


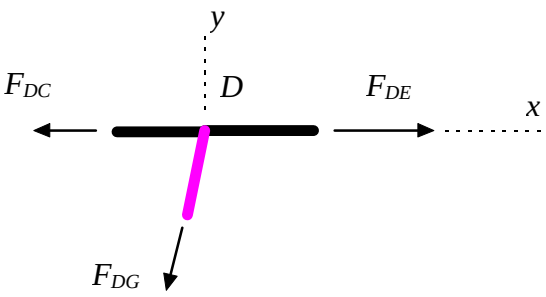
$2j = 18$
$b + r = 17$ } Unstable

Sıfır kuvvetler:

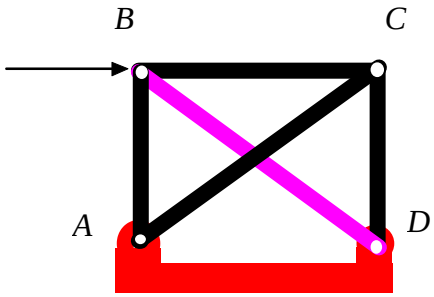


Aşağıdaki serbest cisim diyagramlarından sıfır kuvvetler hesaplanabilir.

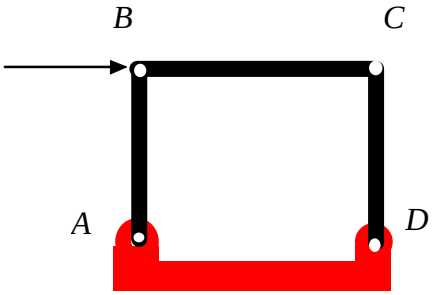




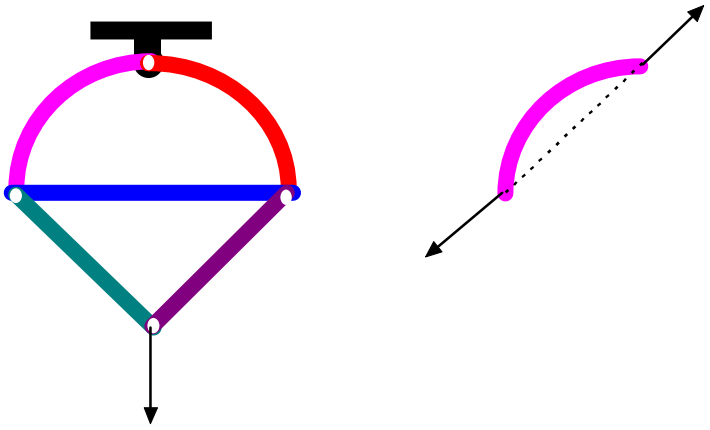
İçten fazla bağlı kafes system



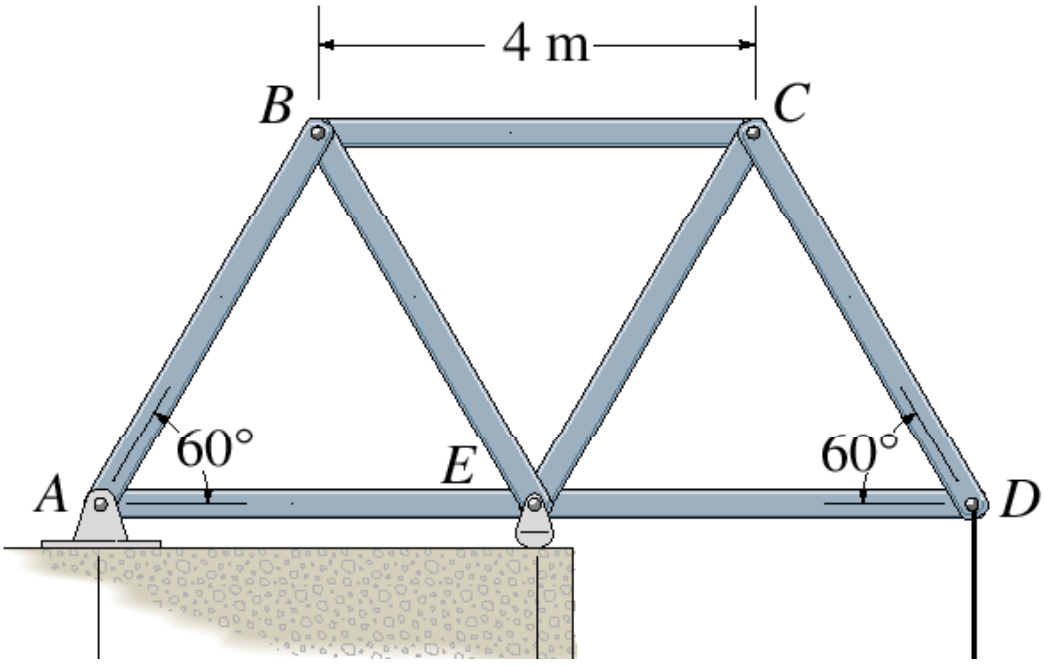
İçten eksik bağlı kafes sistem



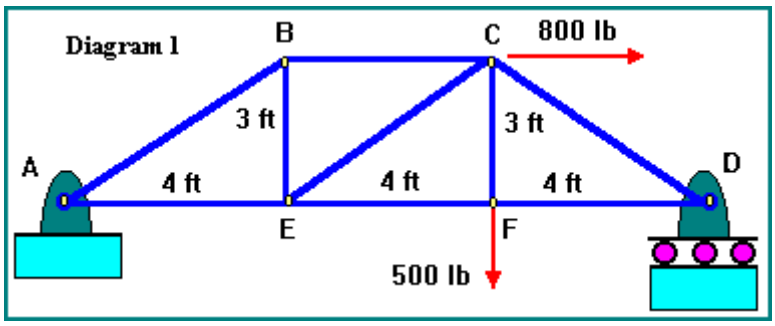
- **Eğrisel eleman**:



