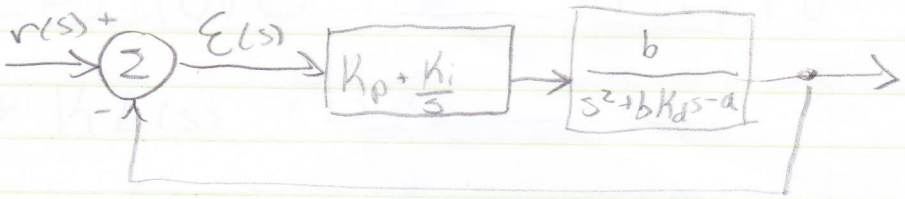
e)



$$\frac{\varepsilon(s)}{r(s)} = \frac{}{1 + \frac{(K_p + \frac{K_i}{s})b}{s^2 + bK_d s - a}} = \frac{s^2 + bK_d s - a}{s^2 + bK_d s - a + bK_p + \frac{bK_i}{s}}$$

$$\frac{\varepsilon(s)}{r(s)} = \frac{s^3 + bK_p s^2 - as}{s^3 + bK_d s^2 + (bK_p - a)s + bK_i}$$

By Final Value Thm. For $r(s) = \frac{1}{s}$ (step function)

$$\varepsilon(t=\infty) = \lim_{s \to 0} s\varepsilon(s) = \lim_{s \to 0} s \cdot \frac{s^3 + bK_p s^2 - as}{s^3 + bK_d s^2 + (bK_p - a)s + bK_i} \cdot \frac{1}{s}$$

$$= \frac{0}{bK_i} = 0$$

The PID controller should provide error-less steady-state tracking for a step input.