Normalised gain for transfer function with additional zero with Step response plot.

```
%Normalised gain
clc; clear; close all;
%G   GIVEN TRANSFER FUNCTION

G = tf([0 0 100],[1 12 100])        %TRANSFER FUNCTION DEFNITION
disp(stepinfo(G));                  %TO DISPLAY ALL TIME DOMAIN
                                    PARAMETERS
figure;
subplot(121)
r=stepplot(G,'b')                   %PLOT FOR THE STEP RESPONSE
grid on;
r.showCharacteristic('PeakResponse')
r.showCharacteristic('RiseTime')
r.showCharacteristic('SettlingTime');
r.showCharacteristic('SteadyState');

subplot(122)
pzplot(G,'r')                               %TO PLOT POLE-ZERO PLOT
poleZeroMap = findobj(gca, 'Type', 'Line');
                                            %TO FORMAT THE PZPLOT
poleZeroMap(3).MarkerSize = 20;                  %TO SET THE POLE
                                                 MARKER SIZE
grid on;                                         %GRID FOR THE PLOT
grid minor;
sgtitle('Response for Transfer function without additional Zero
in it','FontWeight','Bold')                      %TITLE FOR PLOT

%G1  TF WITH a = 6

G1 = tf([100 600], [6 72 600])
disp(stepinfo(G1));                         %DISPLAYING ALL
figure;                                     TIMEDOMAIN
subplot(121)                                PARAMETERS
r=stepplot(G1,'b');                         %ASSIGNING TO THE
grid on;                                    VARIABLE R
r.showCharacteristic('PeakResponse')        %SHOWING STEP RESPONSE
r.showCharacteristic('RiseTime')            PLOT
r.showCharacteristic('SettlingTime');       CHARACTARISTICS
r.showCharacteristic('SteadyState');

subplot(122)
pzplot(G1,'r')                                   %POLE ZERO PLOT
poleZeroMap = findobj(gca, 'Type', 'Line');      %POLE ZERO PLOT
PROPERTIES
```

```
poleZeroMap(3).MarkerSize =
20;
grid on;
sgtitle('Response for
Transfer function with
additional Zero with a = ζωn =
6','FontWeight','Bold')

%G2 TF WITH a = 12

G2 = tf([100 1200],[12 144
1200])
disp(stepinfo(G2));
figure;
subplot(121)
r=stepplot(G2,'b');
grid on;
r.showCharacteristic('PeakRes
ponse')
r.showCharacteristic('RiseTim
e')
r.showCharacteristic('Settlin
gTime');
r.showCharacteristic('SteadyS
tate');

subplot(122)
pzplot(G2,'r')
poleZeroMap = findobj(gca,
'Type', 'Line');
poleZeroMap(3).MarkerSize =
20;
grid on;
sgtitle('Response for
Transfer function with
additional Zero with a = 2ζωn
= 12','FontWeight','Bold')

%G3 TF WITH a = -6

G3 = tf([100 -600],[-6 -72 -
600])
disp(stepinfo(G3));
figure();
subplot(121)
r=stepplot(G3,'b');
grid on;
r.showCharacteristic('PeakRes
ponse')
r.showCharacteristic('RiseTim
e')
r.showCharacteristic('Settlin
gTime');
r.showCharacteristic('SteadyS
tate');

subplot(122)
pzplot(G3,'r')
poleZeroMap = findobj(gca,
'Type', 'Line');
poleZeroMap(3).MarkerSize =
20;
grid on;
sgtitle('Response for
Transfer function with
additional Zero with a = -ζωn
= -6','FontWeight','Bold')

%G4  TF WITH a = 60

G4 = tf([100 6000],[60 720
6000])
disp(stepinfo(G4));
figure();
subplot(121)
r=stepplot(G4,'b');
grid on;
r.showCharacteristic('PeakRes
ponse')
r.showCharacteristic('RiseTim
e')
r.showCharacteristic('Settlin
gTime');
r.showCharacteristic('SteadyS
tate');

subplot(122)
pzplot(G4 ,'r')
poleZeroMap = findobj(gca,
'Type', 'Line');
poleZeroMap(3).MarkerSize =
20;
grid on;
sgtitle('Response for
Transfer function with
additional Zero with a = 10
ζωn = 60','FontWeight','Bold')
```