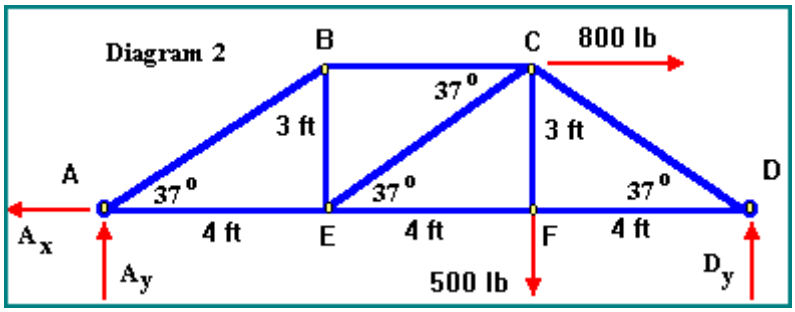
Örnek
Bilinenler
• A – sabit mesnet
• E – kayıcı
• max T çekme kuvveti = 8 kN
• max C basınç kuvveti = 6 kN
İstene:
• P Kuvveti



Örnek 1



Adım1 Serbest cisim diyagramı



Bağ kuvvetlerinin hesabı $\sum Fx = 0: \quad \sum Fy = 0: \quad \sum \tau_p = 0$

Bilinmeyenlerin hesabı

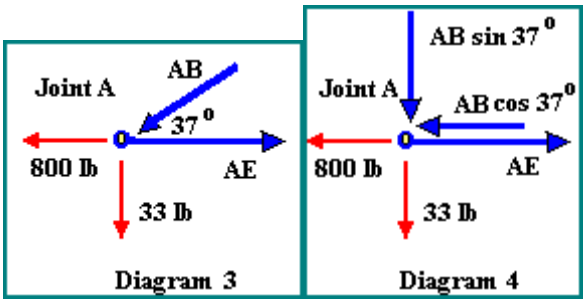
$\sum Fx = 0: \quad -Ax + 800\,lb = 0$

$\sum Fy = 0: \quad Ay + Dy - 500\,lb = 0$

$\sum \tau_A = 0: \quad Dy\,(12\,ft) - 500\,lb\,(8ft) - 800\,lb\,(3ft) = 0$

A_x = 800 lb, A_y = -33 lb, D_y = 533 lb

Adım 2 Kafes elemanlarının hesabı (Düğüm noktası yöntemi)



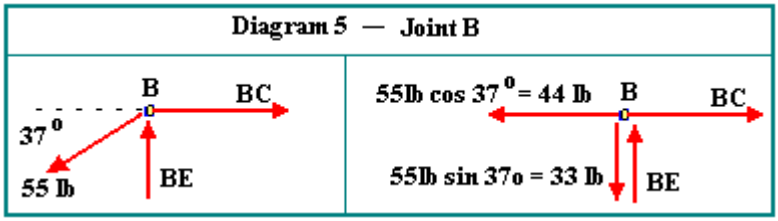
$\sum Fx = 0 \quad \sum Fy = 0$

$\sum Fx = 0: \quad -800\,lb - AB\cos 37^\circ + AE = 0$

$\sum Fy = 0: \quad -33\,lb \; - AB \sin 37^\circ = 0$

Çözüm: AE = 756 lb. (Tension), AB = -55 lb.

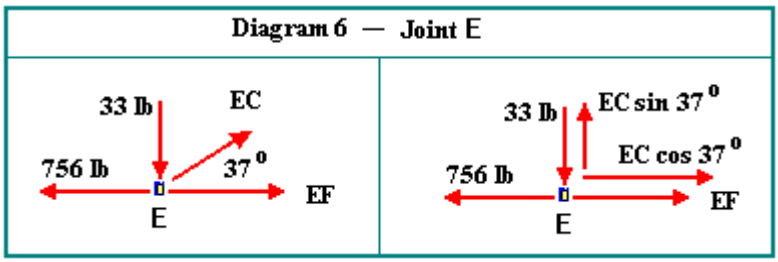
$\sum Fx = 0 \quad \sum Fy = 0$



$\sum Fx = 0: \quad -44\,lb \; - BC = 0$

$\sum Fy = 0: \quad -33\,lb + BE = 0$

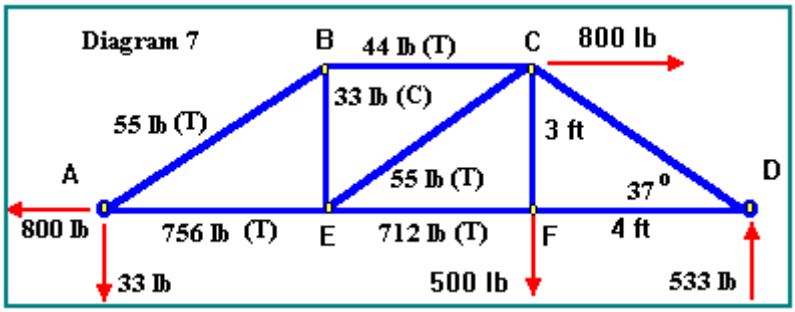
Çözüm : BC = 44 lb. (Çekme) BE = 33 lb. (Basınç)



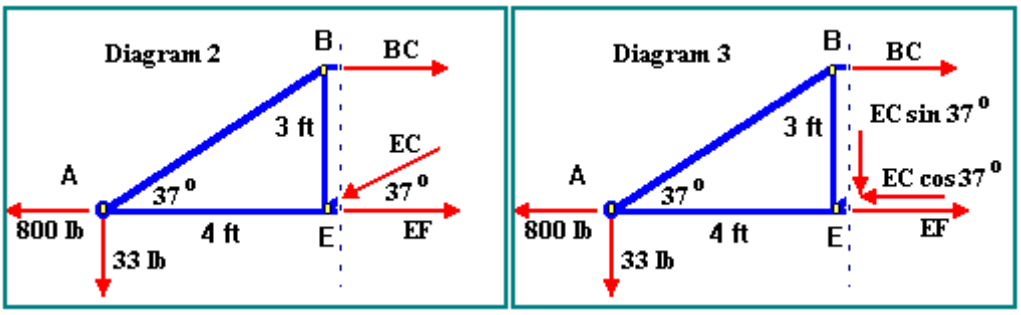
$\sum Fx = 0: \quad -756\,lb + EC \cos 37^\circ + EF = 0$

