CE 201 STATICS (Sections 4 & 6)

First Semester (081)

H.W. Solutions #8

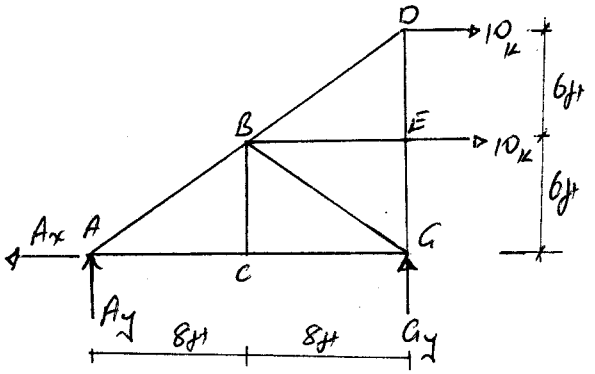
Problem 1

Given: The figure P1 in the question sheet.

Required: Forces in members BD, BE and BG

Solution

First, FBD of truss is drawn.



⇒ Note that for the reactions, we need G_y only (Why?!)

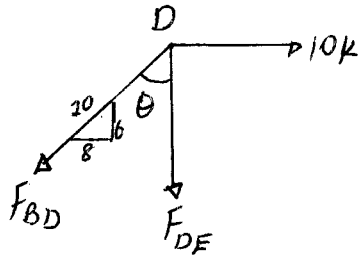
Taking moments about A

$$+\circlearrowleft \Sigma M_A = 0 \Rightarrow (8)G_y - (6)10 - (12)10 = 0$$

$$\Rightarrow G_y = 11.25\,k, \text{ upwards.}$$

Starting with Joint D (Why?!)

FBD of Joint D



$$\pm\rightarrow \Sigma F_x = 0 \Rightarrow -F_{BD}\sin\theta + 10 = 0$$

$$\Rightarrow -F_{BD}\left(\frac{8}{10}\right) + 10 = 0$$

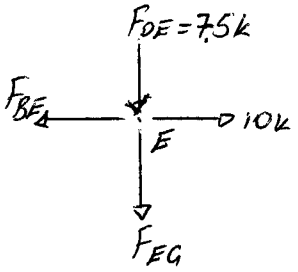
$$\Rightarrow \boxed{F_{BD} = 12.5\,k\ (T)}$$

