

Risposte di Funzioni Di Trasferimento (FDT)

Setup

```
close all;  
clear all;  
clc;  
FS = 18; % FontSize  
LW = 2; % LineWidth
```

Variabili simboliche

```
syms Yel(s)  
syms yel(t)
```

Esempio

Asse del tempo

```
tt = linspace(0, 10, 1000);
```

Esercizio 2.11.1

FDT

```
G = tf([9 1], [2 3 2])
```

G =

$$\frac{9s + 1}{2s^2 + 3s + 2}$$

Continuous-time transfer function.
Model Properties

Modello del sistema

```
[A,B,C,D] = tf2ss(G.Numerator{1}, G.Denominator{1})
```

```
A = 2x2  
   -1.5000   -1.0000  
    1.0000    0  
B = 2x1  
    1  
    0  
C = 1x2  
    4.5000    0.5000  
D =  
    0
```

Autovalori

```
eig(A)
```

```
ans = 2×1 complex  
-0.7500 + 0.6614i  
-0.7500 - 0.6614i
```

Evoluzione libera

Trasformata

```
Yel(s) = simplify(free_evolution(A, C, ones(size(C))'));  
pretty(Yel)
```

```
      20 s - 13  
-----  
      2  
4 s  + 6 s + 4
```

Evoluzione libera nel dominio del tempo

```
yel(t) = simplify(ilaplace(Yel));  
pretty(vpa(yel, 4))
```

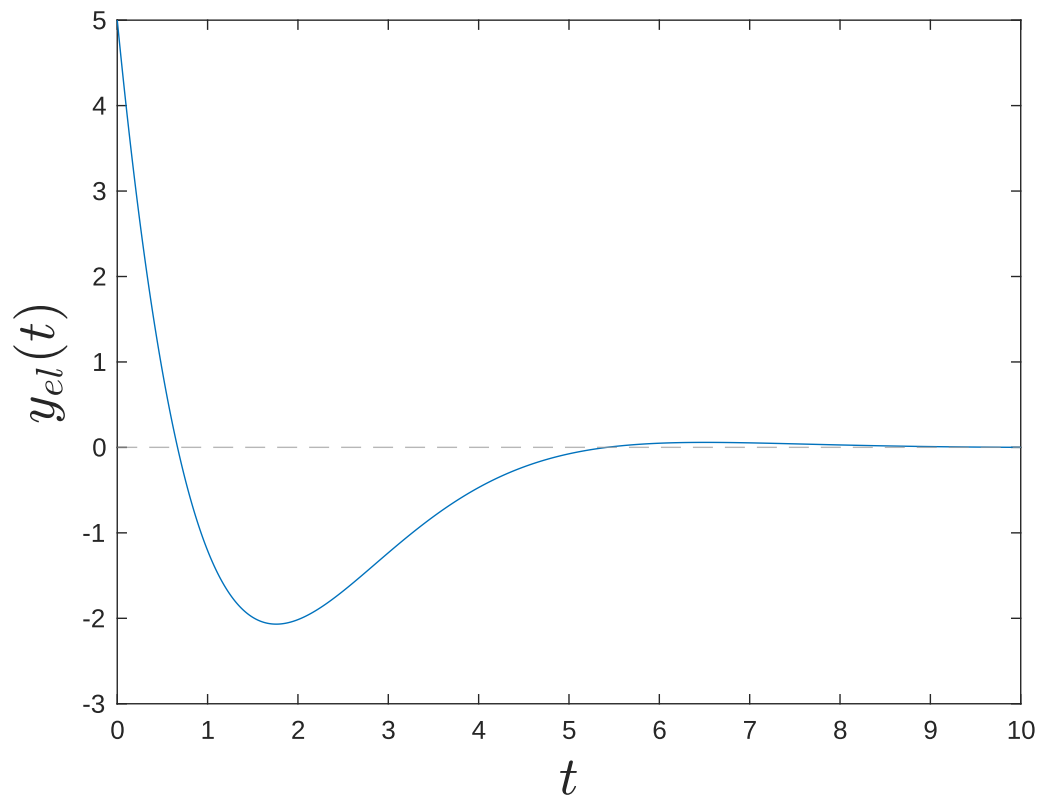
```
exp(-0.75 t) (cos(0.6614 t) - sin(0.6614 t) 2.117) 5.0
```

