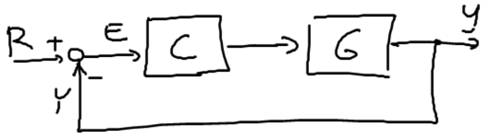
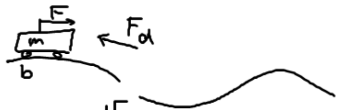


$$G_c(s) = \frac{Y(s)}{R(s)} = \frac{G(s)\cdot C(s)}{1 + G(s)\cdot C(s)} \qquad \frac{E(s)}{R(s)} = \frac{1}{1 + G(s)\cdot C(s)}$$

$$Y = G\cdot C\,(R - Y) = G\cdot C\, R - \underline{G\cdot C\cdot Y}$$

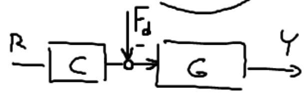
$$(1 + G\cdot C)\,Y = G\cdot C\cdot R$$

$$\frac{Y}{R} = \frac{G\cdot C}{1 + G\cdot C}$$



$$m\dot{v} + bv = F - F_d$$

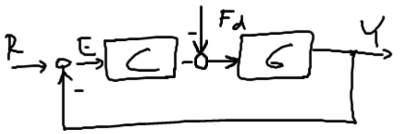
$$(ms + b)\,V(s) = F(s) - F_d(s)$$

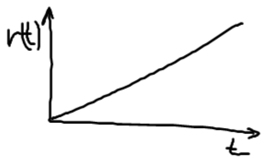


$$G(s) = \frac{1}{ms + b}$$

$$E = R - Y = \underline{R} - G\,C\,\underline{R} + G\cdot F_d$$

$$E = \underbrace{(1 - G\cdot C)}_{\substack{G\cdot C = 1 \\ C = G^{-1}}}\,R + G\cdot F_d$$

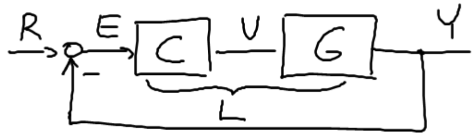




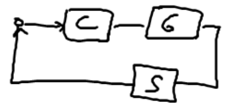
$$\underline{E} = R - Y = R - G\cdot C\cdot \underline{E} + G\cdot F_d$$

$$(1 + G\,C)\,E = R + G\cdot F_d$$

$$E = \underbrace{\frac{1}{1 + G\cdot C}}_{\substack{\approx 0 \\ \Leftrightarrow\ G\cdot C \gg 1}} R + \underbrace{\frac{G}{1 + G\cdot C}}_{\substack{\approx 0 \\ G\cdot C \gg 1}} F_d$$



$$L = G\cdot C$$

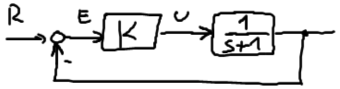


$$L = S\cdot G\cdot C$$

$$\frac{E(s)}{R(s)} = \frac{1}{1 + L(s)} \Rightarrow E(s) = \frac{1}{1 + L(s)}\, R(s)$$

$$e_{ss} = \lim_{s\to 0} \frac{s}{1 + L(s)}\cdot\frac{1}{s^k}$$

$$L(s) = \frac{K}{s+1}$$



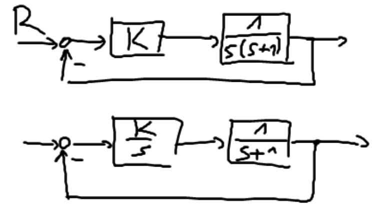
$$e_{ss} = \lim_{s\to 0} \frac{s}{1+\frac{K}{s+1}} \cdot R(s) = \lim_{s\to 0} \frac{s(s+1)}{s+1+K} \cdot R(s)$$

① $R(s) = \frac{1}{s} \Rightarrow \lim_{s\to 0} \frac{\cancel{s}(s+1)}{s+1+K} \cdot \frac{1}{\cancel{s}} = \frac{1}{1+K}$

② $R(s) = \frac{1}{s^2}$ . . . . ∞

③ $R(s) = \frac{1}{s^3}$ . . . . ∞

$$L(s) = \frac{K}{s(s+1)}$$



$$e_{ss} = \lim_{s\to 0} \frac{s}{1+\frac{K}{s(s+1)}} \cdot R(s) = \lim_{s\to 0} \frac{s^2(s+1)}{s(s+1)+K} \cdot R(s)$$

① $R(s) = \frac{1}{s} \Rightarrow 0$

② $R(s) = \frac{1}{s^2} \Rightarrow \frac{1}{K}$

③ $R(s) = \frac{1}{s^3} \Rightarrow \infty$

$$u = K_p \cdot e + K_D \cdot e$$

$$U(s) = K_p \, E(s) + K_D \, s \, E(s)$$

$$\frac{U(s)}{E(s)} = K_p + K_D s$$

$$G = \frac{1}{s+1} \qquad C = K_p + \frac{K_i}{s}$$

$$L(s) = \frac{K_p + \frac{K_i}{s}}{s+1}$$

$$u = K_p e + K_i \int e \, dt$$

$$U(s) = K_p E(s) + K_i \frac{1}{s} \cdot E$$

$$\frac{U(s)}{E(s)} = K_p + \frac{K_i}{s}$$

$$e_{ss} = \lim_{s\to 0} \frac{s}{1+\frac{K_p+\frac{K_i}{s}}{s+1}} =$$

$$= \lim_{s\to 0} \frac{s(s+1)}{s+1+K_p+\frac{K_i}{s}} \cdot \frac{1}{s} = \lim_{s\to 0} \frac{s^2(s+1)}{s^2+(1+K_p)s+K_i} \cdot \frac{1}{\cancel{s}} = 0$$