$\sum Fy = 0: \quad -33\,lb + EC \sin 37^\circ = 0$

Çözüm : EC = 55 lb. (Çekme) EF = 712 lb. (Çekme)



Adım 2 Kafes elemanlarının hesabı (Kesim yöntemi)



$$\sum Fx = 0: \quad \sum Fy = 0: \quad \sum \tau_P = 0$$

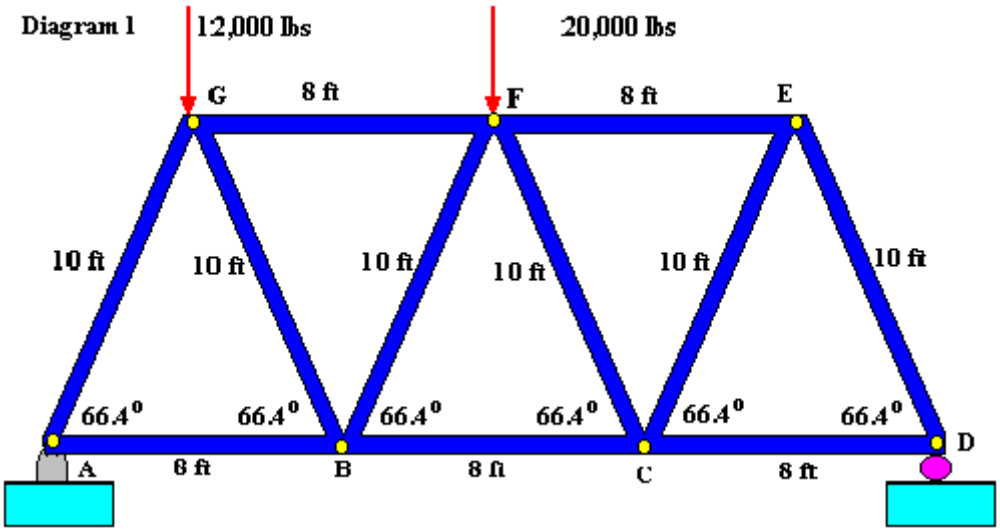
$$\sum Fx = 0: \quad -800\,lb + EF - EC \cos 37^\circ + BC = 0$$

$$\sum Fy = 0: \quad -33\,lb - EC \sin 37^\circ = 0$$

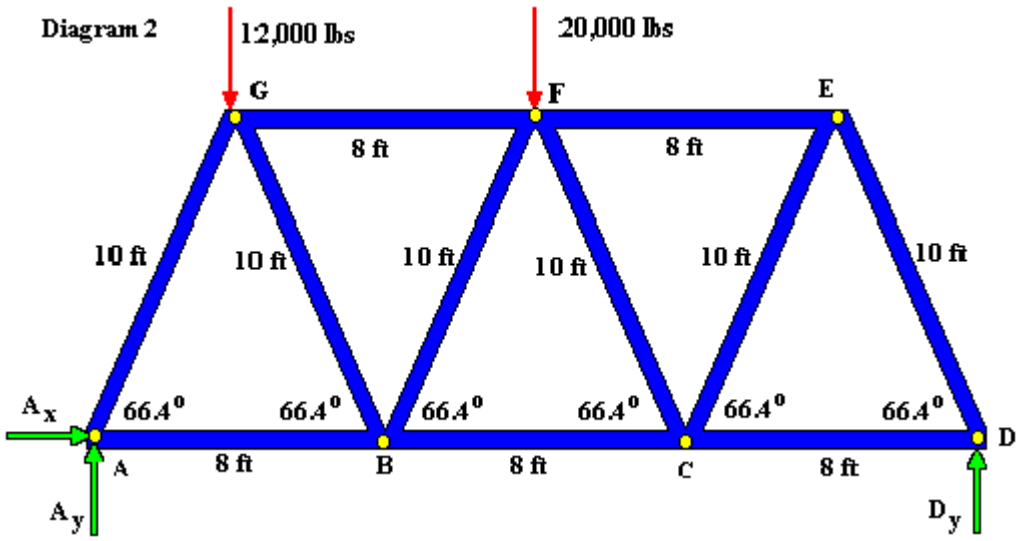
$$\sum \tau_E = 0: \quad 33\,lb\,(4\,ft) - BC\,(3\,ft) = 0$$

BC = 44 lb. , EC = -50 lb. , EF = 712 lb.

Örnek 2



Serbest cisim diyagramı



$\sum Fx = 0$: $\sum Fy = 0$: $\sum \tau_p = 0$

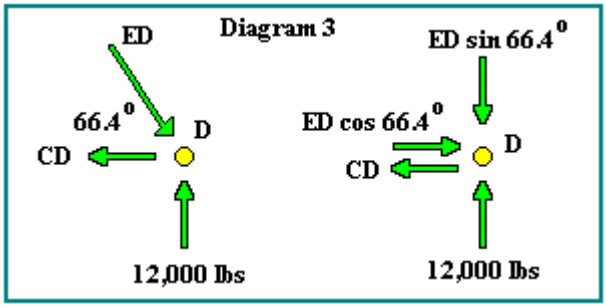
$\sum F_x = 0$: $A_x = 0$

$\sum F_y = 0$: $A_y + D_y - 12{,}000 \text{ lbs} - 20{,}000 \text{ lbs} = 0$

$\sum \tau_A = 0$: $(-12{,}000 \text{ lbs})(4 \text{ ft}) - (20{,}000 \text{ lbs})(12 \text{ ft}) + D_y(24 \text{ ft}) = 0$

$D_y = 12{,}000$ lbs; $A_y = 20{,}000$ lbs.

