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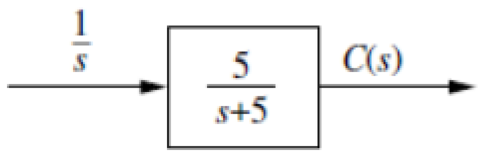
BME

Exercise

1. Plot the step responses for the systems shown in Fig. 1 using MATLAB

a)



$$R(S) = \frac{1}{S}$$

$$G(S) = \frac{5}{S+5}$$

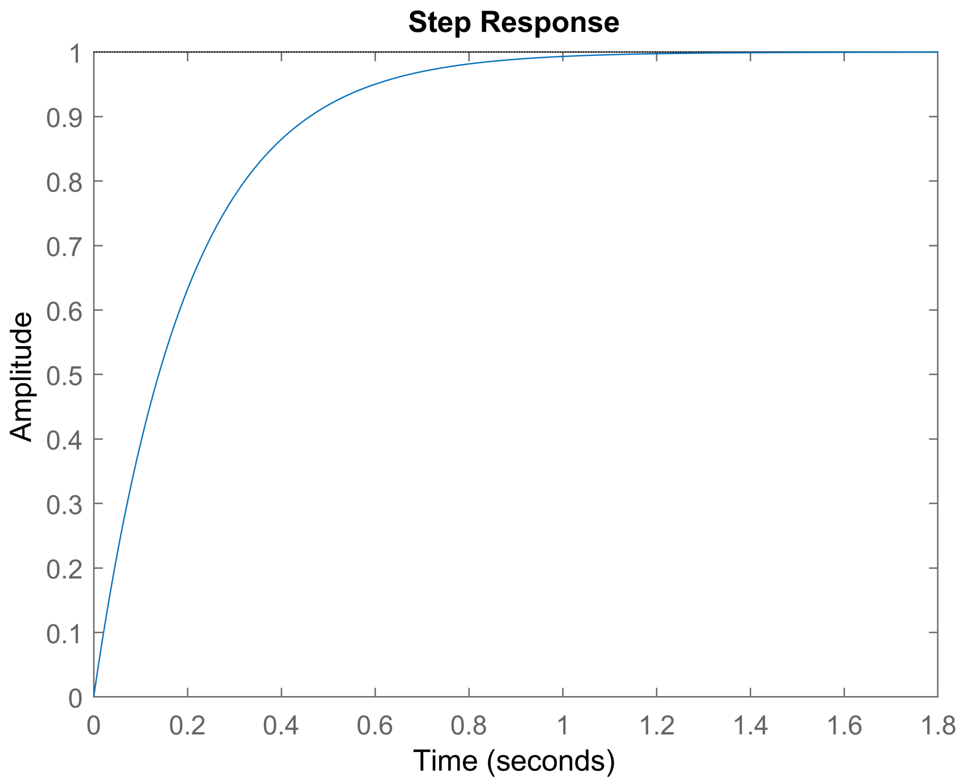
$$C(S) = \frac{5}{S(S+5)}$$

$$\text{Numerator} = 5$$
$$\text{Denominator} = S^2 + 5S$$

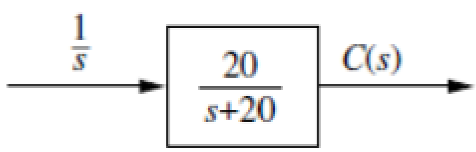
```
num1 = 5;
den1 = [1 5];
H=tf(num1,den1);
display(H);
```

```
H =

    5
  -----
  s + 5

Continuous-time transfer function.
```

```
stepplot(H);
```



b)