Grafico

Evoluzione libera

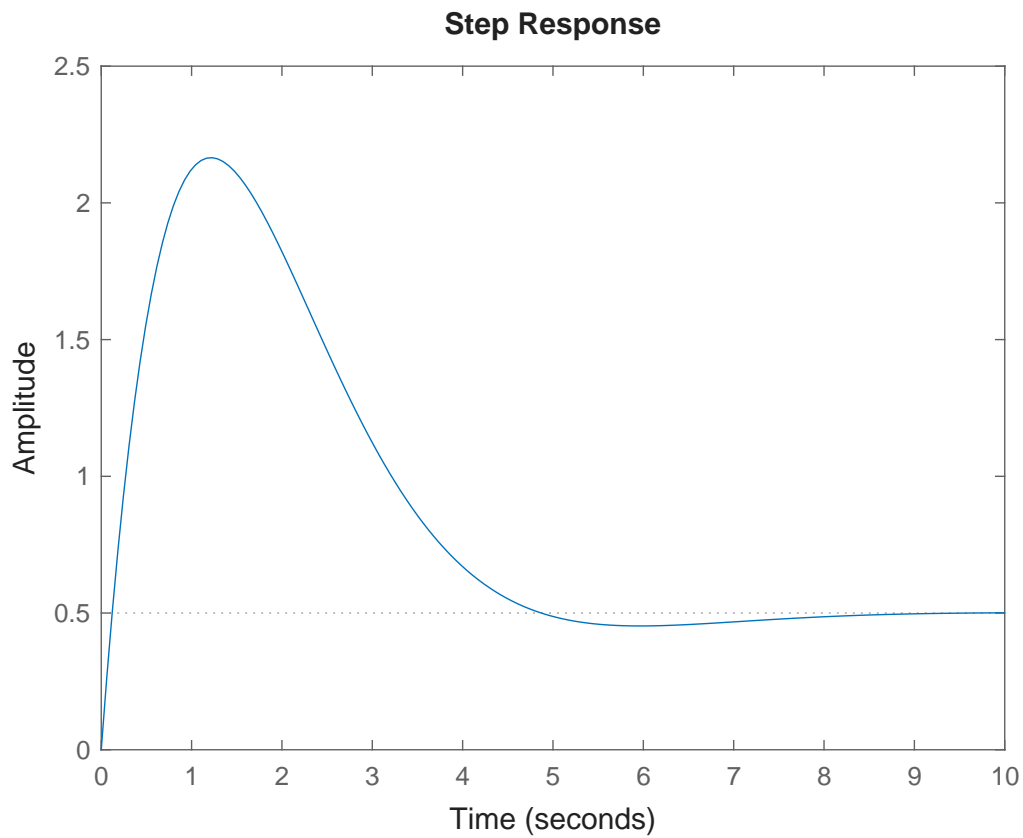
```
figure(Name='Evoluzione libera')  
plot(tt, yel(tt))  
xlim([tt(1) tt(end)])  
xlabel('$$t$$', Interpreter='latex', FontSize=20)  
ylabel('$$y_{el}(t)$$', Interpreter='latex', FontSize=20)  
yline(double(yel(tt(end))), '--', LineWidth=0.5, Color=[0.6 0.6 0.6])  
title("Evoluzione libera", Interpreter='latex', FontSize=20)
```

Evoluzione libera



Risposta al gradino

```
figure(Name='Risposta al gradino')  
step(G)
```



G1

Funzione di trasferimento

```
G1 = zpk([], [-2], 10)
```

G1 =

$$\frac{10}{s+2}$$

Continuous-time zero/pole/gain model.
Model Properties

```
G1 = tf(G1)
```

G1 =

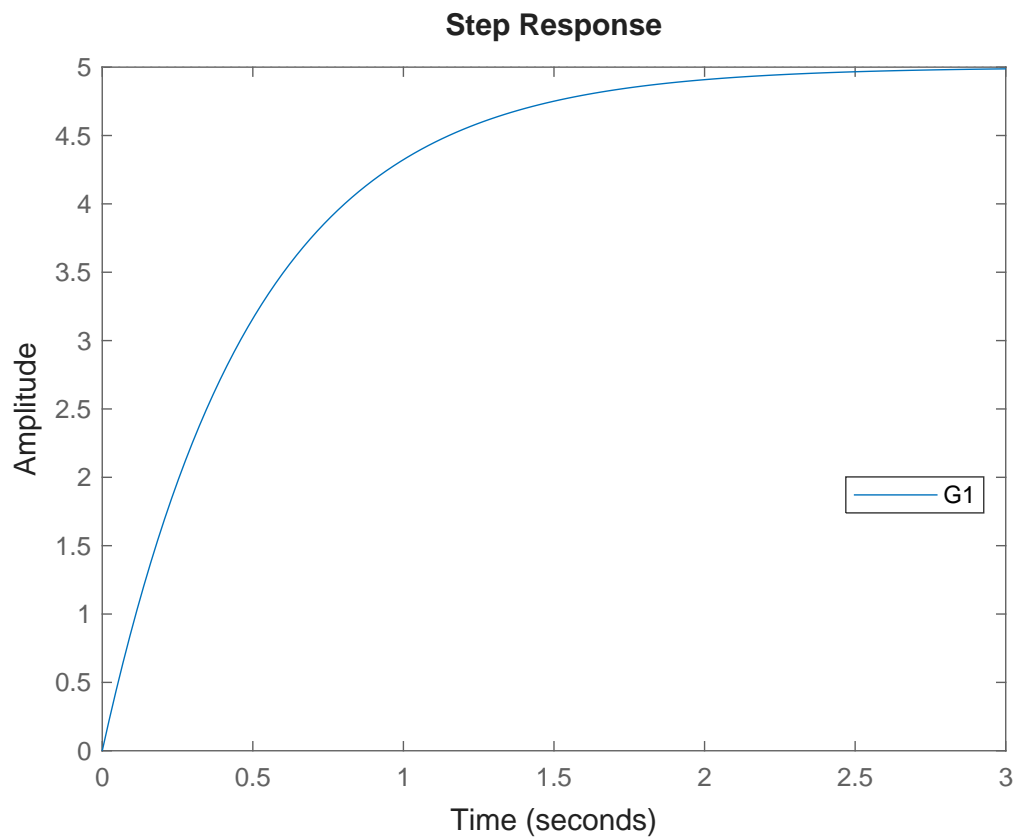
$$\frac{10}{s+2}$$

Continuous-time transfer function.
Model Properties

Risposta al gradino

```
figure(Name='G1')
step(G1)
```

```
set(findall(gcf, Property='FontSize'), FontSize=FS)
set(findall(gcf, Type='Line'), LineWidth=LW)
legend(Location='best');
```



