Problem 2.1

First, we need to find the reaction forces at point A and B, we get that

$$\Sigma F_y = 0; \quad R_A + R_B = P$$

$$\Sigma M_A = 0; \quad R_B(2L) - P(L + x_p) = 0$$

$$R_B = \frac{P}{2}\left(\frac{L + x_p}{L}\right)$$

$$R_A = \frac{P}{2}\left(\frac{L - x_p}{L}\right)$$

Figure 1.1

Now consider the horizontal member, the only possible way to have equilibrium condition is that the forces action at point D and E are both horizontal forces (i.e., no vertical forces acting on the points). You can simply take a moment at either point D or E and you will find that if there is any vertical forces at either D or E, the member DE cannot be in the equilibrium condition (summation of moment is not equal to zero).

Figure 1.2
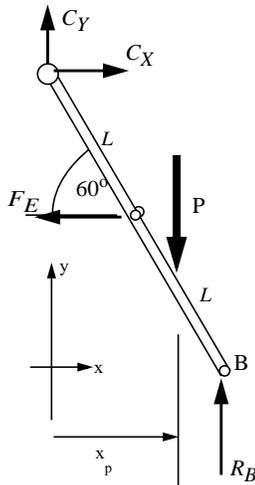
Figure 1.1 shows you the member FBD of the member BC. From the FBD, we get that

$$\Sigma F_y = 0; \quad C_y + R_B = P$$

$$\Sigma F_x = 0; \quad C_x = F_E$$

$$\Sigma M_c = 0; \quad P(x_p) + F_E(L\sin 60) = R_B(L)$$

$$F_E = \frac{R_B(L) - P(x_p)}{L\sin 60} = \frac{P}{\sqrt{3}}\left(1 - \frac{x_p}{L}\right) = C_x = F_D$$

$$C_y = \frac{P}{2}\left(1 - \frac{x_p}{L}\right)$$

Figure 1.3

Problem 2.2

From figure 2.1 (a) and (b), we can find the equivalent force by

$$\Sigma M_f = 3W(x) = W(L)+W(4L)+W(5L) = 10WL$$
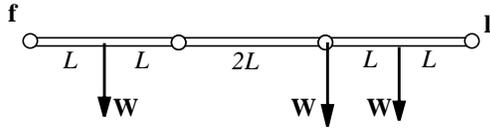
$$x = \frac{10}{3}L$$

$$\Sigma M_f = 0; \quad R_l(6L) = 10WL$$

$$R_l = \frac{5}{3}W$$

$$\Sigma F_y = 0; \quad R_f + R_l = 3W$$

$$R_f = 3W - R_l = \frac{4}{3}W$$
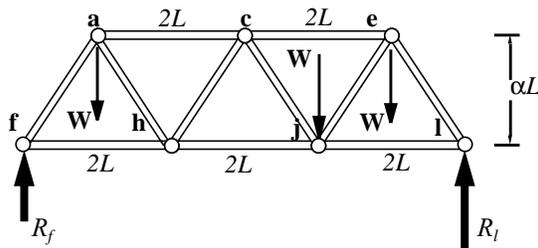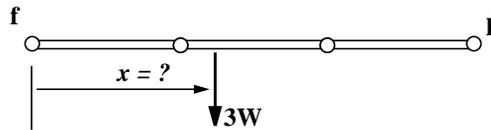
Figure 2.1 (a), (b), and (c) for top, middle, and bottom, respectively

To find the forces in the member **ch** with a single FBD, we use method of section and cut the truss as shown in the figure 2.2. We get that

$$\Sigma M_h = 0; \quad F_{ac}(\alpha L)+ R_f(2L) = W(L)$$

$$F_{ac} = -\frac{5W}{3\alpha}$$

$$\Sigma F_y = 0; \quad R_f + F_{ch}(\sin\theta) = W$$

$$F_{ch} = -\frac{W}{3(\sin\theta)}$$

$$\Sigma F_x = 0; \quad F_{ac} + F_{ch} + F_{hj} = 0$$

$$F_{hj} = \frac{5W}{3\alpha}+\frac{W}{3(\sin\theta)} = \frac{W}{3}\left[\frac{5}{\alpha}+\frac{1}{\sin\theta}\right]$$
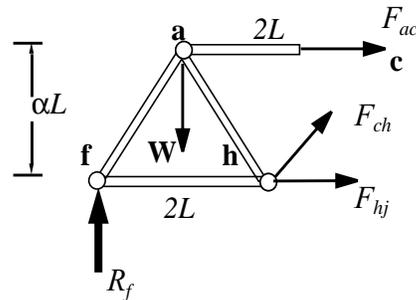
Figure 2.2