MATLAB Command Window output

```
G =
        100
  ----------------
  s^2 + 12 s + 100

Continuous-time transfer
function.

        RiseTime: 0.1856
    SettlingTime: 0.5943
     SettlingMin: 0.9083
     SettlingMax: 1.0948
       Overshoot: 9.4773
      Undershoot: 0
            Peak: 1.0948
        PeakTime: 0.3914


G1 =
     100 s + 600
  ------------------
  6 s^2 + 72 s + 600

Continuous-time transfer
function.

        RiseTime: 0.0629
    SettlingTime: 0.7220
     SettlingMin: 0.9001
     SettlingMax: 1.4103
       Overshoot: 41.0277
      Undershoot: 0
            Peak: 1.4103
        PeakTime: 0.1996



G2 =
      100 s + 1200
  ---------------------
  12 s^2 + 144 s + 1200

Continuous-time transfer
function.

        RiseTime: 0.1219
    SettlingTime: 0.5032
     SettlingMin: 0.9178
     SettlingMax: 1.1583
       Overshoot: 15.8333
      Undershoot: 0
            Peak: 1.1583
        PeakTime: 0.2763


G3 =
     -100 s + 600
  ------------------
  6 s^2 + 72 s + 600

Continuous-time transfer
function.

        RiseTime: 0.1287
    SettlingTime: 0.6678
     SettlingMin: 0.9038
     SettlingMax: 1.1466
       Overshoot: 14.6551
      Undershoot: 54.5713
            Peak: 1.1466
        PeakTime: 0.4682

G4 =
      100 s + 6000
  ---------------------
  60 s^2 + 720 s + 6000

Continuous-time transfer
function.

        RiseTime: 0.1822
    SettlingTime: 0.5768
     SettlingMin: 0.9155
     SettlingMax: 1.0963
       Overshoot: 9.6275
      Undershoot: 0
            Peak: 1.0963
        PeakTime: 0.3761
```

Step and Pole-Zero plots for different cases of "a"