$$+\uparrow \Sigma F_y = 0 \Rightarrow -F_{BD}\cos\theta - F_{DE} = 0$$

$$\Rightarrow -(12.5)\left(\frac{6}{10}\right) - F_{DE} = 0$$

$$\Rightarrow F_{DE} = -7.5k, \Rightarrow F_{DE} = 7.5k\ (C)$$

FBD of Joint E



$\pm \rightarrow \Sigma F_x = 0 \Rightarrow -F_{BE} + 10 = 0$

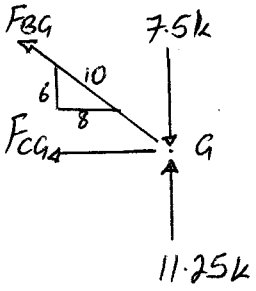
$\Rightarrow \boxed{F_{BE} = 10k\ (T)}$

$+\uparrow \Sigma F_y = 0 \Rightarrow -F_{DE} - F_{EG} = 0$

$\Rightarrow -7.5 - F_{EG} = 0$

$\Rightarrow \underline{F_{EG} = 7.5k\ (C)}$

FBD of Joint G



$+\uparrow \Sigma F_y = 0 \Rightarrow F_{BG} \sin\theta - 7.5 + 11.25 = 0$

$\Rightarrow F_{BG}\left(\frac{6}{10}\right) + 3.75 = 0$

$\Rightarrow \boxed{F_{BG} = 6.25k\ (C)}$

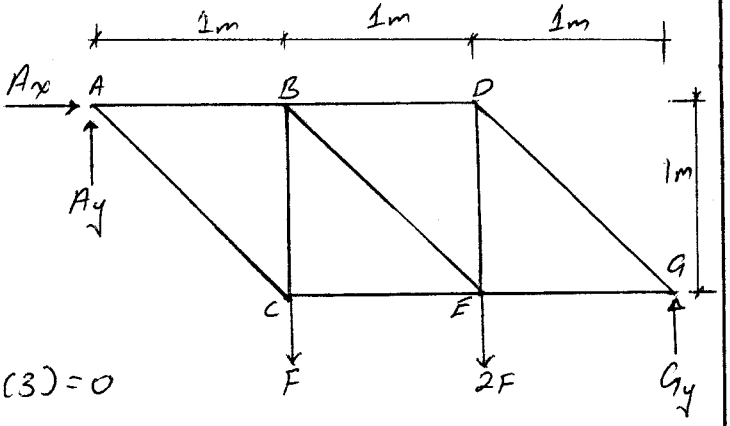
Problem 2

Given:- A truss as shown in Fig. P2 of question sheet
- Each member can safely support a tensile force of 28kN and compressive force of 12kN

Required: The largest safe value of F.

Solution.

FBD of truss is drawn first.



⇒ Note that either the reactions at A or G are needed (Why?!)

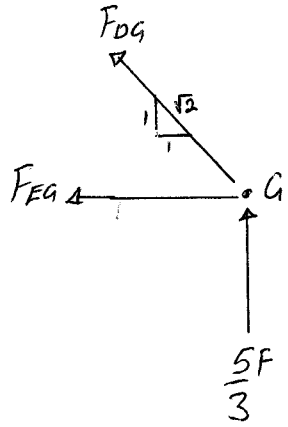
Taking moments about point A.

$+\circlearrowright \sum M_A = 0 \Rightarrow -F(1) - 2F(2) + G_y(3) = 0$

$\Rightarrow -5F + 3G_y = 0$

$\Rightarrow G_y = \frac{5}{3}F$

FBD of Joint G



$+\uparrow \sum F_y = 0 \Rightarrow F_{DG}\sin\theta + \frac{5}{3}F = 0$

$\Rightarrow F_{DG}\left(\frac{1}{\sqrt{2}}\right) + \frac{5}{3}F = 0$

$\Rightarrow F_{DG} = \frac{-5\sqrt{2}}{3}F \Rightarrow \underline{F_{DG} = \frac{5\sqrt{2}}{3}F \ (C)}$

$\xrightarrow{+} \sum F_x = 0 \Rightarrow -F_{DG}\cos\theta - F_{EG} = 0$

$\Rightarrow -\left(\frac{-5\sqrt{2}F}{3}\right)\left(\frac{1}{\sqrt{2}}\right) - F_{EG} = 0$

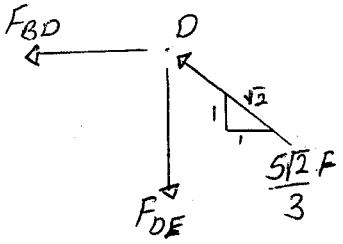
$\Rightarrow \underline{F_{EG} = \frac{5}{3}F \ (T)}$

FBD of Joint D

$\pm\rightarrow \sum F_x = 0 \Rightarrow -F_{BD} - \frac{5\sqrt{2}}{3}F\sin\theta = 0$

$\Rightarrow -F_{BD} - \frac{5\sqrt{2}}{3}F\left(\frac{1}{\sqrt{2}}\right) = 0$

$\Rightarrow F_{BD} = \frac{-5}{3}F \Rightarrow \underline{F_{BD} = \frac{5}{3}F\ (C)}$



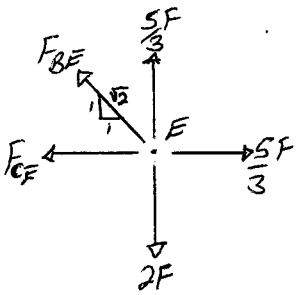
$+\uparrow \sum F_y = 0 \Rightarrow -F_{DE} + \frac{5\sqrt{2}}{3}F\cos\theta = 0$

$\Rightarrow -F_{DE} + \frac{5\sqrt{2}}{3}F\left(\frac{1}{\sqrt{2}}\right) = 0 \Rightarrow \underline{F_{DE} = \frac{5}{3}F\ (T)}$

