Assignment – 01

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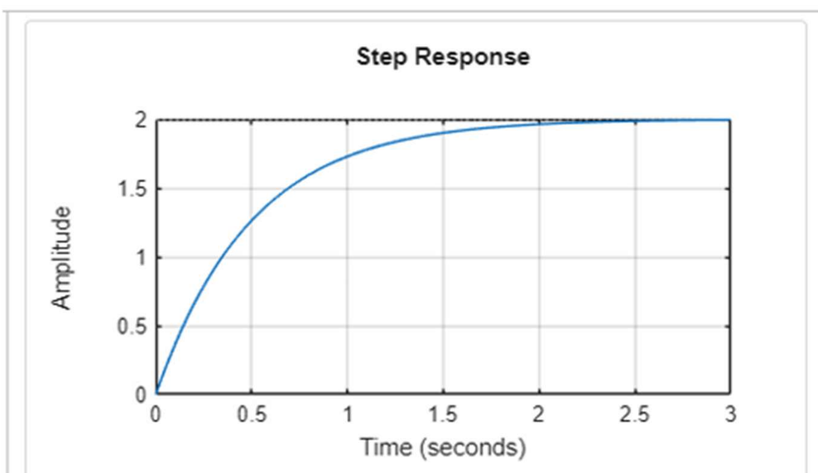
Question 1

untitled *

```
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
```

$\zeta = 0.45538$

1. $t_n = 2.2\tau = 1.0585$

obtained value from graph: $1.5587 \simeq 2$

Theoretical value:

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

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

$$y_{ss} = \frac{4}{2} = 2$$

for

$$e_{ss} = \frac{1}{1+k_p}$$

$$k_p = \lim_{s \to 0} G(s) H(s)$$

Assume $H(s) = 1$

$$k_p = 2$$

$$e_{ss} = \frac{1}{3}$$

Question 2

2. $G(s) = \frac{10}{s(s+5)}$

i) Nod poles at origin of $G(s)$.
One s in denominator (at origin)

Type-I system (integrator)

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

$e_{ss} = (1 - \infty)$

∞ refers a very large quantity.

$E(s) = \frac{R(s)}{1+G(s)}$ for $R(s) = \frac{1}{s}$ unit step

$e_{ss} = \lim_{s \to 0} sE(s) = \lim_{s \to 0} \frac{1}{1+G(s)} = 0$

Stedy state error $= 0$

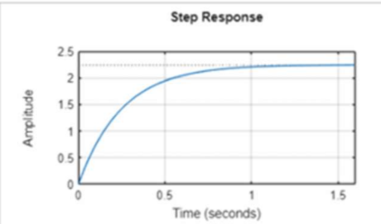
(iii) $\lim_{s \to \infty} y(s) = \lim_{s \to 0} \frac{sG(s)R(s)}{1+G(s)} = 1$

- Poles at 0 $\Rightarrow$ stable & not oscillatory
- NO need to settle below 1
- No stedy state error.

Question 3

untitled * × +

```
s = tf('s');
G = 9/(s+4);
step(G), grid on
stepinfo(G)
```




```
ans = struct with fields:
        RiseTime: 0.5493
   TransientTime: 0.9780
    SettlingTime: 0.9780
     SettlingMin: 2.0351
     SettlingMax: 2.2485
       Overshoot: 0
      Undershoot: 0
            Peak: 2.2485
        PeakTime: 1.8306
```

3. $t_s < 1.2$ Seconds

$e_{ss} = 0.1$

i) $t_s = \frac{4}{a} < 1.2$

$a > 3.33$

$e_{ss} = 0.1 = \frac{1}{1+k}$

$0.1k + 0.1 = 1$

$k = 9$

ii) $G_{new}(s) = \frac{k}{s+a} = \frac{9}{s+4}$

iii) Q1 pole was at $s=-2$

(a) New pole is at $s=-4$

More negative pole ⇒ faster Response

(b)

$y(\infty) = \frac{K}{a} = \frac{9}{4} = 2.25$

in Q1

final Value $= 2$

Q3 has higher final value than Q1.

Question 4

untitled *
1
2
3
4
s = tf('s');
G = (4*s+12)/(7*s+15);
step(G), grid on
stepinfo(G)
Step Response
Amplitude
0.8
0.75
0.7
0.65
0.6
0.55
0
0.5
1
1.5
2
2.5
3
Time (seconds)
ans = struct with fields:
RiseTime: 0.4900
TransientTime: 1.8256
SettlingTime: 1.2411
SettlingMin: 0.7207
SettlingMax: 0.7998
Overshoot: 0
Undershoot: 0
Peak: 0.7998
PeakTime: 3.4170

4. $G(s) = \frac{3}{s+1}$ $\quad C(s) = K(s+2)$

i) Zero should be left of the pole for reducing rise time.

pole at $s=-1$

Choose $z=3$

Closed loop DC gain

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

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

$$C(s)G(s) = \frac{3K(s+3)}{s+1}$$

At $s=0$

$$y_{ss} = \frac{9K}{1+9K} = 0.8$$

$$9K = 0.8 + 7.2K$$

$$K = \frac{4}{9}$$

$M_p < 10\% \Rightarrow e^{\left(\frac{-\delta\pi}{\sqrt{1-\delta^2}}\right)} < 10\%$

$$\delta \geq 0.6$$