D NOKTASI:

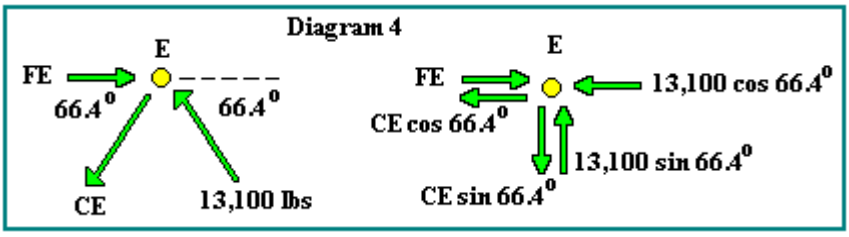


$\sum F_x = 0$: $-CD + ED \cos(66.4^o) = 0$

$\sum F_y = 0$: $12{,}000 \text{ lbs} - ED \sin(66.4^o) = 0$

ED = 13,100 lbs (C); CD = 5,240 lbs (T)

E NOKTASI:

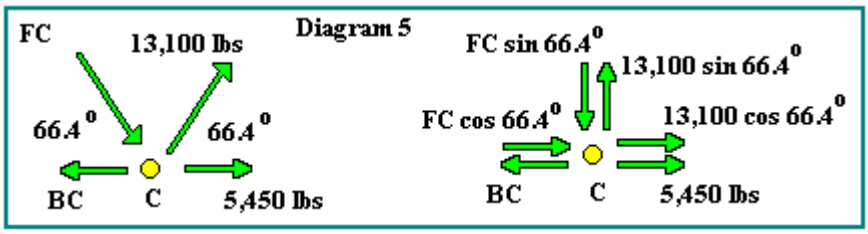


$\sum F_x = 0$ FE -(13,100 lbs) cos (66.4°) - CE cos (66.4°) = 0

$\sum F_y = 0$:(13,100 lbs) sin (66.4°) - CE sin (66.4°) = 0

FE = 10,500 lbs (C); CE = 13,100 lbs (T)

C NOKTASI:



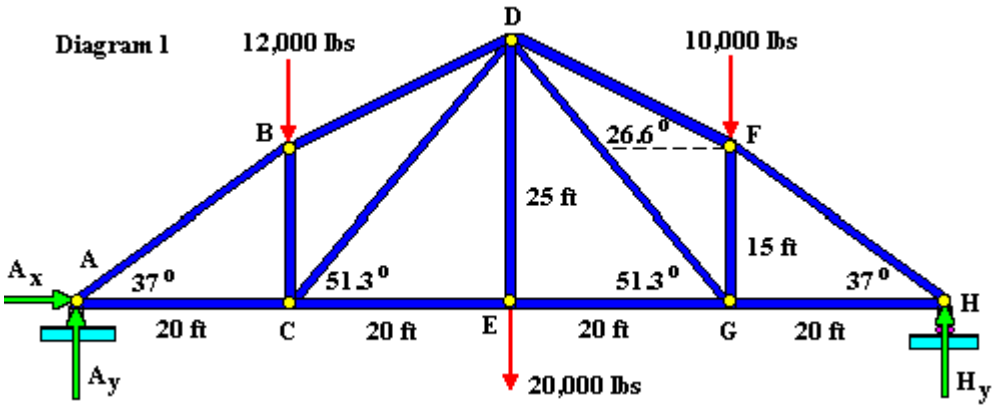
$\sum F_x = 0$ $\sum F_y = 0$

$\sum F_x = 0$: 5,450 + (13,100 lbs) cos (66.4°) + FC cos (66.4°) - BC = 0

$\sum F_y = 0$: 13,100 lbs sin (66.4°) - FC sin (66.4°) = 0

FC = 13,100 lbs (c); BC = 15,950 lbs (t)

Örnek 3



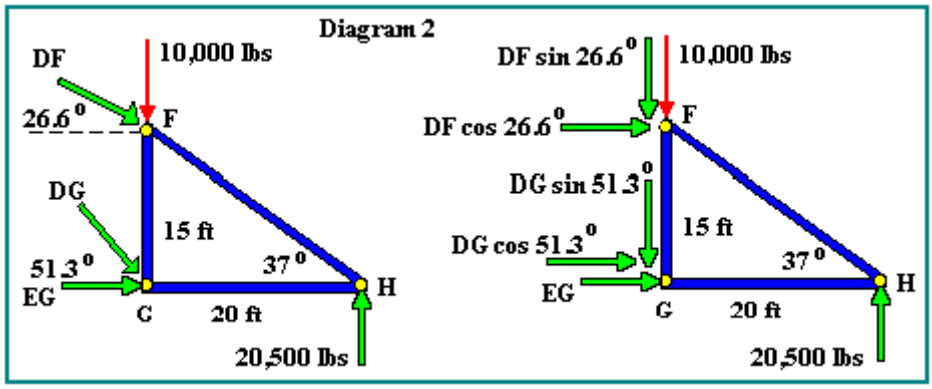
$\sum F_x = 0$: $\sum F_y = 0$: $\sum \tau_p = 0$

$\sum F_x = 0$: $A_x = 0$

$\sum F_y = 0$: $A_y + H_y$ -12,000 lbs - 20,000 lbs - 10,000 lbs = 0

$\sum \tau_A = 0$: (-12,000 lbs)(20 ft) - (20,000 lbs)(40 ft) - (10,000 lbs)(60 ft) + H_y(80 ft) = 0

A_y = 21,500 lbs; H_y = 20,500 lbs.



