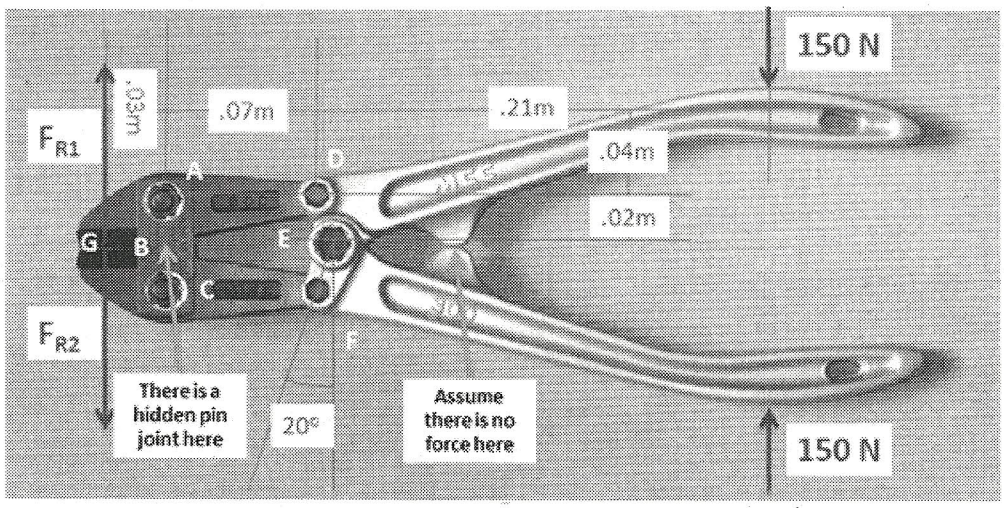
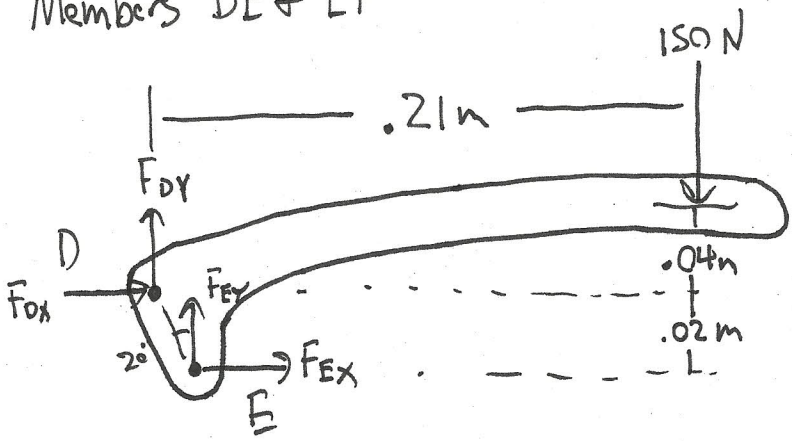
Question 3:

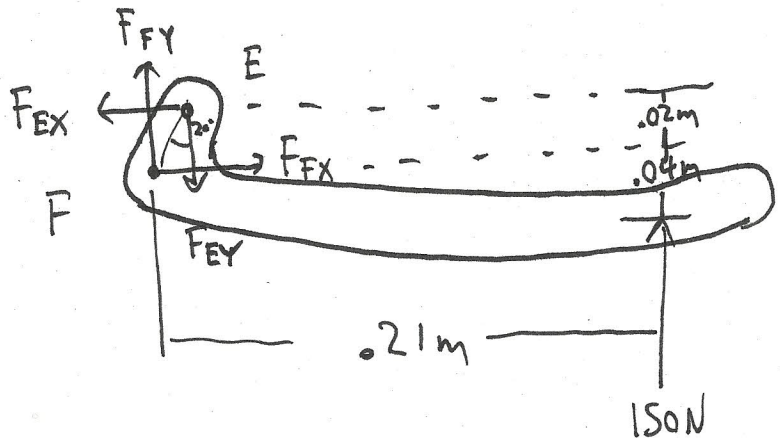
Find all the forces acting on each of the members in the structure below.



