MATLAB R2025b

HOME PLOTS APPS Param

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Name

Command Window

```
>> s = tf('s');
>> G = 4/(s+2);
>> step(G),grid on
>> stepinfo(G)

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

>> \
```

Workspace

Name	Value
ans	1×1 struct
G	1×1 tf
s	1×1 tf

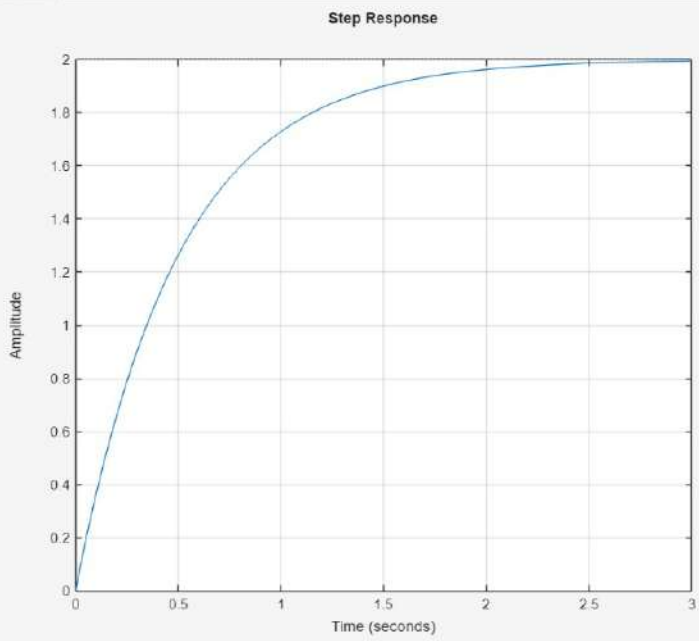
Figures

FIGURE FORMAT TOOLS LAYOUT

Save As Copy Figure Print Show Code FILE

Title Subtitle X-Label Y-Label Legend Grid Text Arrow Arrow LABELS AND ANNOTATIONS

Figure 1



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Assignment_1

(2) 1) Time constant τ :-

For 1st order system, τ is the time at which output reaches 63.2% of the final value.

$\therefore$ 63.2% of 2 = 1.264

$\therefore$ time corresponding to 1.264 on plot is

$\boxed{\tau \approx 0.5 \text{ second}}$

2) Rise time t_r :-

It is the time taken for the response to rise from 10% to 90% of the final value.

$\therefore$ Final value = 2

$\therefore$ Rise time $\Rightarrow$ time taken for output to go from 0.2 to 1.8.

$\therefore$ $t_{0.2} \approx 0.05s$, $t_{90\%} = 1.1s$

$\therefore$ $\boxed{t_r = \text{Rise time} = 1.05s}$

For 1st order systems, $\boxed{t_r = 2.2\tau}$

3) Settling time (t_s) :-

$\rightarrow$ time required for response to remain within $\pm$ 2% of final value.

$\therefore$ $2 \pm 0.04 = [1.96, 2.04]$

$\therefore$ $\boxed{t_s \approx 2 \text{ seconds}}$

Also, $\boxed{t_s = 4\tau}$ {For 1st order systems}

4) Final value.

$\rightarrow$ Final value $= \lim_{t \to \infty} c(t) = \lim_{s \to 0} sC(s) = \lim_{s \to 0} G(s)$

$\therefore$ $y_{ss} = \lim_{s \to 0} \frac{4}{s+2} \Rightarrow \boxed{y_{ss} = 2}$

5) Steady state error [ess]

$e_{ss} = r(\infty) - c(\infty)$

For a unit step input:

$r(\infty) = 1$

$\therefore \boxed{|e_{ss}| = |1-2| = 1}$

$\boxed{e_{ss} = -1}$

③ According to the plot, $\boxed{\text{Final value} = 2.}$

Q2) $G(s) = \dfrac{10}{s(s+5)}$

1] System Type = Number of pure integrators in the open-loop transfer function.

* pure integrator $\Rightarrow \frac{1}{s}$ term.