$\sum F_x = 0$: $\sum F_y = 0$: $\sum \tau_P = 0$

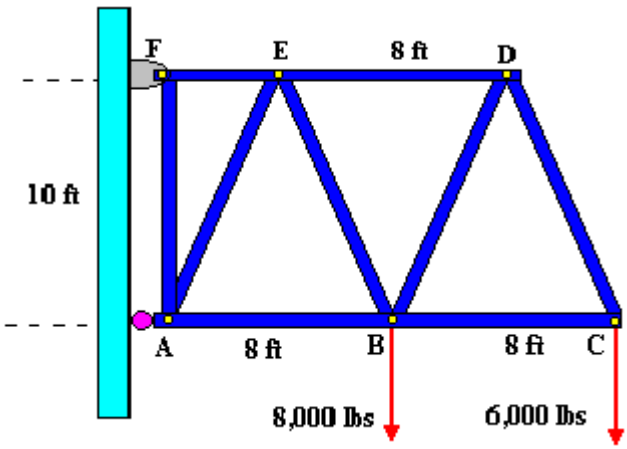
$\sum F_x = 0$:EG + DG cos (51.3º) + DF cos (22.6º) = 0

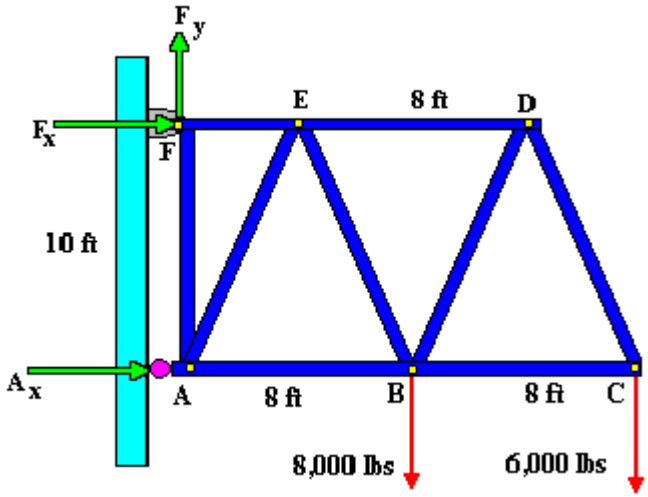
$\sum F_y = 0$: -10,000 lbs + 20,500 lbs - DG sin (51.3º) - DF sin (26.6º) = 0

$\sum \tau_G = 0$: -DF cos (26.6º)(15 ft) + (20,500 lbs)(20 ft) = 0

DF = 30,600 lbs (C); DG = -4,090 (ters yön)= 4,090 lbs (T); EG = -24,800(ters yön)= 24,800 lbs (T)

Örnek





Çözüm:

$A_x + F_x = 0$

F_y - 8,000 lbs - 6,000 lbs = 0

Sum T_A = (-8,000 lbs)(8 ft) - (6,000 lbs)(16 ft) - F_x(10 ft) = 0

Çözüm:

A_x = 16,000 lbs; F_x = -16,000 lbs; F_y = 14,000 lbs

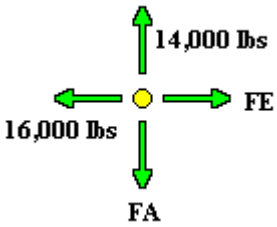
F Noktası :

FE - 16,000 lbs = 0

14,000 lbs - FA = 0

Çözüm:

FE = 16,000 lbs (t); FA = 14,000 lbs (t)

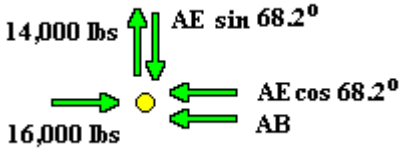


A Noktası :

16,000 lbs - AB -AE cos (68.2°) = 0

14,000 lbs - AE sin (68.2°) = 0

Çözüm: AE = 15,080 lbs (c); AB = 10,400 lbs (c)

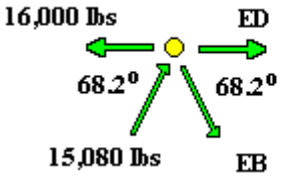


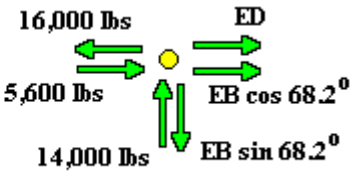
E Noktası :

