Equivalent Force-Couple System
Example Problem
Steven Vukazich
San Jose State University
Replace the force system acting on the body by an equivalent force-couple system acting at:

1. Point E
2. Point A
Express the Force at B in Components

\[
\left(\frac{4}{5}\right)20 = 16 \text{ lb}
\]

\[
\left(\frac{3}{5}\right)20 = 12 \text{ lb}
\]
Replace Each Component of the Force at B by an Equivalent Force-Couple System at Point E

(16 lb)(15 ft) = 240 ft-lb

(12 lb)(13 ft) = 156 ft-lb
Replace the Force at A by an Equivalent Force-Couple System at Point E

\[
\begin{align*}
(16 \text{ lb})(15 \text{ ft}) &= 240 \text{ ft-lb} \\
(12 \text{ lb})(13 \text{ ft}) &= 156 \text{ ft-lb} \\
(18 \text{ lb})(13 \text{ ft}) &= 234 \text{ ft-lb}
\end{align*}
\]
Replace the Force at D by an Equivalent Force-Couple System at Point E

- \(16 \text{ lb}(15 \text{ ft}) = 240 \text{ ft-lb}\)
- \(12 \text{ lb}(13 \text{ ft}) = 156 \text{ ft-lb}\)
- \(18 \text{ lb}(13 \text{ ft}) = 234 \text{ ft-lb}\)
- \(30 \text{ lb}(9 \text{ ft}) = 270 \text{ ft-lb}\)
Add the Force Components and Couples

\[ M = 156 + 270 - 234 - 240 = -48 \text{ ft-lb} \]
Equivalent Force-Couple System at Point A

\[
\left(\frac{4}{5}\right)20 = 16 \text{ lb}
\]

\[
\left(\frac{3}{5}\right)20 = 12 \text{ lb}
\]

\[
\frac{3}{4} = 16 \text{ lb}
\]

\[
\frac{5}{4} = 12 \text{ lb}
\]

18 lb

8 ft

5 ft

30 lb
Replace Each Component of the Force at B by an Equivalent Force-Couple System at Point A

16 lb \times 15 \text{ ft} = 240 \text{ ft-lb}

12 \text{ lb} = 240 \text{ ft-lb}

30 \text{ lb}

18 \text{ lb}

16 \text{ lb}

8 \text{ ft}

5 \text{ ft}
Replace Each Component of the Force at D by an Equivalent Force-Couple System at Point A

12 lb
(16 lb)(15 ft) = 240 ft-lb

16 lb
(30 lb)(9 ft) = 270 ft-lb

18 lb
8 ft

30 lb
5 ft
Add the Force Components and Couples

\[ M = 270 - 240 = 30 \text{ ft-lb} \]
All Three Force Systems are Equivalent

20 lb
30 lb
18 lb

= 48 ft-lb

= 14 lb

14 lb
6 lb
30 ft-lb

6 lb

Question – Is the Body in Equilibrium?