$$R(S) = \frac{1}{S}$$

$$G(S) = \frac{20}{S+20}$$

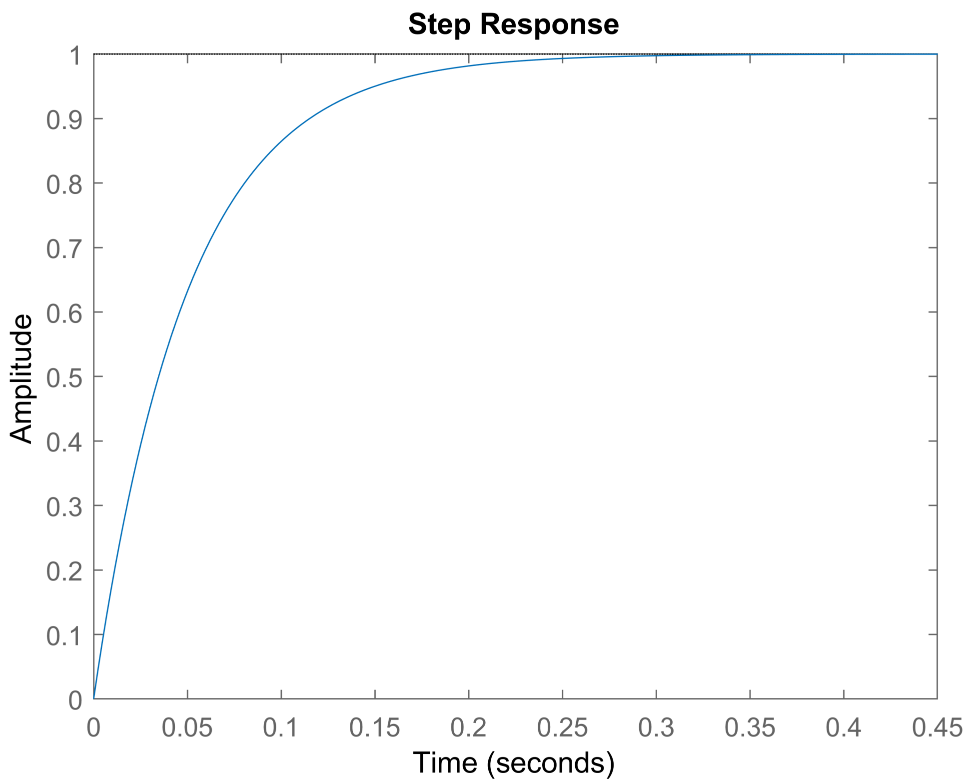
$$C(S) = \frac{20}{S(S+20)}$$

```
num2 = 20;
den2 = [1 20];
H2=tf(num2,den2);
display(H2);
```

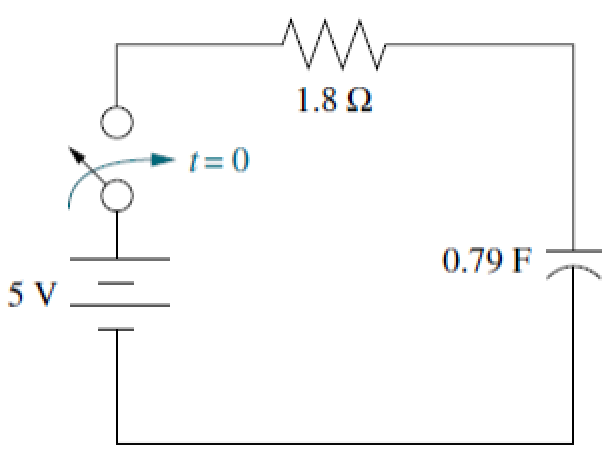
```
H2 =
```

```
  20
------
s + 20

Continuous-time transfer function.
```

```
stepplot(H2);
```



2. Plot the step response for the system shown in Fig. 2 using MATLAB. From your plots, find the time constant, rise time, and settling time and compare them with ones you obtain from the equations.