-16,000 lbs + ED + 5,600 lbs + EB cos (68.2°) = 0

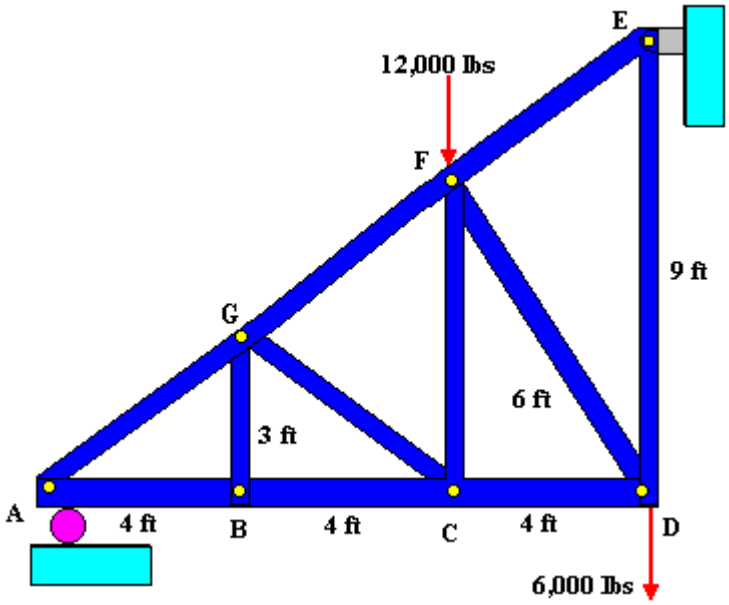
14,000 lbs - EB sin (68.2°) = 0

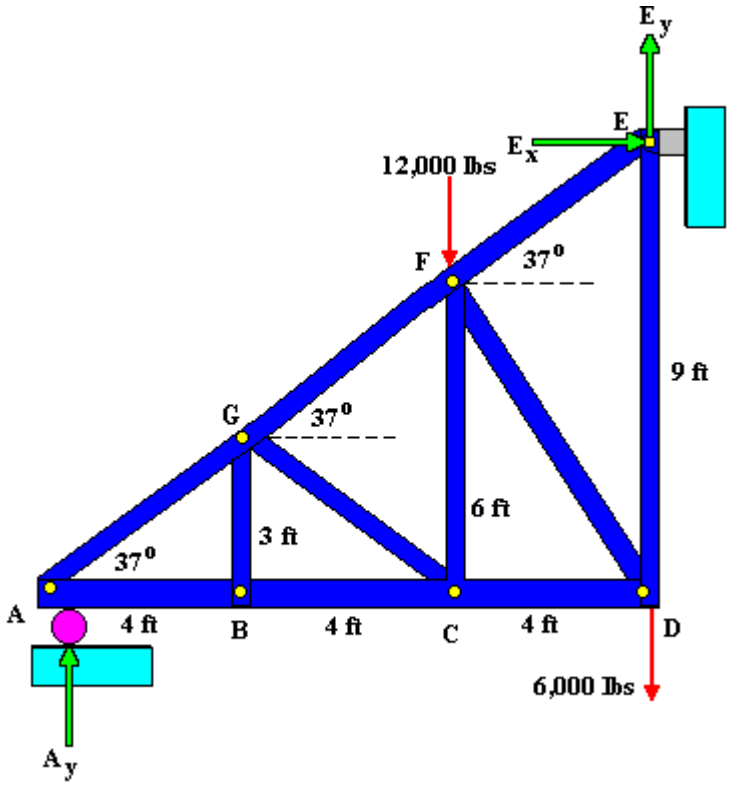
Çözüm:ED = 4,800 lbs (t); EB = 15,080 lbs (t)





Örnek


E
12,000 lbs
F
9 ft
G
6 ft
3 ft
A
4 ft
B
4 ft
C
4 ft
D
6,000 lbs


E y
E
E x
12,000 lbs
F
37°
9 ft
G
37°
6 ft
3 ft
37°
A
4 ft
B
4 ft
C
4 ft
D
6,000 lbs
A y

Çözüm:

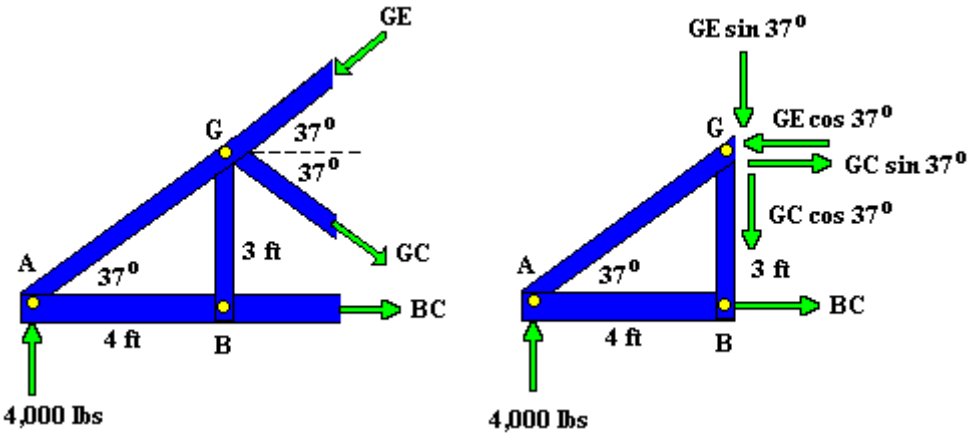
$E_x = 0$

$F_y = A_y + E_y - 12{,}000 \text{ lbs} - 6{,}000 \text{ lbs} = 0$

Sum $T_E = (12{,}000 \text{ lbs})(4 \text{ ft}) - A_y(12 \text{ ft}) = 0$

Çözüm:

$E_y = 14{,}000 \text{ lbs}$; $A_y = 4{,}000 \text{ lbs}$



- GE cos (37°) + GC cos (37°) + BC = 0

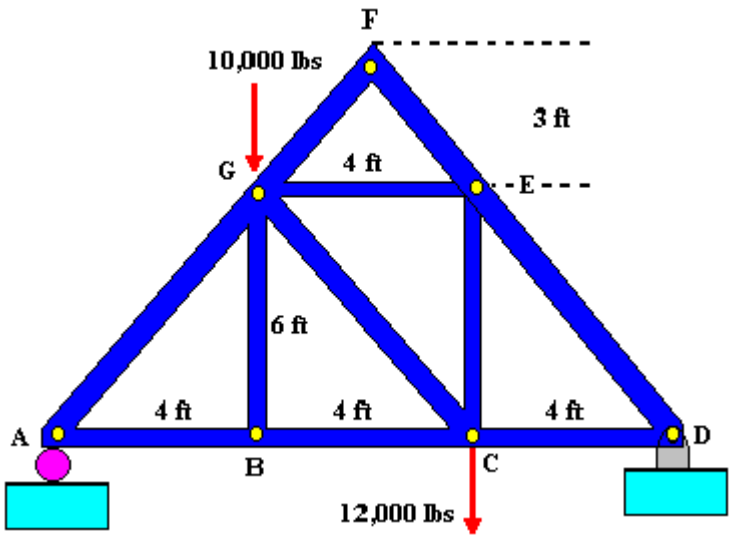
4,000 lbs - GE sin (37°) - GC sin (37°) = 0