$\therefore G(s) = \dfrac{10}{s(s+5)} \Rightarrow$ No. of $\frac{1}{s}$ terms $= 1$

$\therefore$ $\boxed{\text{system Type} = \text{Type } 1}$

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

$= 1 - \lim_{s \to 0} G(s) = 1 - \infty \to -\infty$

3] MATLAB's step response should overshoot 1.

Q3] $t_s < 1.2$ seconds, $e_{ss} = 0.1$

1]

$\rightarrow t_s = \frac{4}{a} < 1.2 \Rightarrow a > \frac{4}{1.2} \Rightarrow \boxed{a > 3.33}$

$e_{ss} = \frac{1}{1+K} = 0.1 = \frac{1}{10} \Rightarrow \boxed{K = 9}$

2]

$G_{new}(s) = \frac{K}{s+a} \Rightarrow \boxed{G_{new}(s) = \frac{9}{s+3.33}}$

3) • ~~Final value = $\lim_{s \to 0} s \cdot G(s) \cdot \frac{1}{s}$~~

~~$= \frac{9}{3.33} = 2.7$~~ $e_{ss} = 1 -$ Final value

$\therefore$ $\boxed{\text{Final value} = 1 - e_{ss} = 0.9}$

$\therefore$ Final value is ~~higher~~ less than in Q1.

• As seen from the plot, final value reaches in 1.8s only implying that this plot is faster.

Q4) $G(s) = \frac{3}{s+1}$, $\boxed{C(s) = K(s+z)}$

- Closed Loop Transfer function

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

1) To reduce rise time,
zero z is to be placed near the plant pole.

$\therefore \boxed{z = 1}$

$\therefore$ Put $z = 1$.

$$\therefore \boxed{T(s) = \frac{3K\cancel{(s+1)}}{(1+3K)\cancel{(s+1)}} = \frac{3K}{1+3K}}$$

Now, $y_{ss} = \lim_{s \to 0} T(s) = 0.8 = \frac{4}{5} = \frac{3K}{1+3K}$

$\therefore 15K = 4 + 12K \Rightarrow \boxed{K = \frac{4}{3}} \Rightarrow \boxed{K = 1.33}$

- $M_p = e^{-\frac{\delta\pi}{\sqrt{1-\delta^2}}} < \frac{1}{10}$

$\therefore \ln 10 < \frac{\delta\pi}{\sqrt{1-\delta^2}} \Rightarrow (\ln 10)^2 < \frac{\delta^2\pi^2}{1-\delta^2}$

$\therefore 1-\delta^2 < \delta^2\left(\frac{\pi}{\ln 10}\right)^2$

$\therefore 1 < \delta^2\left[\left(\frac{\pi}{\ln 10}\right)^2 + 1\right] \Rightarrow \boxed{\delta^2 > \frac{1}{1+\left(\frac{\pi}{\ln 10}\right)^2}}$

2) $T(s) = \frac{4}{1+4} = \frac{4}{5}$

3) • Adding zero tends to increase overshoot [thereby decreasing Rise time].
BUT, here,
Adding zero makes transfer function = constant
$\Rightarrow$ overshoot = 0 and remains 0.
Hence, constant and No change.

• $y_{ss} = \frac{3}{\frac{1}{K}+3} \Rightarrow K\uparrow, \frac{1}{K}\downarrow \Rightarrow 3+\frac{1}{K}\downarrow, \frac{3}{3+\frac{1}{K}}\uparrow$

$\therefore \boxed{\uparrow K \Rightarrow \uparrow y_{ss}}$

• Yes. Response is faster as $t_s < 2s$.

Q5]

→ 1] In open loop,

$$T(s) = C(s)\,G(s) = \frac{3K(s+2)}{s+1} \Rightarrow \text{Type } 0.$$

In closed loop,

$$T(s) = \frac{3K(s+2)}{s+1+3K(s+2)} \Rightarrow \text{Type } 0.$$

$\therefore$ $\boxed{\text{Type 0 for closed-loop system.}}$

2] Ramp error for Type 0 system = infinite.

3] $$e_{ss}^{ramp} = \lim_{s\to 0} s\left(\frac{1}{s^2} - \frac{T(s)}{s^2}\right) = \infty$$

4] No effect.

—x—x—x—