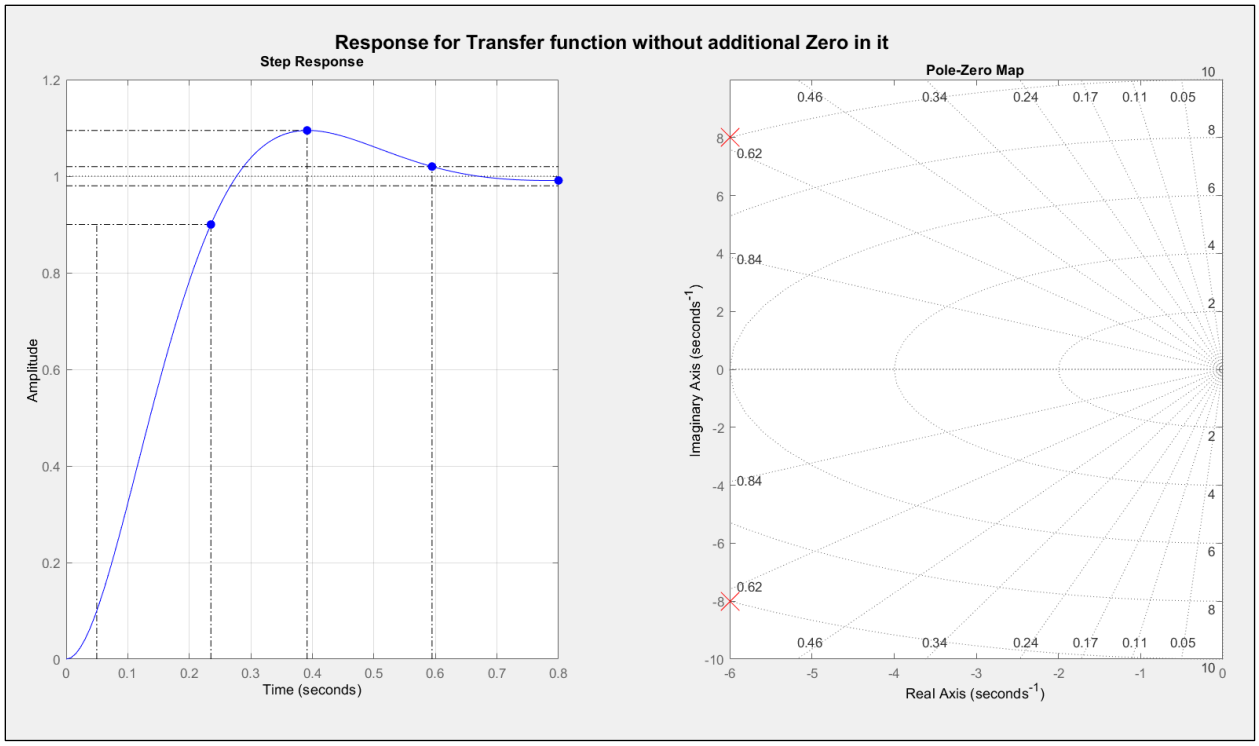

Fig-1

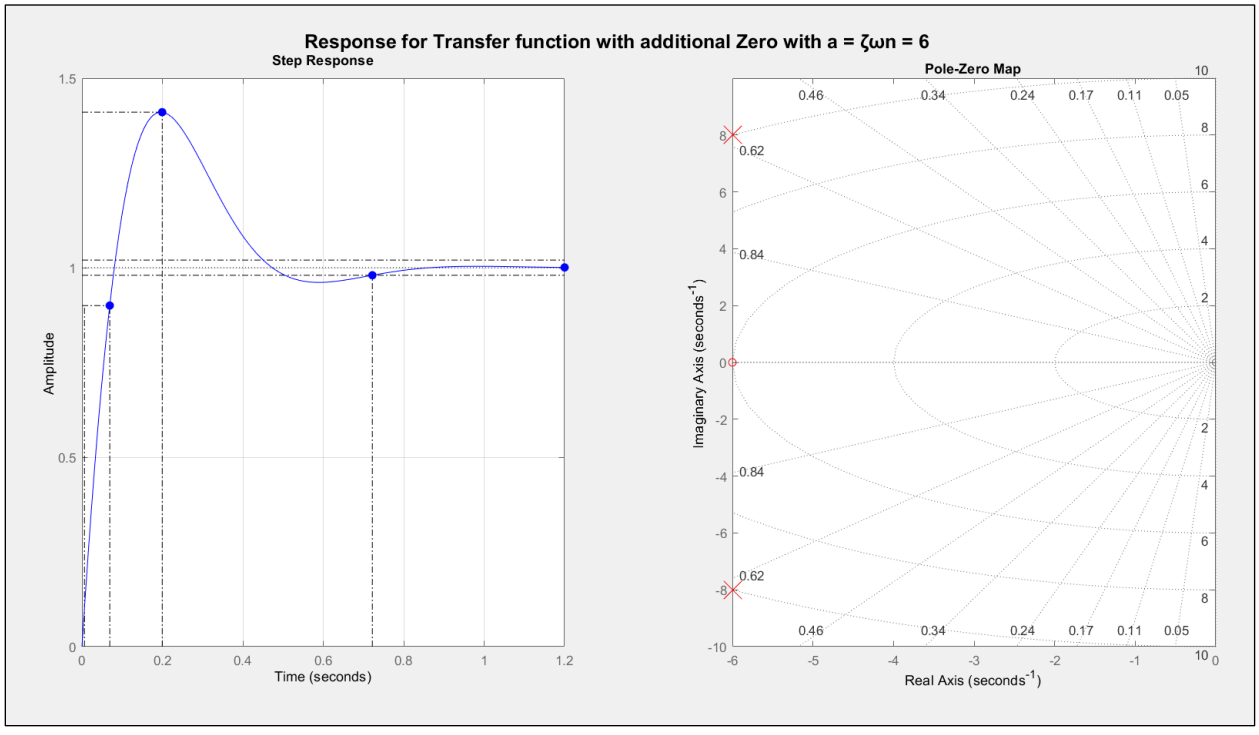

Fig-2

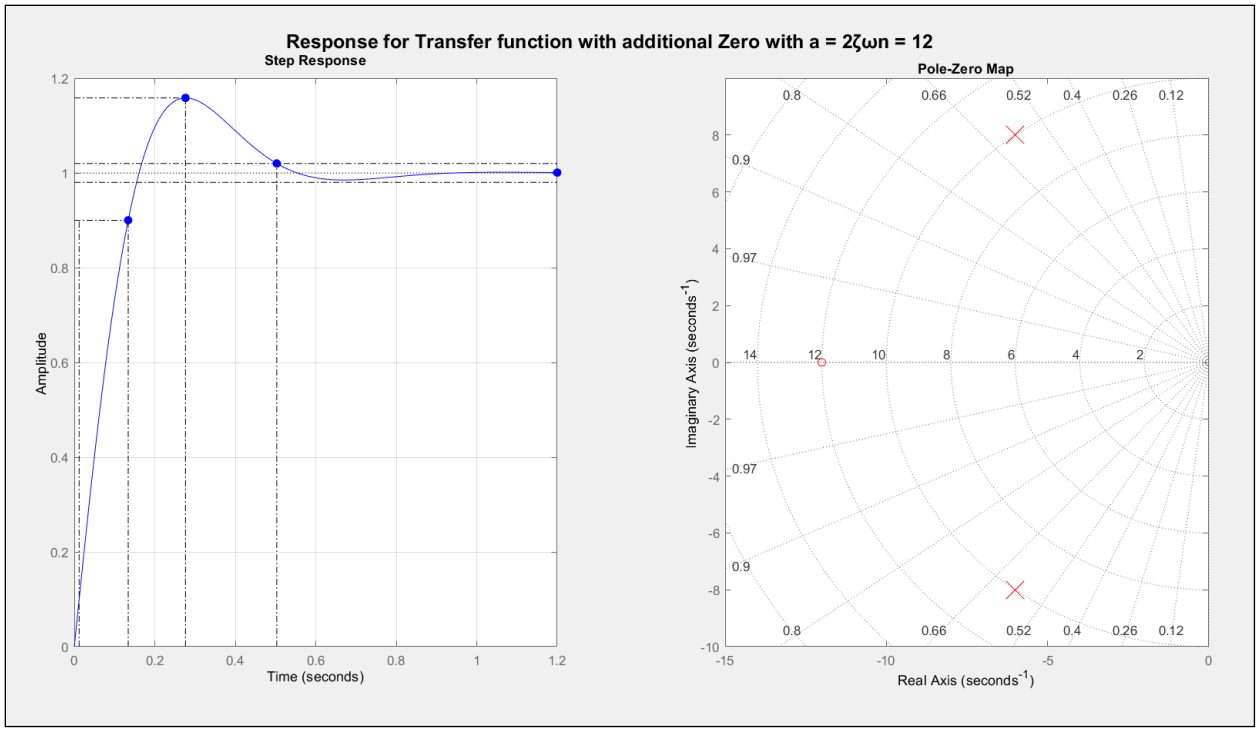
Response for Transfer function with additional Zero with a = 2ζωn = 12
Step Response
Amplitude
Time (seconds)
Pole-Zero Map
Imaginary Axis (seconds^{-1})
Real Axis (seconds^{-1})