Calculations:

Members DE & EF





top handle

$$\Sigma F_x = F_{DX} + F_{EX} = 0$$

$$\Sigma F_y = F_{DY} + F_{EY} - 150 = 0$$

$$\Sigma M_D = (.02)F_{EX} + (.02\tan(20))(F_{EY}) - (.21)(150) = 0$$

bottom handle

$$\Sigma F_x = -F_{EX} + F_{FX} = 0$$

$$\Sigma F_y = -F_{EY} + F_{FY} + 150 = 0$$

$$\Sigma M_F = (.02)F_{EX} - (.02\tan(20))(F_{EY}) + (.21)(150) = 0$$

$$F_{DX} + F_{EX} = 0$$
$$F_{DY} + F_{EY} = 150$$
$$.02F_{EX} + .02\tan(20)F_{EY} = 31.5$$
$$-F_{EX} + F_{FX} = 0$$
$$-F_{EY} + F_{FY} = -150$$
$$.02F_{EX} - .02\tan(20)F_{EY} = -31.5$$

$$\begin{matrix} F_{DX} & F_{DY} & F_{EX} & F_{EY} & F_{FX} & F_{FY} \end{matrix}$$
$$\begin{bmatrix} 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 0 & .02 & .02\tan(20) & 0 & 0 \\ 0 & 0 & -1 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 & 0 & 1 \\ 0 & 0 & .02 & -.02\tan(20) & 0 & 0 \end{bmatrix} \begin{bmatrix} F_{DX} \\ F_{DY} \\ F_{EX} \\ F_{EY} \\ F_{FX} \\ F_{FY} \end{bmatrix} = \begin{bmatrix} 0 \\ 150 \\ 31.5 \\ 0 \\ -150 \\ -31.5 \end{bmatrix}$$

$F_{DX} = 0$

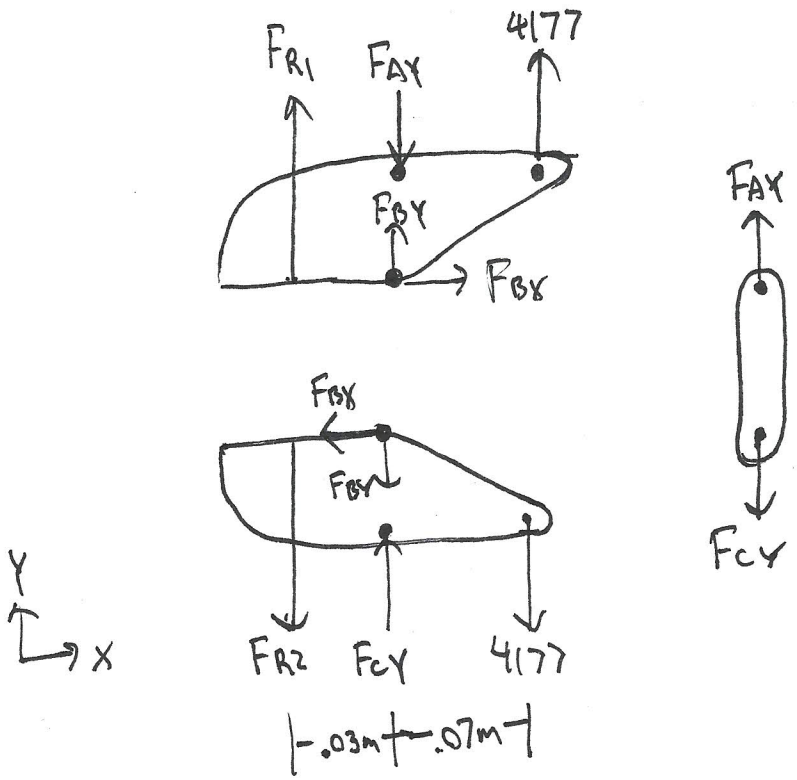
$F_{DY} = -4177\ N$

$F_{EX} = 0$

$F_{EY} = 4327\ N$

$F_{FX} = 0$

$F_{FY} = 4177\ N$



Top Blade

$$\sum F_X = F_{BX} = 0$$

$$\sum F_Y = F_{R1} + F_{BY} - F_{AY} + 4177 = 0$$

$$\sum M_B = -(.03) F_{R1} + (.07) 4177 = 0$$

Bottom Blade

$$\sum F_X = -F_{BX} = 0$$

$$\sum F_Y = -F_{R2} - F_{BY} + F_{CY} - 4177 = 0$$

$$\sum M_B = (.03) F_{R2} - (.07) 4177 = 0$$

Connector

$$F_{AY} = F_{CY}$$

$$F_{R1} = \frac{(.07)\,4177}{(.03)} = \boxed{9746\ N}$$

$$F_{R2} = \frac{(.07)\,4177}{(.03)} = \boxed{9746\ N}$$