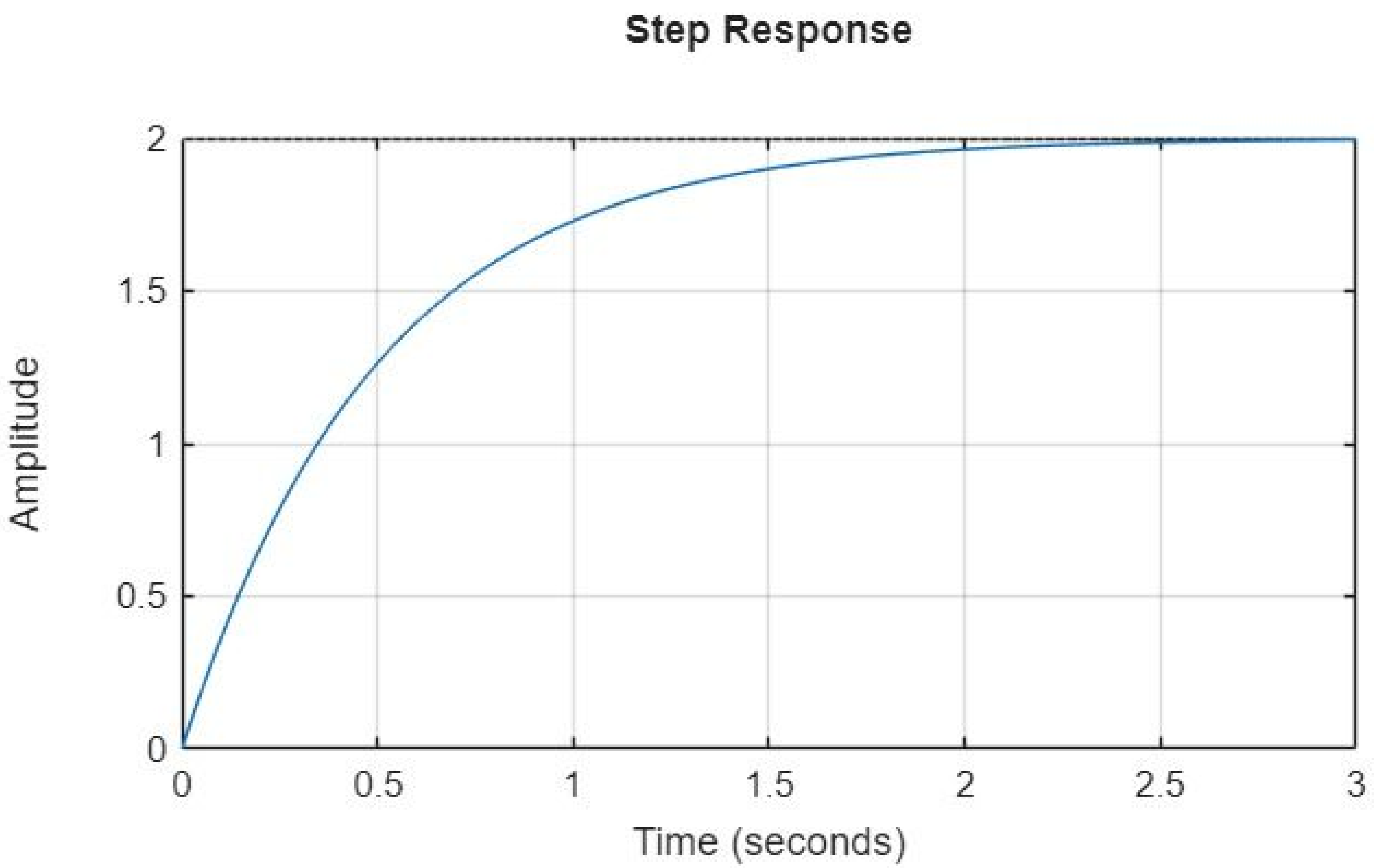


```
ans = struct with fields:
        RiseTime: 1.0985
   TransientTime: 1.9560
    SettlingTime: 1.9560
     SettlingMin: 1.8090
     SettlingMax: 1.9987
       Overshoot: 0
      Undershoot: 0
            Peak: 1.9987
        PeakTime: 3.6611
```

Q1(1)

ASSIGNMENT 1

Q1. 2. $\rightarrow \tau = \frac{1}{2} s = \underline{0.5\,s}$

$\rightarrow t_r = \underline{1.0985\ s}$

$\rightarrow t_s = \underline{1.9560\ s}$

$\rightarrow y_{ss} = \lim_{s \to 0} s . G(s) . \frac{1}{s} = \lim_{s \to 0} G(s)$

$= \lim_{s \to 0} \frac{4}{(s+2)} = \underline{2}$

$\rightarrow e_{ss} = \lim_{s \to 0} s . \left(\frac{1}{s} - G(s) . \frac{1}{s} \right) = \lim_{s \to 0} (1 - G(s))$

$= 1 - 2 = \underline{-1}$

3. y_{ss} matches MATLAB's step response final value.