G2

Funzione di trasferimento

```
G2 = zpk([], [-2, -10-10j, -10+10j], 2000)
```

G2 =

$$\frac{2000}{(s+2)(s^2 + 20s + 200)}$$

Continuous-time zero/pole/gain model.
Model Properties

```
G2 = tf(G2)
```

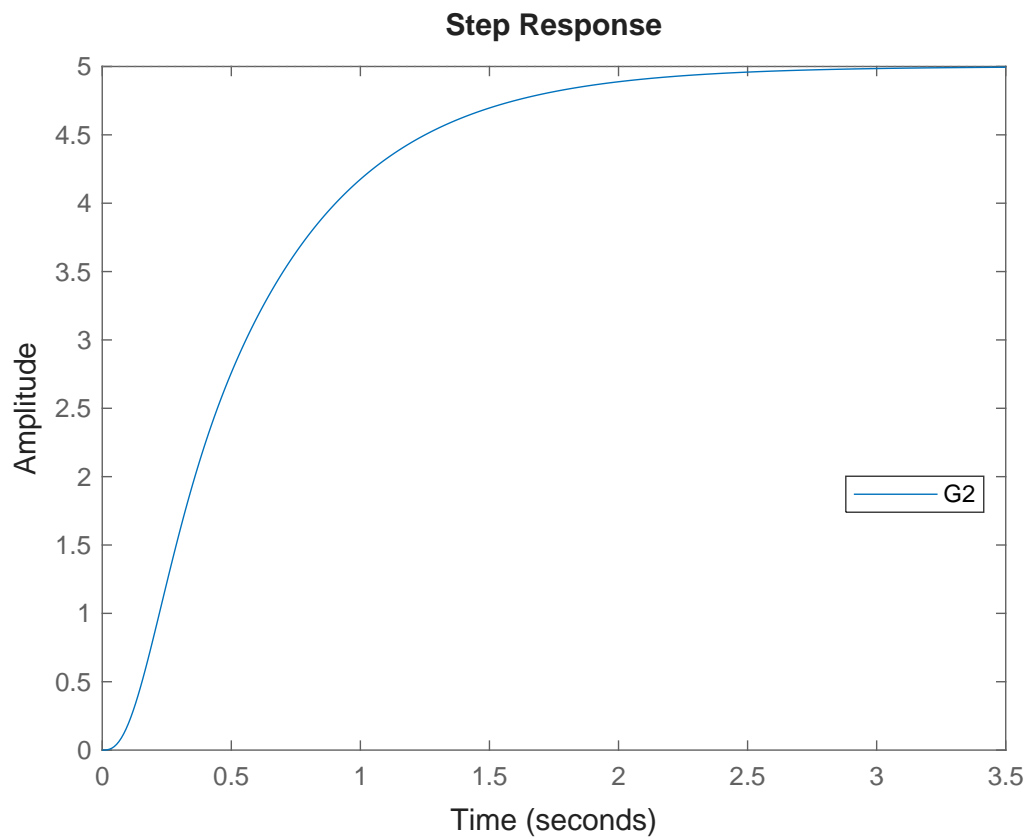
G2 =

$$\frac{2000}{s^3 + 22 s^2 + 240 s + 400}$$

Continuous-time transfer function.
Model Properties

Risposta al gradino

```
figure(Name='G2')
step(G2)
set(findall(gcf, Pproperty='FontSize'), FontSize=FS)
set(findall(gcf, Type='Line'), LineWidth=LW)
legend(Location='best');
```