. The negative sign for F_{ch} indicates that the direction that I assumed in the figure above is not correct. (If the angle θ is 60 degree, the F_{ch} is equal to $F_{ch} = -\dfrac{2W}{3\sqrt{3}}$)And the correct direction is opposite of that in the figure 2.2. It is important to note the correct F_{ch} in this case is compression.

Problem 2.3

First, we need to find the reaction at point A and B. Assuming each member length is L (except the member CF which is longer than other members), we get that

$$\Sigma M_A = 0; \quad R_{by}\left(\frac{L}{2}\right) + R_{bx}\left(L\sin 60\right) = P(3L)$$

$$\Sigma F_y = 0; \quad R_{by} = R_{ay} + P$$
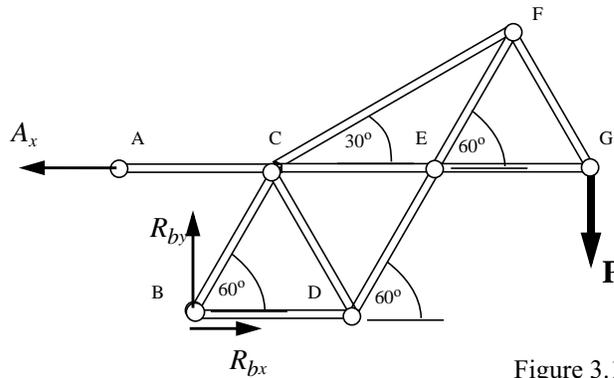
Figure 3.1

However, since AC is a two force member, R_{ay} must be 0 to maintain the equilibrium condition for that member.. Therefore, we get that $R_{by} = P$ and . $\qquad R_{bx} = \dfrac{5P}{\sqrt{3}}$

Now consider cutting the joint B, we get that
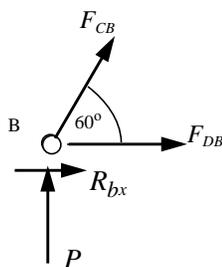
$$\Sigma F_x = 0; \qquad 0 = F_{bc}\left(\cos 60\right) + F_{bd} + R_{bx}$$

$$\Sigma F_y = 0; \quad 0 = P + F_{bc}\left(\sin 60\right)$$

$$F_{bc} = -\frac{2P}{\sqrt{3}}$$

$$F_{bd} = -R_{bx} - F_{bc}\left(\cos 60\right) = \frac{-5P}{\sqrt{3}} + \frac{2P}{\sqrt{3}(2)} = \frac{-4P}{\sqrt{3}}$$

Now consider the joint D, we get that   {This needs to be checked}

$$\sum F_y = 0: \qquad F_{cd} \cdot \sin 60 + F_{de} \cdot \sin 60 = 0 \qquad F_{cd} = -F_{de}$$

$$\sum F_x = 0: \qquad -F_{cd} \cos 60 + F_{de} \cdot \cos 60 - F_{bd} = 0$$

$$F_{cd} = -\frac{F_{bd}}{2\cos 60}$$

$$F_{cd} = \frac{F_{bd}}{2(\cos 60)} = \left(\frac{4P}{\sqrt{3}}\right)\left(\frac{2}{2}\right) = \frac{4P}{\sqrt{3}} \text{ in tension}$$
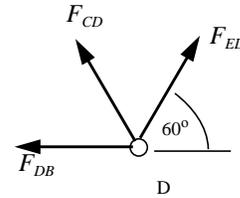
Problem 2.4

The reactions acting at point A and B are equivalent to PL/h. They are equal but opposite in the direction. Also, the total vertical reaction at the point A and B are equal to P (acting upward).