$$V_c(S) = \frac{3.519}{S(S + 0.703)}$$

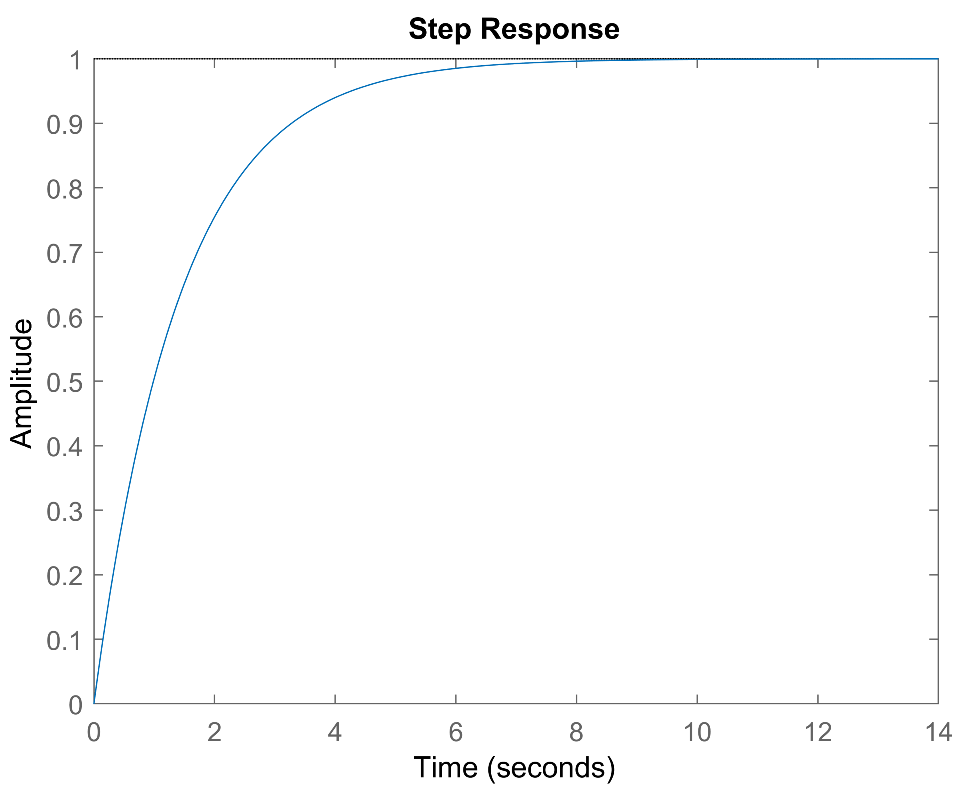
$$V(S) = \frac{5}{S}$$

$$T(S) = \frac{V_c(S)}{V(S)} = \frac{(0.703)}{S + 0.703}$$

```
num2 = 0.703;
den2 = [1 0.703];
H2=tf(num2,den2);
display(H2);
```

```
H2 =

    0.703
  ---------
  s + 0.703

Continuous-time transfer function.
```

```
stepplot(H2,0:0.001:14);
```



$t = 1.416s \quad < - - - \quad Y = 0.632$

Therfore, $\quad T_{\text{calculated}} \simeq T_{\text{graphs}}$

$t_1 = 0.153s \quad < - - - \quad Y = 0.1$

$t_2 = 3.280s \quad < - - - \quad Y = 0.9$

$T_r = t_2 - t_1 = 3.127s$

Therfore, $T_{r(\text{calculated})} \simeq T_{r(\text{graphs})} = 3.127s$

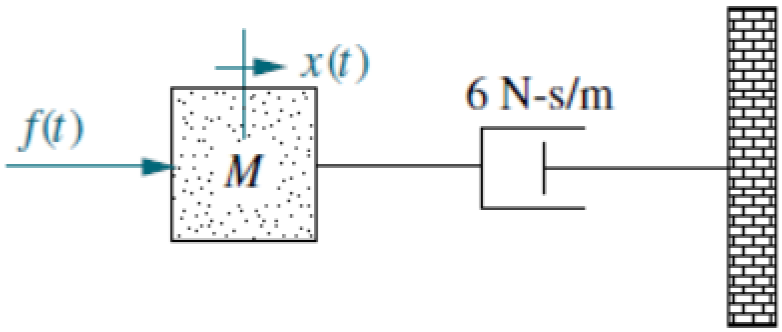
$T_r \simeq 2.2T$

$t_3 = 5.565s \quad < - - - \quad Y = 0.98$

Therfore, $T_{s(\text{calculated})} \simeq T_{s(\text{graphs})} = 5.565s$

$T_r \simeq 4T$

3. Plot the step response for the system shown in Fig. 3 using MATLAB. From your plots, find the time constant, rise time, and settling time. Use M = 1 and M = 2.



$$G(S) = \frac{1}{M\left(S + \frac{6}{M}\right)}$$

$\boldsymbol{M} = 1,$

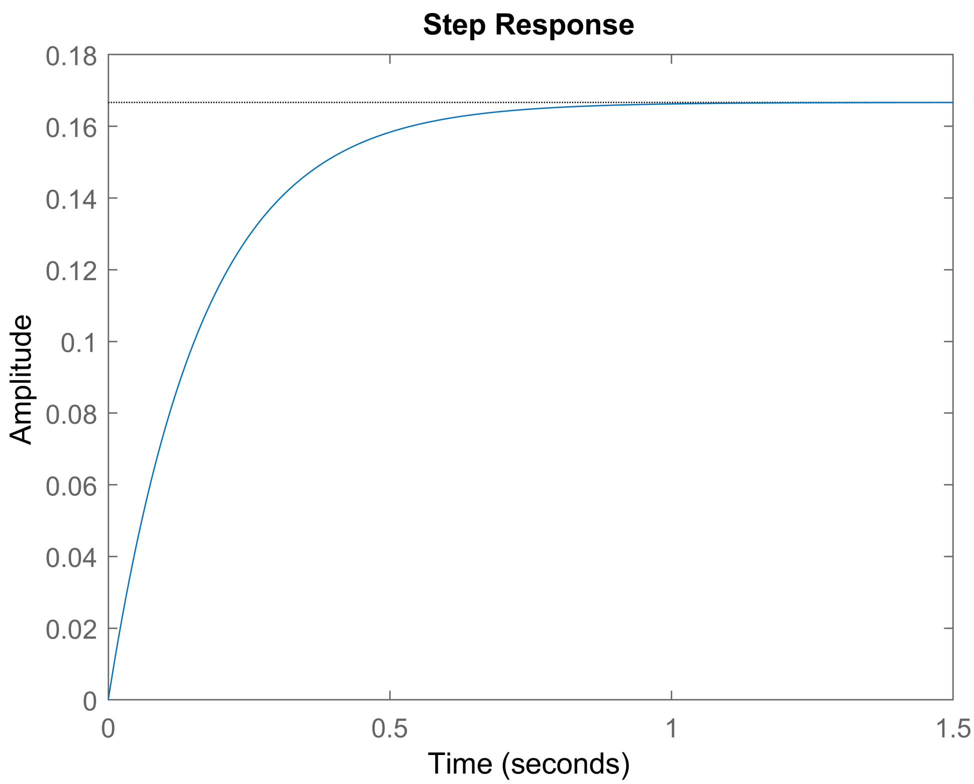
$$G(S) = \frac{1}{(S + 6)}$$

```
num3 = 1;
den3 = [1 6];
H3=tf(num3,den3);
display(H3);
```

```
H3 =
```

```
      1
    -----
    s + 6

  Continuous-time transfer function.
```

```
stepplot(H3,0:0.001:1.5);
```