G3

Funzione di trasferimento

```
G3 = zpk([], [-2, -2-2j, -2+2j], 80)
```

G3 =

$$\frac{80}{(s+2)(s^2 + 4s + 8)}$$

Continuous-time zero/pole/gain model.
Model Properties

```
G3 = tf(G3)
```

G3 =

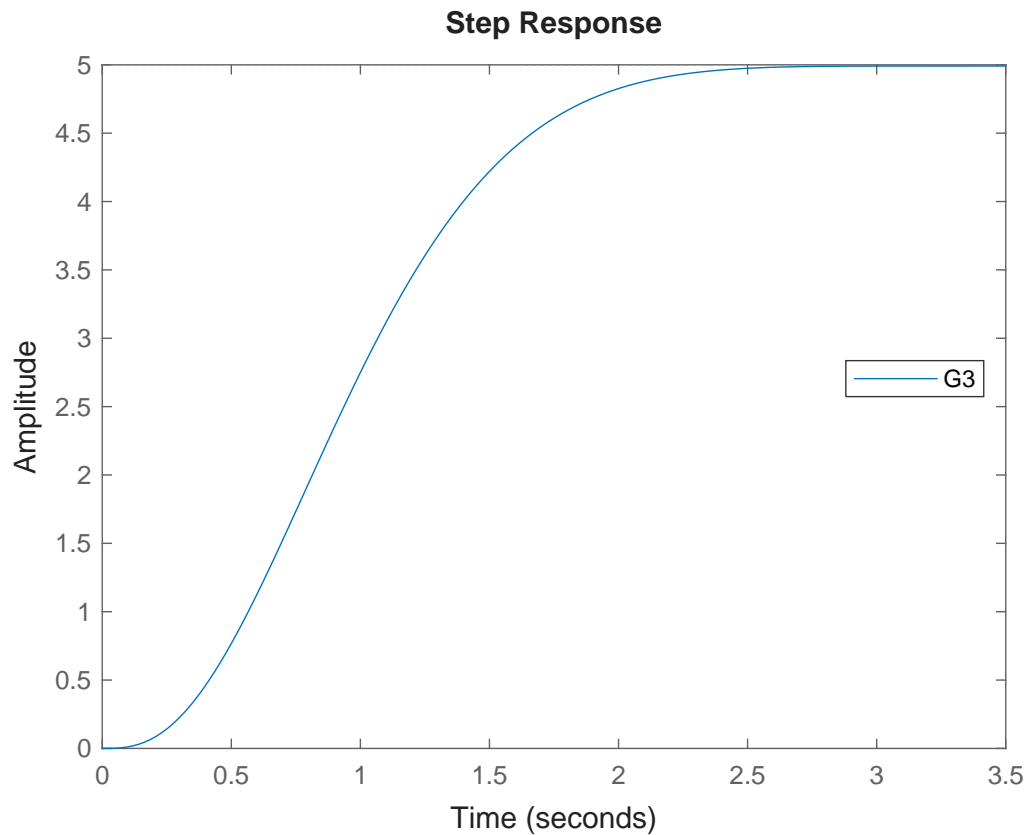
$$80$$

$$\frac{s^3 + 6s^2 + 16s + 16}{s^3 + 6s^2 + 16s + 16}$$

Continuous-time transfer function.
Model Properties

Risposta al gradino

```
figure(Name='G3')
step(G3)
set(findall(gcf, Property='FontSize'), FontSize=FS)
set(findall(gcf, Type='Line'), LineWidth=LW)
legend(Location='best');
```



G4

Funzione di trasferimento

```
G4 = zpk([], [-2, -2-20j, -2+20j], 4040)
```

G4 =

$$\frac{4040}{(s+2)(s^2 + 4s + 404)}$$

Continuous-time zero/pole/gain model.
Model Properties

```
G4 = tf(G4)
```

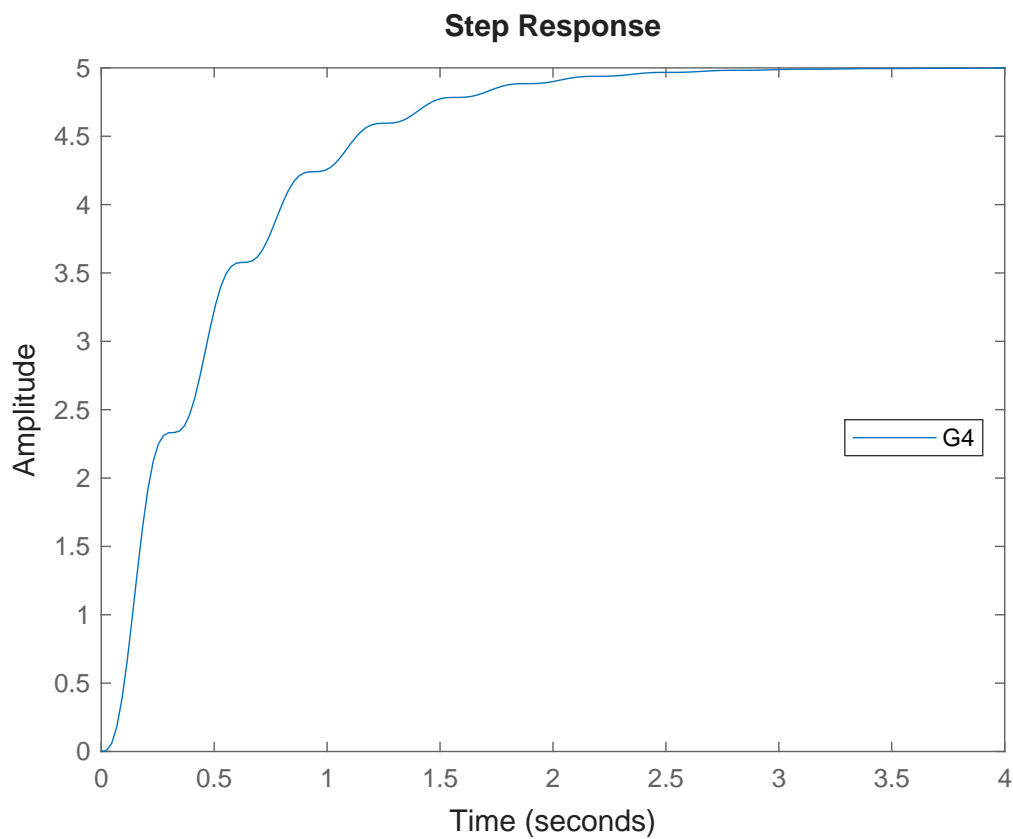
G4 =

$$\frac{4040}{s^3 + 6s^2 + 412s + 808}$$

Continuous-time transfer function.
Model Properties

Risposta al gradino

```
figure(Name='G4')  
step(G4)  
set(findall(gcf, Property='FontSize'), FontSize=FS)  
set(findall(gcf, Type='Line'), LineWidth=LW)  
legend(Location='best');
```