FBD of Joint E

$+\uparrow \sum F_y = 0 \Rightarrow F_{BE}\sin\theta + \frac{5}{3}F - 2F = 0$

$\Rightarrow F_{BE}\left(\frac{1}{\sqrt{2}}\right) - \frac{F}{3} = 0 \Rightarrow \underline{F_{BE} = \frac{\sqrt{2}}{3}F\ (T)}$



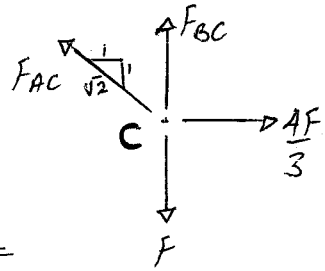
$\pm\rightarrow \sum F_x = 0 \Rightarrow -F_{CE} - F_{BE}\cos\theta + \frac{5}{3}F = 0$

$\Rightarrow -F_{CE} - \frac{\sqrt{2}}{3}F\times\frac{1}{\sqrt{2}} + \frac{5}{3}F = 0 \quad \underline{F_{CE} = \frac{4}{3}F\ (T)}$

FBD of Joint C

$\pm\rightarrow \sum F_x = 0 \Rightarrow -F_{AC}\sin\theta + \frac{4}{3}F = 0$

$\Rightarrow -F_{AC}\left(\frac{1}{\sqrt{2}}\right) + \frac{4}{3}F = 0 \Rightarrow \underline{F_{AC} = \frac{4\sqrt{2}}{3}F\ (T)}$

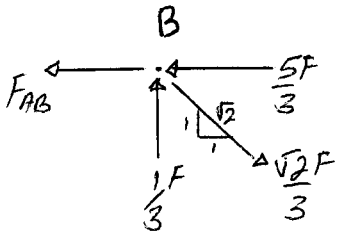


$+\uparrow \sum F_y = 0 \Rightarrow F_{AC}\cos\theta + F_{BC} - F = 0$

$\Rightarrow \frac{4\sqrt{2}}{3}F\times\frac{1}{\sqrt{2}} + F_{BC} - F = 0$

$\Rightarrow F_{BC} = \frac{-1}{3}F \Rightarrow \underline{F_{BC} = \frac{1}{3}F\ (C)}$

FBD of Joint B



$\pm \Sigma F_x = 0 \Rightarrow -F_{AB} - \frac{5F}{3} + \frac{\sqrt{2}F}{3}\left(\frac{1}{\sqrt{2}}\right) = 0$

$\Rightarrow -F_{AB} - \frac{4}{3}F = 0$

$\Rightarrow F_{AB} = \frac{-4}{3}F \Rightarrow F_{AB} = \frac{4}{3}F\,(C)$

The maximum tensile force is in members;

DE and FG $= \frac{5}{3}F$

Solving for F;

$\Rightarrow \frac{5}{3}F = 28\,kN \Rightarrow F = 16.8\,kN$

And the Maximum compressive force is in member

$DG = \frac{5\sqrt{2}}{3}F$

Solving for F;

$\Rightarrow \frac{5\sqrt{2}}{3}F = 12\,kN \Rightarrow F = 5.091\,kN$

Thus from the above, the largest safe value of F is the minimum of the two

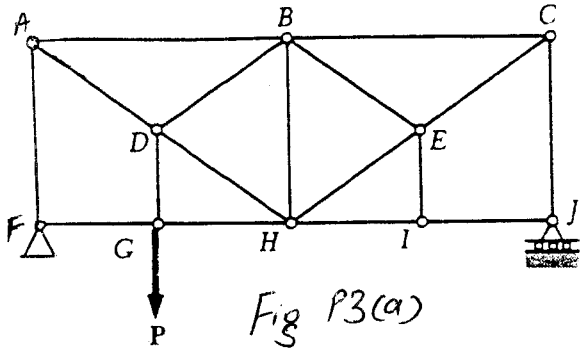
$\Rightarrow$ **F = 5.091 kN**

Problem 3

Given: Trusses in Figs. P3 a and b as shown.

Required: All zero-force members in the trusses by inspection.