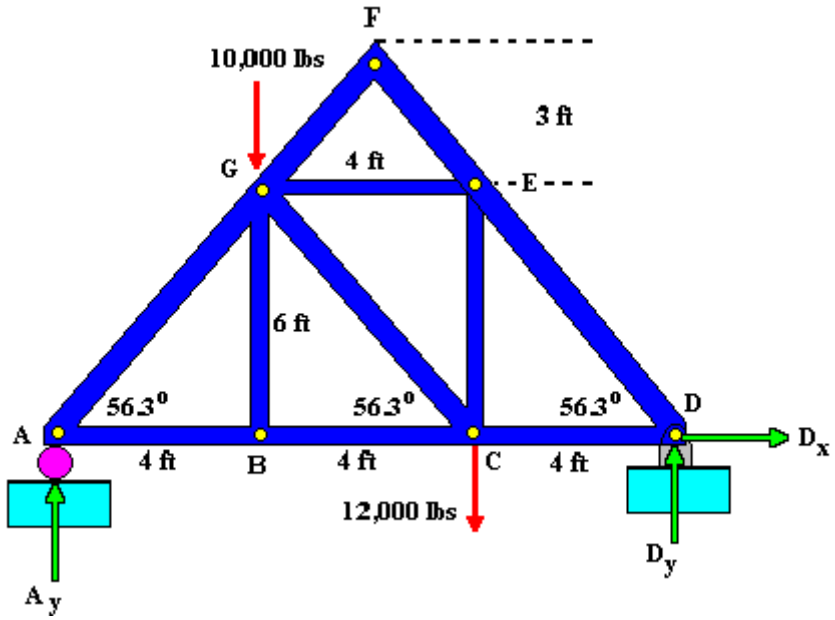
Sum $T_G = (-4{,}000 \text{ lbs})(4 \text{ ft}) + BC(3 \text{ ft}) = 0$

Çözüm:

BC = 5,330 lbs; GE = 6,670 lbs; GC = 0 lbs

Örnek


F
10,000 lbs
3 ft
G
4 ft
E
6 ft
4 ft
4 ft
4 ft
A
B
C
D
12,000 lbs


F
10,000 lbs
3 ft
G
4 ft
E
6 ft
56.3°
56.3°
56.3°
A
D
D_x
4 ft
B
4 ft
C
4 ft
12,000 lbs
D_y
A_y

Çözüm:

$D_x = 0$

$A_y + D_y - 10{,}000 \text{ lbs} - 12{,}000 \text{ lbs} = 0$

Sum $T_A = D_y(12 \text{ ft}) - (12{,}000 \text{ lbs})(8 \text{ ft}) - (10{,}000 \text{ lbs})(4 \text{ ft}) = 0$

Çözüm:

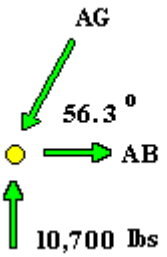
$D_y = 11{,}300$ lbs; $A_y = 10{,}700$ lbs

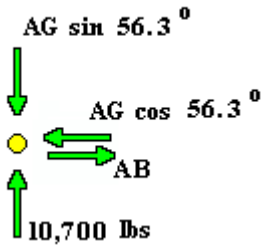
A Noktası :

$AB - AG \cos(56.3^o) = 0$

$10{,}700 \text{ lbs} - AG \sin(56.3^o) = 0$

Çözüm: AG = 12,900 lbs (c); AB = 7,140 lbs (t)



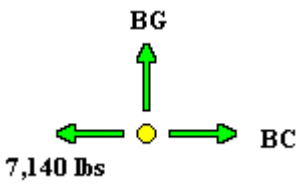


B Noktası :

$-7{,}140\text{lbs} + BC = 0$

$BG = 0$

Çözüm: BG = 0 lbs ; BC = 7,140 lbs (t)

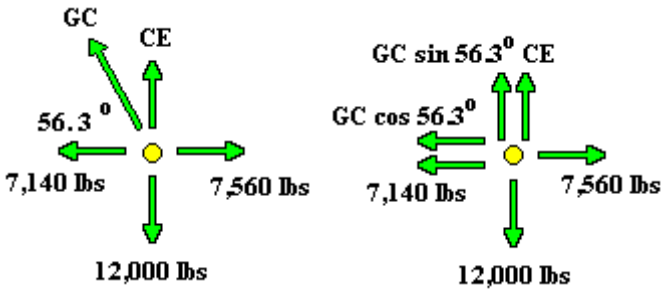


D Noktası :

-CD +ED cos (56.3°) = 0

11,300 lbs - ED sin (56.3°) = 0

Çözüm: CD = 7,560 lbs (t); ED = 13,600 lbs (c)

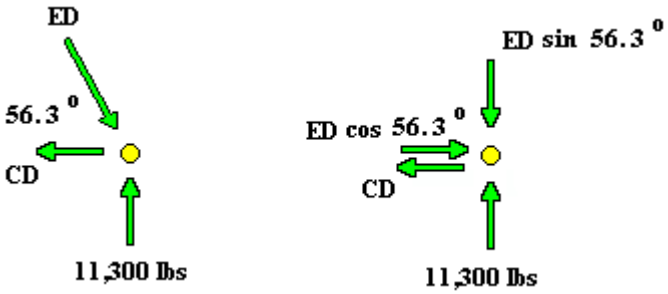


C Noktası :

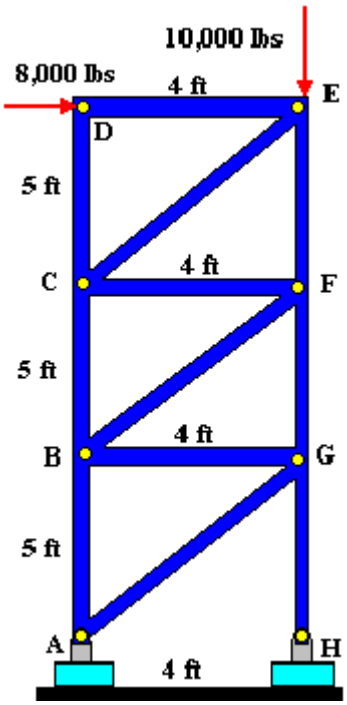
7,560 lbs - 7,140 lbs - GC cos (56.3°) = 0