G5

Funzione di trasferimento

```
G5 = zpk([], [-10, -2-20j, -2+20j], 20200)
```

G5 =

$$\frac{20200}{s^3 + 10s^2 + 40s + 20}$$


```
(s+10) (s^2 + 4s + 404)
```

Continuous-time zero/pole/gain model.
Model Properties

```
G5 = tf(G5)
```

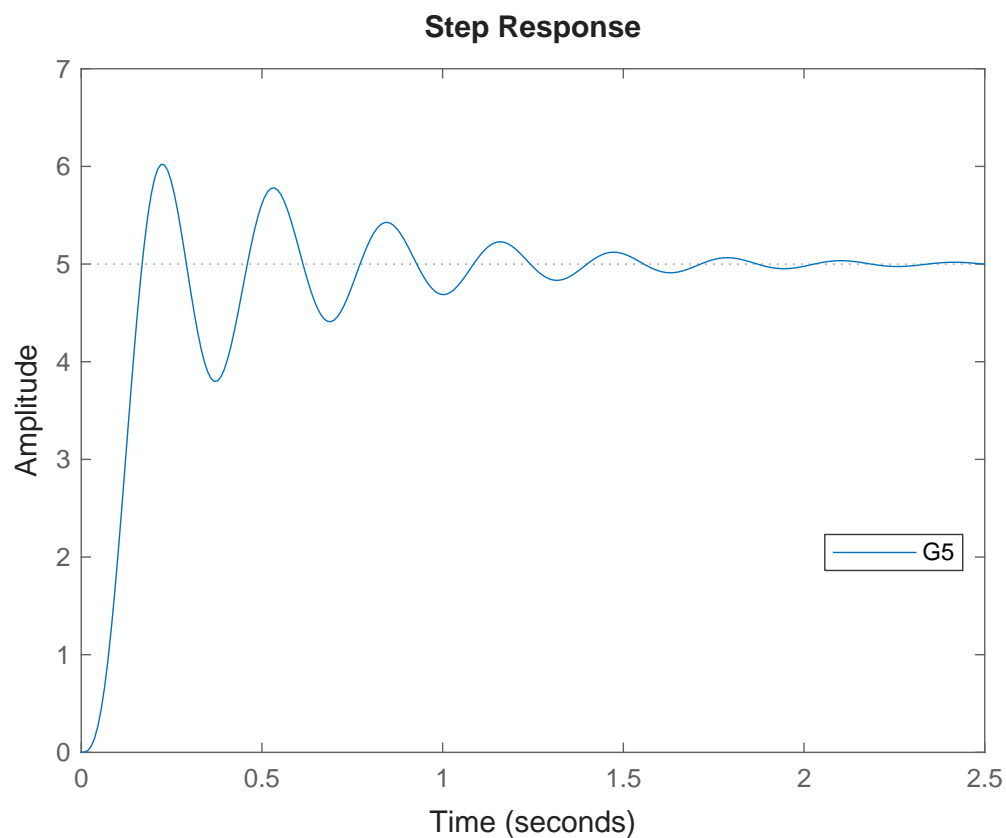
G5 =

$$\frac{20200}{s^3 + 14s^2 + 444s + 4040}$$

Continuous-time transfer function.
Model Properties

Risposta al gradino

```
figure(Name='G5')  
step(G5)  
set(findall(gcf, Property='FontSize'), FontSize=FS)  
set(findall(gcf, Type='Line'), LineWidth=LW)  
legend(Location='best');
```



H1

Funzione di trasferimento

```
H1 = zpkm([], [-2, -10-100j, -10+100j], 101000)
```

H1 =

$$\frac{1.01e+05}{(s+2)(s^2 + 20s + 1.01e04)}$$

Continuous-time zero/pole/gain model.
Model Properties

H1 = tf(H1)

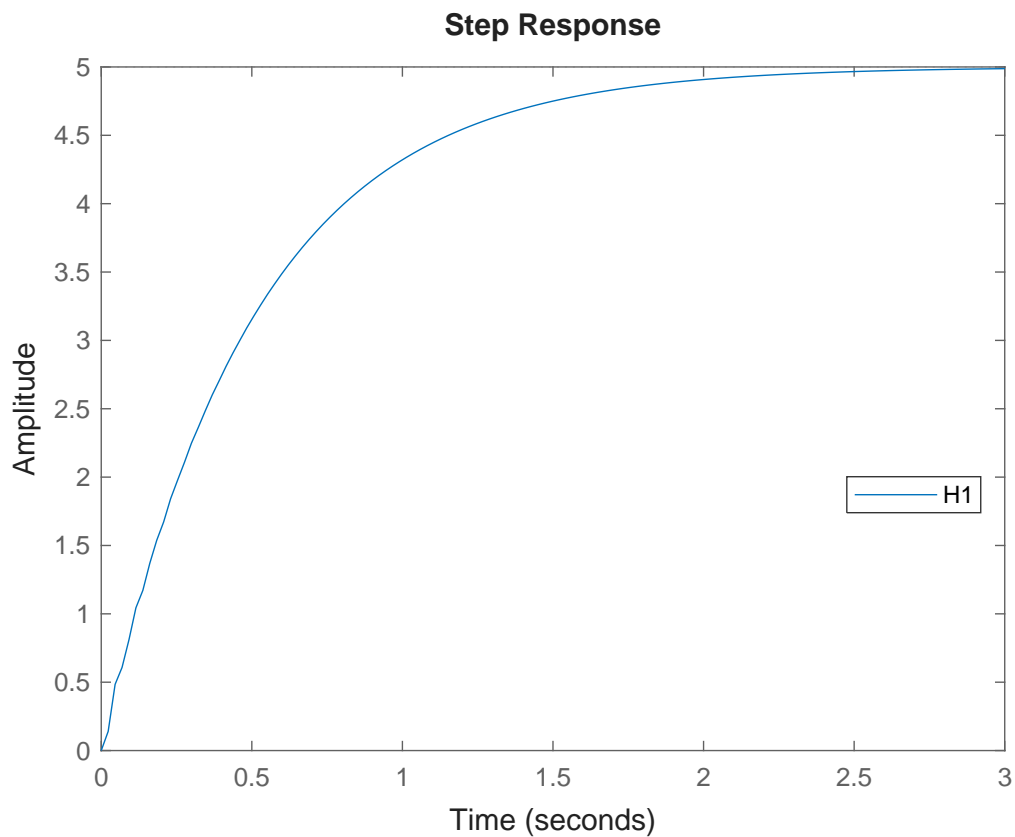
H1 =

$$\frac{101000}{s^3 + 22s^2 + 10140s + 20200}$$

Continuous-time transfer function.
Model Properties

Risposta al gradino

```
figure(Name='H1')
step(H1)
set(findall(gcf, Property='FontSize'), FontSize=FS)
set(findall(gcf, Type='Line'), LineWidth=LW)
legend(Location='best');
```



