(6.3.15)

A) Person on the bike

\[ \sum F_x = 0 \]
\[ \Rightarrow -F + f = 0 \]
\[ F = f \quad \text{(1)} \]

\[ \sum M_0 = 0 \]
\[ \Rightarrow T R_c = F_p R_p \]
\[ T = \frac{R_p}{R_c} F_p \quad \text{(2)} \]

\[ \sum M_n = 0 \]
\[ \Rightarrow T R_s = f R_r \quad \text{(3)} \]

Substitute (2) in:

\[ \frac{R_p R_s}{R_c} F_p = f R_r \]

\[ \Rightarrow f = \frac{R_p R_s}{R_c R_r} \cdot F_p \]

Substitute in (1):

\[ F = \frac{R_p R_s}{R_c R_r} \cdot F_p \]

F has the same sign as \( F_p \)
\[ \Rightarrow F < 0 \]
6) Person standing next to the bike

Relation 2 & 3 remain unchanged as FBD 2 & 3 stay the same.

FBD 1 needs to be updated:

\[ \sum F_x = 0 \]

\[ \Rightarrow F + F_p = f \quad (4) \]

As derived in part a)

\[ f = \frac{R_{pR}S}{R_cR_R} \cdot F_p \quad \text{(Same as part a)} \]

\[ \Rightarrow F + F_p = \frac{R_{pR}S}{R_cR_R} \cdot F_p = \frac{F}{F_p} \]

\[ F = \left( \frac{R_{pR}S}{R_cR_R} - 1 \right) F_p \]

If \( f < F_p \), which it is for all commercial bicycles in all gears, then \( F < 0 \). (Bike tries to go backwards.)

Always \( R_cR_R > R_{pR}S \) and \( R_c > R_R \) often

Then the gearing says

\[ R_{cR_R} > R_{pR}S \]

\[ \Rightarrow \frac{R_{pR}S}{R_{cR_R}} - 1 < 0 \quad \Rightarrow F \text{ has an opposite sign to } F_p \]

\[ \Rightarrow F < 0 \]