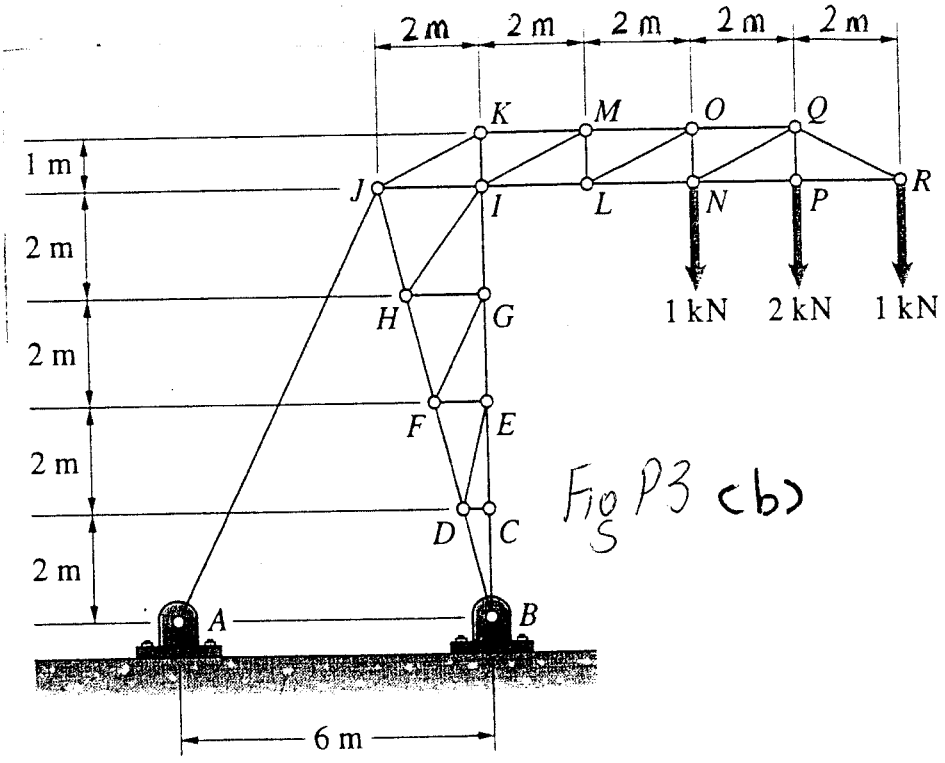
Solution



Figs P3(a)

The zero-force members in Figs P3a above are;

IE, EB, JI, IH, FG, GH



Figs P3 (b)

The zero-force members in Figs 3b above are;

CD, DE, EF, FG, GH, HI

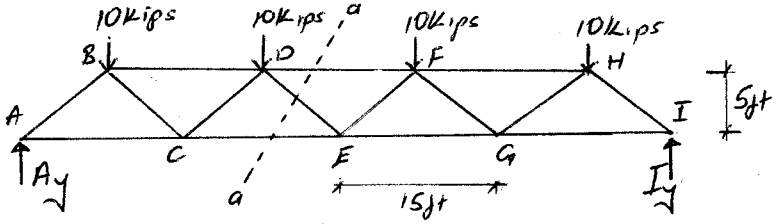
Problem 4

Given: The warren truss in Figure PH. in the question sheet

Required: forces in members DF, DE and CE by method of sections.

Solution:

FBD of truss is drawn.

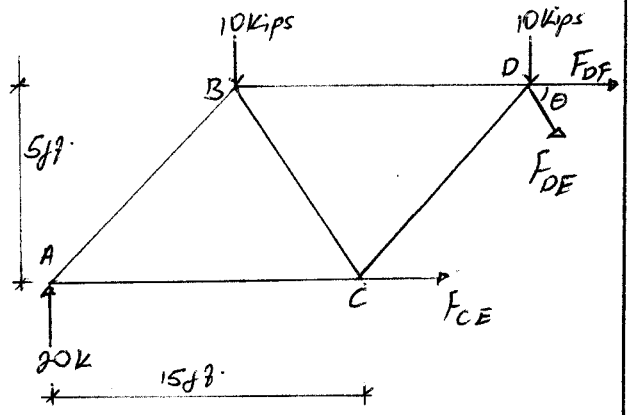


$\Rightarrow$ Due to symmetry,

$A_y = 20 kips$

$I_y = 20 kips$

Considering a Section a-a drawn to the left of FBD



$+\uparrow \sum F_y = 0 \Rightarrow 20 - 2(10) - F_{DE} \sin\theta = 0$

$\Rightarrow \boxed{F_{DE} = 0}$

Taking moments of forces about Point D

$+\circlearrowleft \sum M_D = 0$

$\Rightarrow F_{CE}(5) + 10(15) - 20(22.5) = 0$

$\Rightarrow \boxed{F_{CE} = 60 kips (T)}$

$\pm \rightarrow \sum F_x = 0 \Rightarrow F_{DF} + F_{DE}\cos\theta + F_{CE} = 0$