Q2. 1. System type = $\underline{1}$ (Only one pole at origin)

2. Open Loop system,

$$e_{ss} = \lim_{s\to 0} s\left(\frac{1}{s} - \frac{10}{s(s+5)}\cdot\frac{1}{s}\right) = \lim_{s\to 0}\left(1 - \frac{10}{s(s+5)}\right)$$

$$= \boxed{-\text{ infinity}}$$

Closed loop system,

$$\cancel{e_{ss} = \lim_{s\to 0} s\left(\frac{1}{s}\right)} \quad \frac{C(s)}{R(s)} = \frac{G(s)}{1+G(s)}$$

$$E(s) = R(s) - C(s)$$

$$= R(s) - \frac{R(s)\,G(s)}{1+G(s)} = \frac{R(s)}{1+G(s)}$$

$$e_{ss} = \lim_{s\to 0} s\,E(s) = \lim_{s\to 0} \frac{s\cdot\frac{1}{s}}{1+\frac{10}{s(s+5)}}$$

$$= \boxed{0}$$

3. $$\frac{C(s)}{R(s)} = \frac{\frac{10}{s(s+5)}}{1+\frac{10}{s(s+5)}} = \frac{10}{s^2+5s+10} = \frac{10}{\left(s+\frac{5}{2}\right)^2+\frac{15}{4}}$$

$$\rightarrow c(t) = \frac{4\sqrt{5}}{\sqrt{3}}\cdot e^{-\frac{5}{2}t}\cdot \sin\left(\frac{\sqrt{15}}{2}t\right)\cdot u(t)$$

$\therefore$ ~~[illegible]~~ $\boxed{\text{Overshoot } 1}$

Q3. 1. $\rightarrow \frac{4}{a} < 1.2$, &, $0.1 = \frac{1}{1+K}$

$a > \frac{10}{3}$ $\qquad K = 9$

2. Consider ~~a = 9~~ . $a = \frac{10}{3}$

$$G_{new}(s) = \frac{9}{s+\frac{10}{3}}$$

3. • It should be faster than Q1 (because $t_s < 1.2s$)

- $e_{ss} = \lim_{s \to 0} \dfrac{s \cdot \frac{1}{s}}{1 + \frac{9}{s+a}} = \dfrac{1}{1+\frac{9}{a}} < \dfrac{10}{37} \approx \boxed{0.27}$

final value would be both higher or lower for varying a.

Q4. So, $T(s) = \dfrac{C(s)\,G(s)}{1 + C(s)\,G(s)}$

$$= \frac{3K(s+z)}{(s+1) + 3K(s+z)} = \boxed{\frac{3K(s+z)}{(3K+1)s + (3Kz+1)}}$$

1.
- $\boxed{z=1} \rightarrow$ Cancels pole at $s=-1$, increasing speed.
- $y_{ss} = \lim_{s \to 0} s.T(s).\frac{1}{s} = T(0)$

$$= \frac{3Kz}{3Kz+1} = \frac{4}{5} \longrightarrow 3Kz = 4$$

$$z = 1 \rightarrow 3K = 4 \rightarrow \boxed{K = 4/3}$$

- $M_p < 10\%$

$$\rightarrow e^{-\frac{\pi \zeta}{\sqrt{1-\zeta^2}}} < \frac{1}{10} \rightarrow e^{\frac{\pi \zeta}{\sqrt{1-\zeta^2}}} > 10$$

$$\rightarrow \frac{\zeta}{\sqrt{1-\zeta^2}} > \frac{\ln 10}{\pi} \rightarrow \zeta^2 > \left(\frac{\ln 10}{\pi}\right)^2 \Big/ \left(1 + \left(\frac{\ln 10}{\pi}\right)^2\right)$$

$$\rightarrow \cancel{\zeta > 0.5} \quad \boxed{\zeta \approx 0.5911}$$

2. $T(s) = \dfrac{4(s+1)}{5s+5} = \boxed{\dfrac{4}{5}}$

3.
- increase overshoot.
- increase y_{ss}
- Yes, the response would be faster the the original plant.

Q5
1. Type 0, as, $T(s) = 4/5$
2. Infinite

3. $e_{ss}^{ramp} = \lim_{s \to 0} s \cdot \left(\frac{1}{s^2} - \frac{4}{5} \cdot \frac{1}{s^2} \right)$

$= \lim_{s \to 0} s \left(\frac{1}{5s^2} \right) =$ infinite. $\Rightarrow$ Verified.

4. Adding a zero at $(s+z)$ does not help ramp tracking in any way.