$t = 0.166s \quad < - - - \quad Y = 0.632 \times 1.666 = 0.105$

Therfore, $\quad T = 0.166s$

$t_1 = 0.018s \quad < - - - \quad Y = 0.1 \times 1.666 = 0.017$

$t_2 = 0.384s \quad < - - - \quad Y = 0.9 \times 1.666 = 0.150$

$T_r = t_2 - t_1 = 0.366s$

$t_3 = 0.637s \quad < - - - \quad Y = 0.98 \times 1.666 = 0.163s$

Therfore, $T_s = 0.637s$

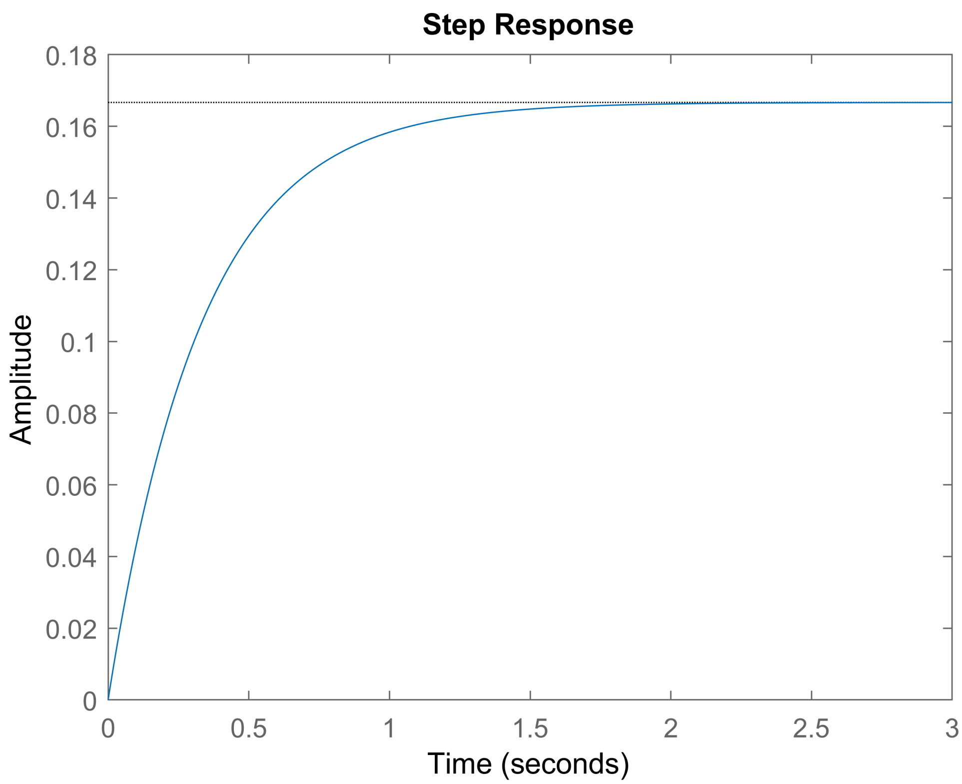
$\boldsymbol{M} = 2,$

$G(S) = \dfrac{1}{2(S+3)}$

```
num4 = 1;
den4 = [2 6];
H4=tf(num4,den4);
display(H4);
```

```
H4 =

      1
  -------
  2 s + 6

Continuous-time transfer function.
```

```
stepplot(H4,0:0.001:3);
```



$t = 0.331s \quad < - - - \quad Y = 0.632 \times 1.666 = 0.105$

Therfore, $\quad T = 0.331s$

$t_1 = 0.036s \quad < - - - \quad Y = 0.1 \times 1.666 = 0.017$

$t_2 = 0.767s \quad < - - - \quad Y = 0.9 \times 1.666 = 0.150$

$T_r = t_2 - t_1 = 0.731s$

$t_3 = 0.163s \quad < - - - \quad Y = 0.98 \times 1.666 = 0.163s$

Therfore, $T_s = 1.268s$