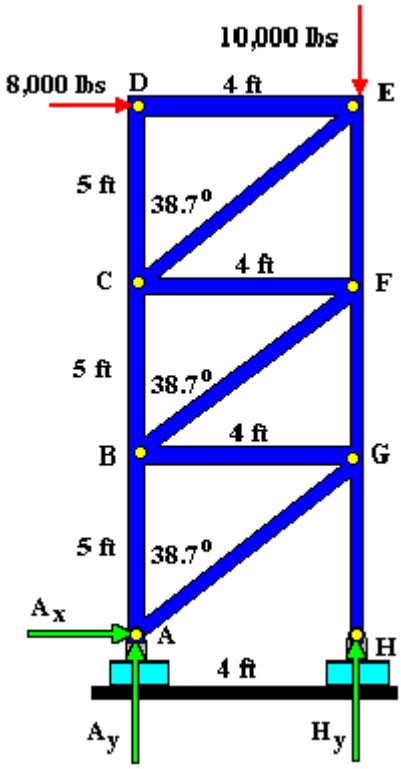
CE - 12,000 lbs - GC sin (56.3°) = 0

Çözüm: CE = 11,400 lbs (t); GC = 730 lbs (t)



Örnek



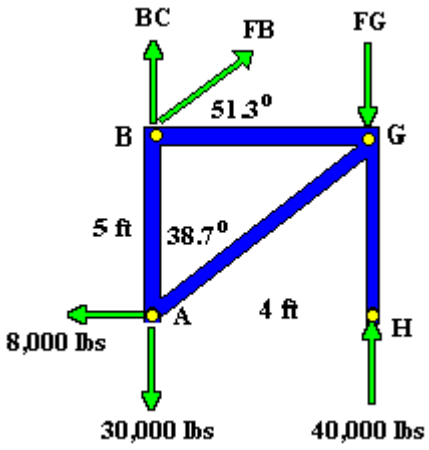


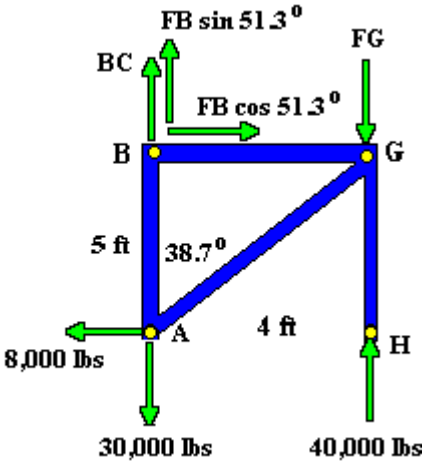
$A_x + 8{,}000 \text{ lbs} = 0$

$A_y + H_y - 10{,}000 \text{ lbs} = 0$

Sum $T_A = H_y(4 \text{ ft}) - (10{,}000 \text{ lbs})(4 \text{ ft}) - (8{,}000 \text{ lbs})(15 \text{ ft}) = 0$

$H_y = 40{,}000 \text{ lbs}$; $A_x = -8{,}000 \text{ lbs}$; $A_y = -30{,}000 \text{ lbs}$



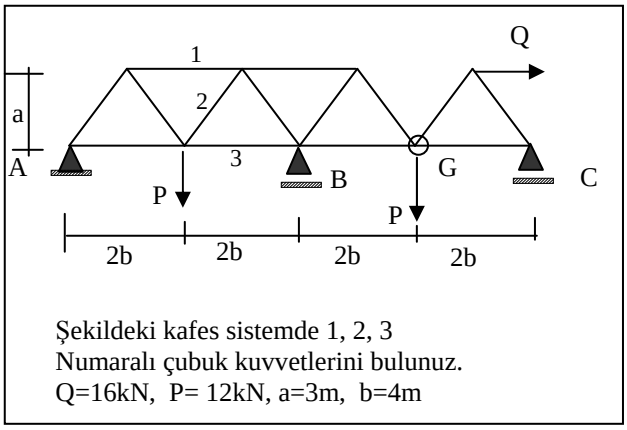


FB cos (51.3^{o}) - 8,000 lbs = 0

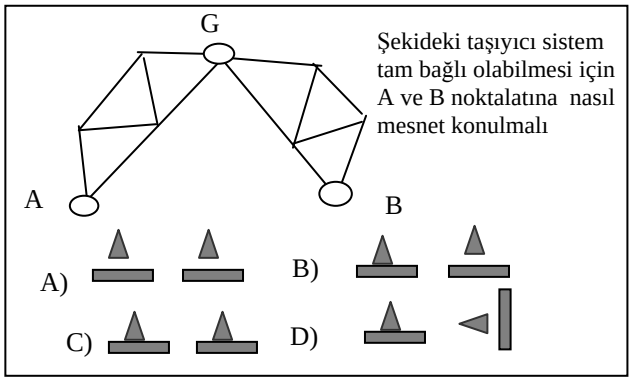
BC - 30,000 lbs + FB sin (51.3^{o}) - GF + 40,000 lbs = 0

Sum T_B = (-8,000 lbs)(5 ft) - GF(4 ft) + (40,000 lbs)(4 ft) = 0

Çözüm: FB = 12,8000 lbs (t); GF = 30,000 lbs (c); BC = 10,000 lbs (t)

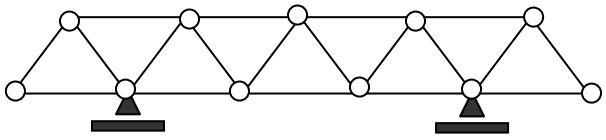


Şekildeki kafes sistemde 1, 2, 3 Numaralı çubuk kuvvetlerini bulunuz.
Q=16kN, P= 12kN, a=3m, b=4m



Şekildeki taşıyıcı sistem tam bağlı olabilmesi için A ve B noktalatına nasıl mesnet konulmalı

Şekildeki kafes sistem:
A) içten ve dıştan tam bağlı
B) içten tam bağlı dıştan eksik bağlı
C) içten ve dıştan eksik bağlı
D) içten eksik bağlı dıştan tam bağlı



Şekildeki kafes sistemde kaç tane çubuk kuvveti sıfırdır
A) 2 B) 3 C) 4 D) 5