H2

Funzione di trasferimento

```
H2 = zpk([-1.9], [-2, -10-100j, -10+100j], 101000/1.9)
```

H2 =

$$\frac{53158 (s+1.9)}{(s+2) (s^2 + 20s + 1.01e04)}$$

Continuous-time zero/pole/gain model.
Model Properties

```
H2 = tf(H2)
```

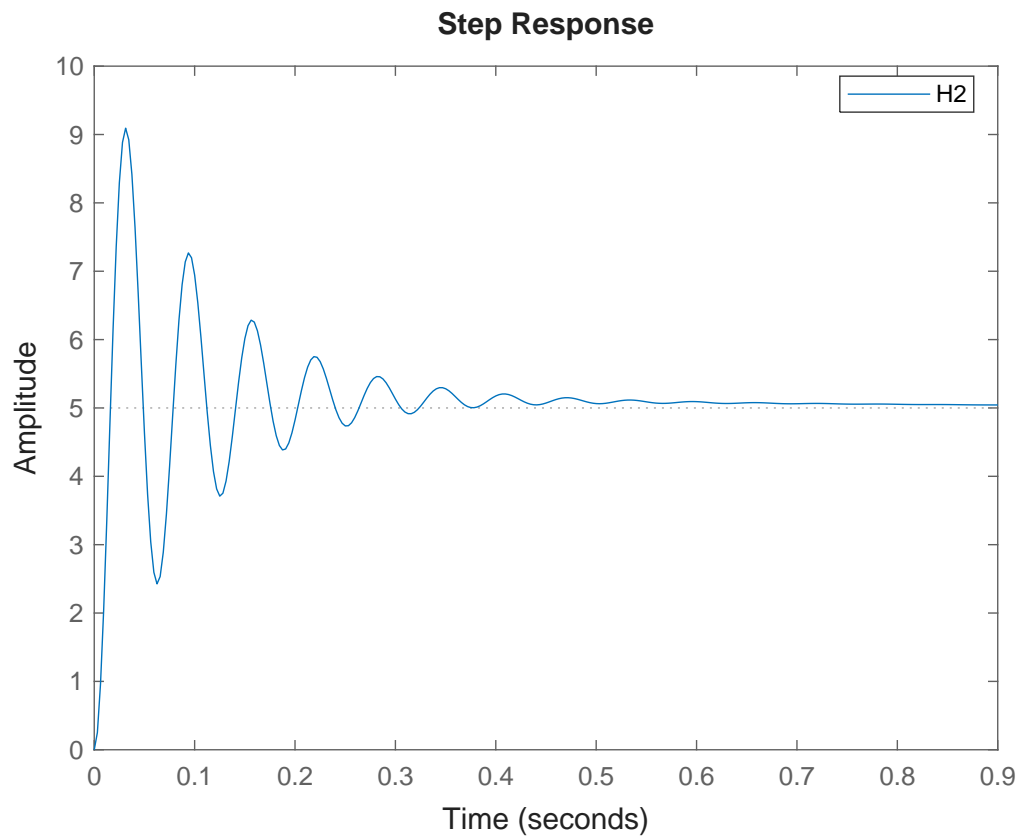
H2 =

$$\frac{5.316e04 s + 101000}{s^3 + 22 s^2 + 10140 s + 20200}$$

Continuous-time transfer function.
Model Properties

Risposta al gradino

```
figure(Name='H2')  
step(H2)  
set(findall(gcf, Property='FontSize'), FontSize=FS)  
set(findall(gcf, Type='Line'), LineWidth=LW)  
legend(Location='best');
```



H3

Funzione di trasferimento

```
H3 = zpke([-5], [-2, -10-100j, -10+100j], 20200)
```

H3 =

$$\frac{20200 (s+5)}{(s+2) (s^2 + 20s + 1.01e04)}$$

Continuous-time zero/pole/gain model.
Model Properties

```
H3 = tf(H3)
```

H3 =

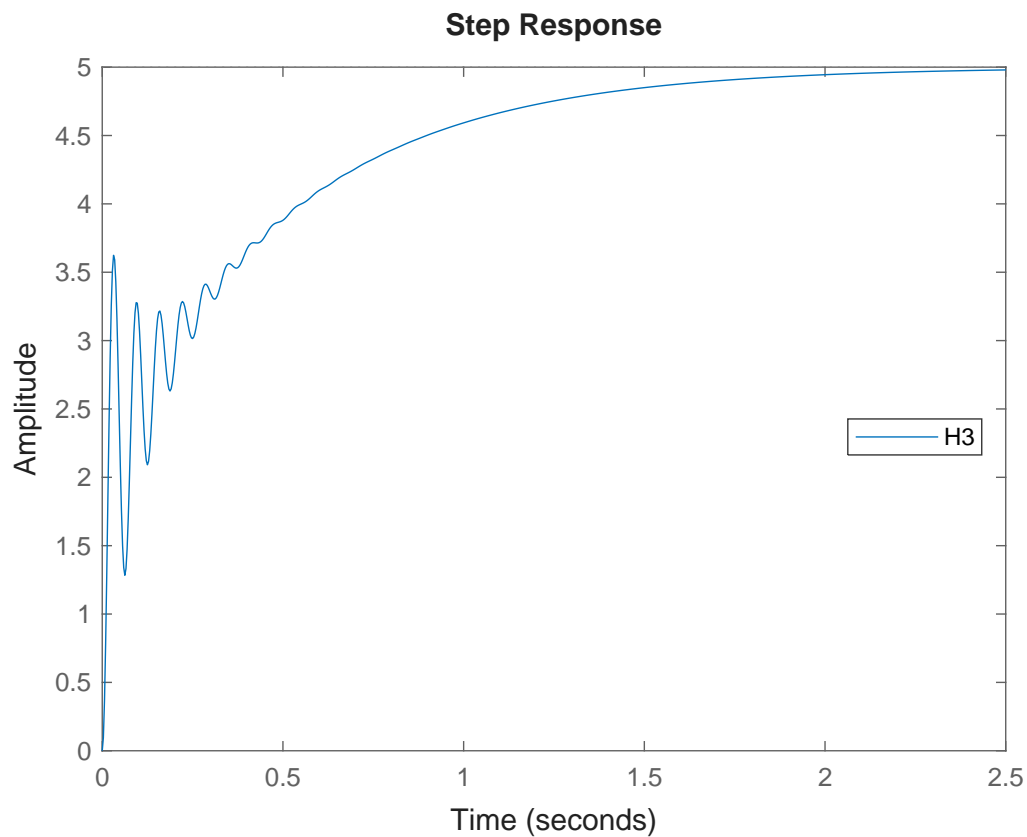
$$\frac{20200 s + 101000}{s^3 + 22 s^2 + 10140 s + 20200}$$