$\Rightarrow F_{DF} + 60 = 0$

$\Rightarrow \boxed{F_{DF} = 60 kips (C)}$

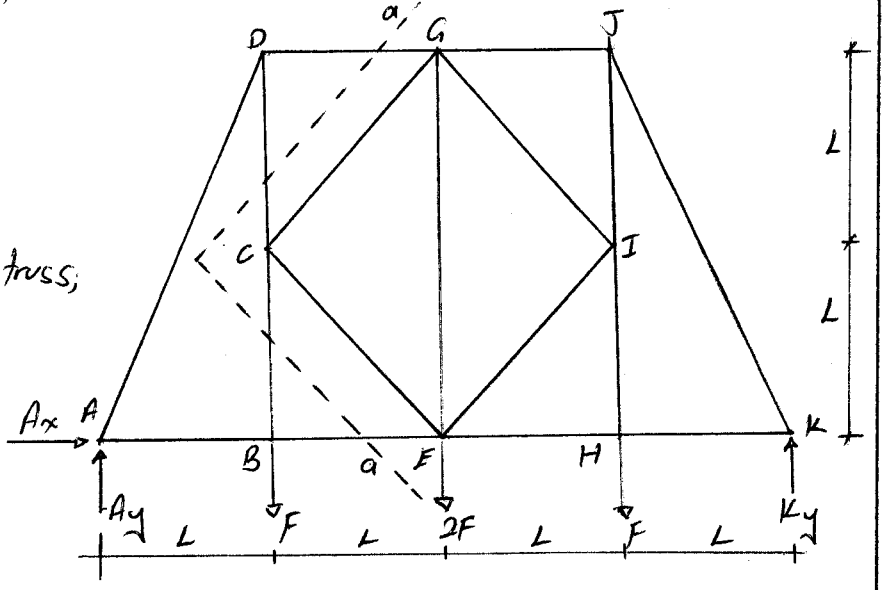
Problem 5

Given: K-truss as shown in Fig. P5 of question sheet.

Required: Forces in members DG and BE using the method of sections

Solution

FBD of K-truss is first drawn.



⇒ By inspection,

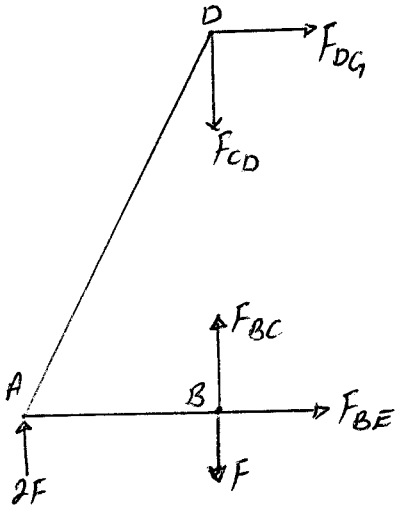
$A_x = 0$

⇒ Due to symmetry of truss;

$A_y = 2F$ and

$K_y = 2F$

Taking a section a-a as shown and considering the left part of FBD



⇒ Taking moments of forces about point B;

⇒ $\overset{+}{\circlearrowright} M_B = 0 \Rightarrow$

$\Rightarrow -F_{DG}(2L) - 2F(L) = 0$

$\Rightarrow -F_{DG} - F = 0 \Rightarrow F_{DG} = -F$

$\Rightarrow \boxed{F_{DG} = F \ (C)}$

$\overset{+}{\rightarrow} \Sigma F_x = 0 \Rightarrow F_{DG} + F_{BE} = 0$

$\Rightarrow -F + F_{BE} = 0$

$\Rightarrow \boxed{F_{BE} = F \ (T)}$