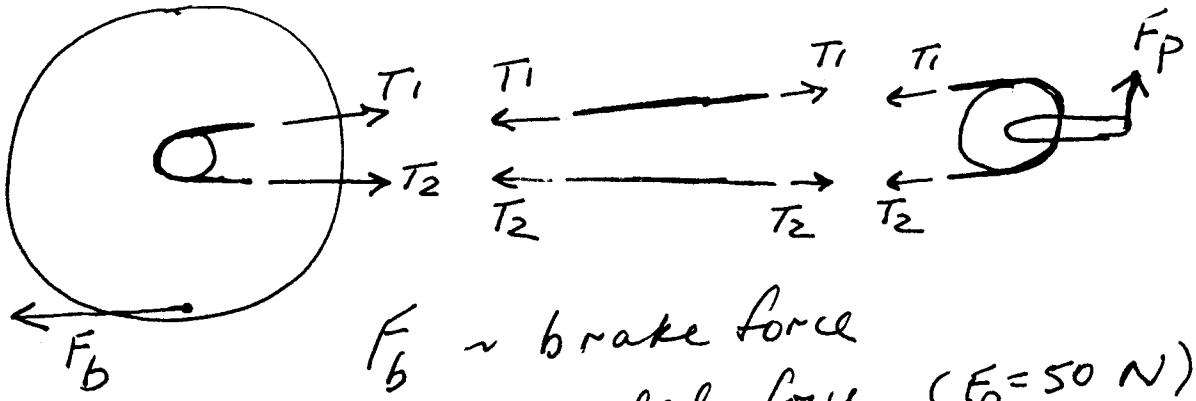
Solutions to Problem Set #3, 24-261, Fall 2001

1. separate out four bodies and draw free body diagrams



F_b ~ brake force

F_p ~ pedal force ($F_p = 50\ N$)

Consider rotational equilibrium about z-axis (out of paper) for each body with a sprocket. Take moments about centers

Front sprocket: $\Sigma M|_z = F_p(15\,cm) + T_1\left(\frac{20\,cm}{2}\right) - T_2\left(\frac{20\,cm}{2}\right) = 0$

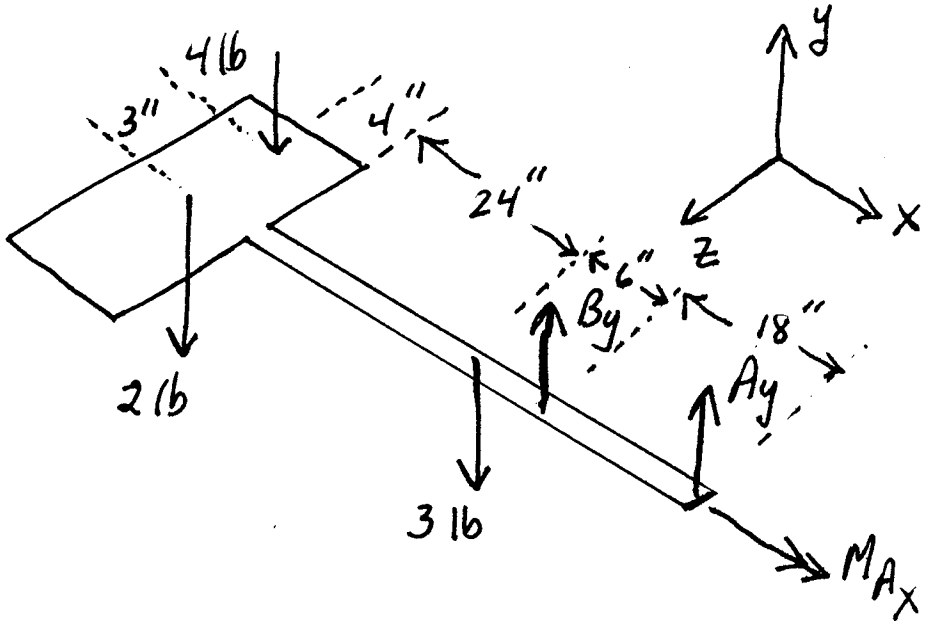
$$\Rightarrow \quad T_2 - T_1 = F_p\left(\frac{15}{10}\right) = 75\ N$$

Rear sprocket: $\Sigma M|_z = -T_1\left(\frac{12\,cm}{2}\right) + T_2\left(\frac{12\,cm}{2}\right) - F_b\left(\frac{82\,cm}{2}\right) = 0$

$$F_b = (T_2 - T_1)\frac{6}{41} = 75\left(\frac{6}{41}\right) \cong 11\ N$$

Note: chains are in equilibrium under equal + opposite tensions.

(Configuration 3)



$$\Sigma F_y = -2-4-3+B_y+A_y=0$$

$$\Sigma M|_{A_z} = 2(52)+4(52)+3(24)-B_y(18)=0$$

$$B_y = 21.3 \text{ lb}$$

$$A_y = 9-21.3 = -12.3 \text{ lb}$$

$$\Sigma M|_{A_x} = -4(3)+M_{A_x}=0 \Rightarrow M_{A_x}=12 \text{ lb-in}$$