Continuous-time transfer function.
Model Properties

Risposta al gradino

```
figure(Name='H3')
step(H3)
```

```
set(findall(gcf, Property='FontSize'), FontSize=FS)
set(findall(gcf, Type='Line'), LineWidth=LW)
legend(Location='best');
```



H4

Funzione di trasferimento

```
H4 = zpk([2], [-2, -10-100j, -10+100j], -50500)
```

H4 =

$$\frac{-50500 (s-2)}{(s+2) (s^2 + 20s + 1.01e04)}$$

Continuous-time zero/pole/gain model.
Model Properties

```
H4 = tf(H4)
```

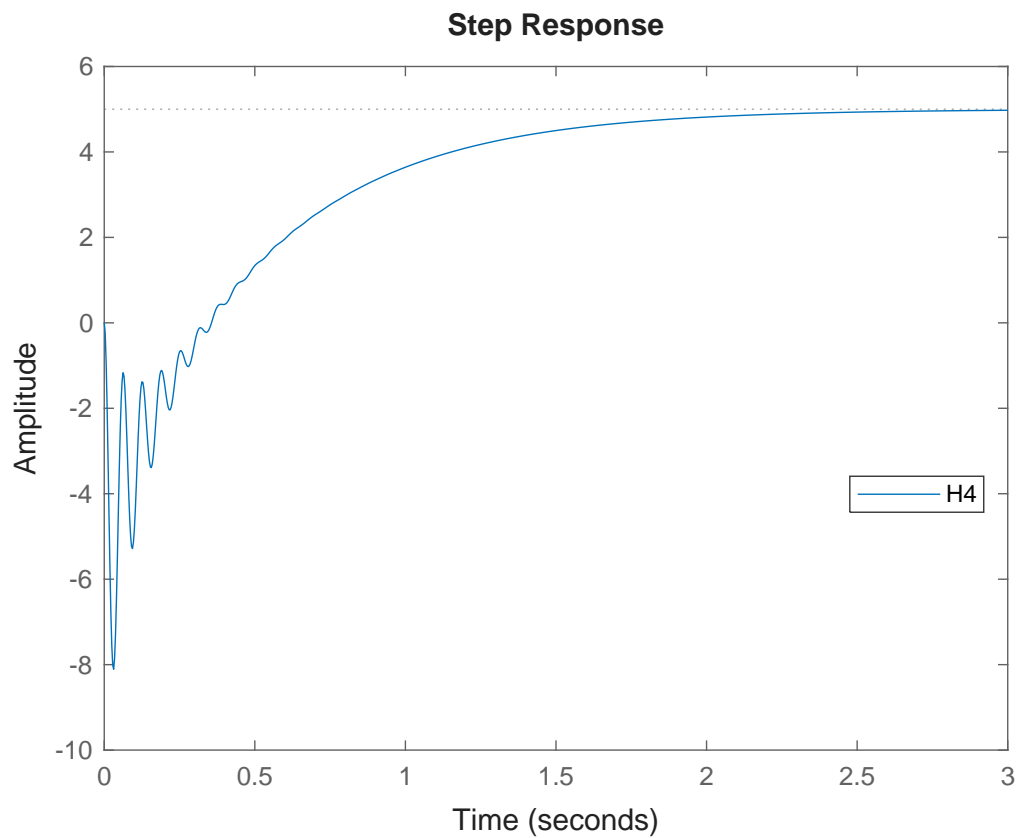
H4 =

$$\frac{-50500 s + 101000}{s^3 + 22 s^2 + 10140 s + 20200}$$

Continuous-time transfer function.
Model Properties

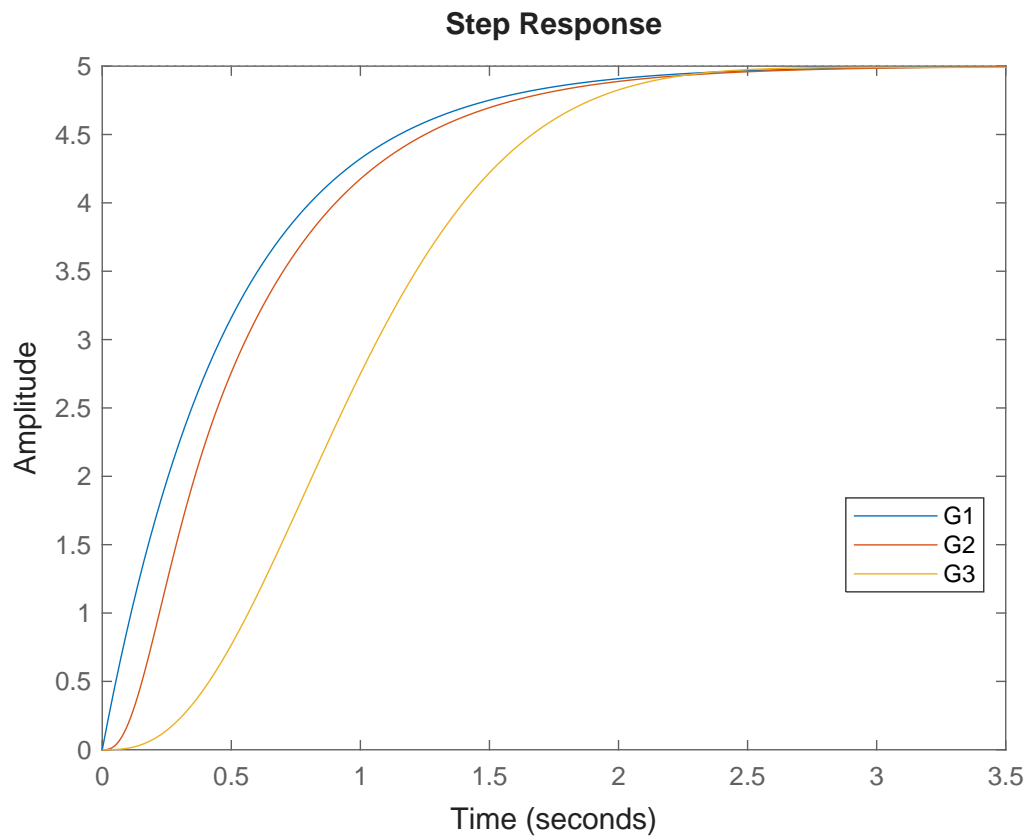
Risposta al gradino

```
figure(Name='H4')
step(H4)
set(findall(gcf, Property='FontSize'), FontSize=FS)
set(findall(gcf, Type='Line'), LineWidth=LW)
legend(Location='best');
```

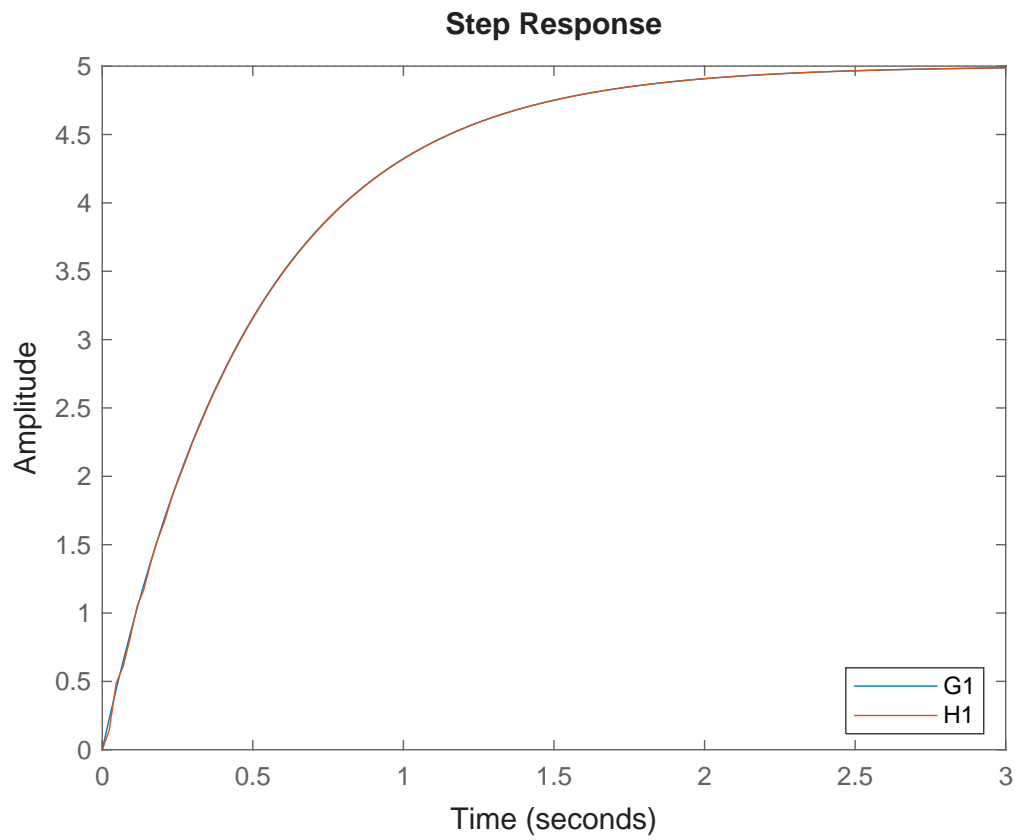


Confronti tra più grafici

```
step(G1, G2, G3)
set(findall(gcf, Property='FontSize'), FontSize=FS)
set(findall(gcf, Type='Line'), LineWidth=LW)
legend(Location='best');
```



```
step(G1, H1)
set(findall(gcf, Property='FontSize'), FontSize=FS)
set(findall(gcf, Type='Line'), LineWidth=LW)
legend(Location='best');
```



```
step(H1, H2, H3)
set(findall(gcf, Property='FontSize'), FontSize=FS)
set(findall(gcf, Type='Line'), LineWidth=LW)
legend(Location='best');
```