Fig-3

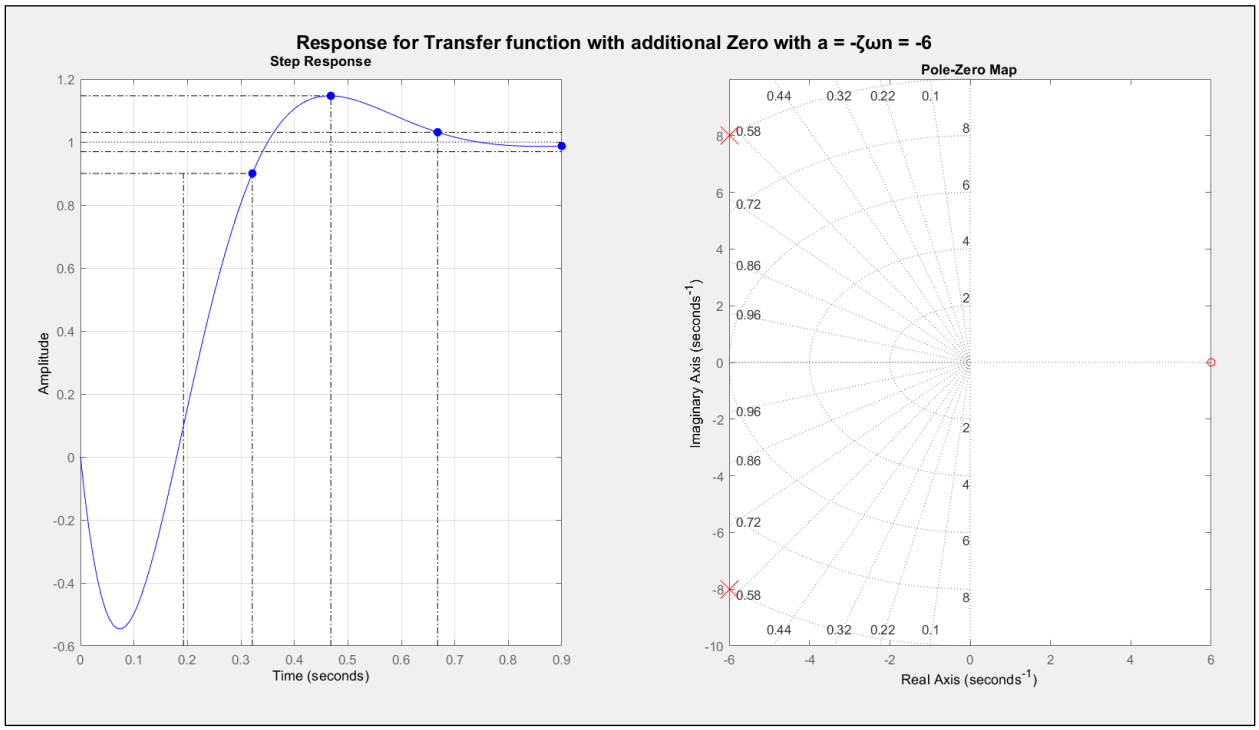
Response for Transfer function with additional Zero with a = -ζωn = -6
Step Response
Amplitude
Time (seconds)
Pole-Zero Map
Imaginary Axis (seconds^{-1})
Real Axis (seconds^{-1})

Fig-4

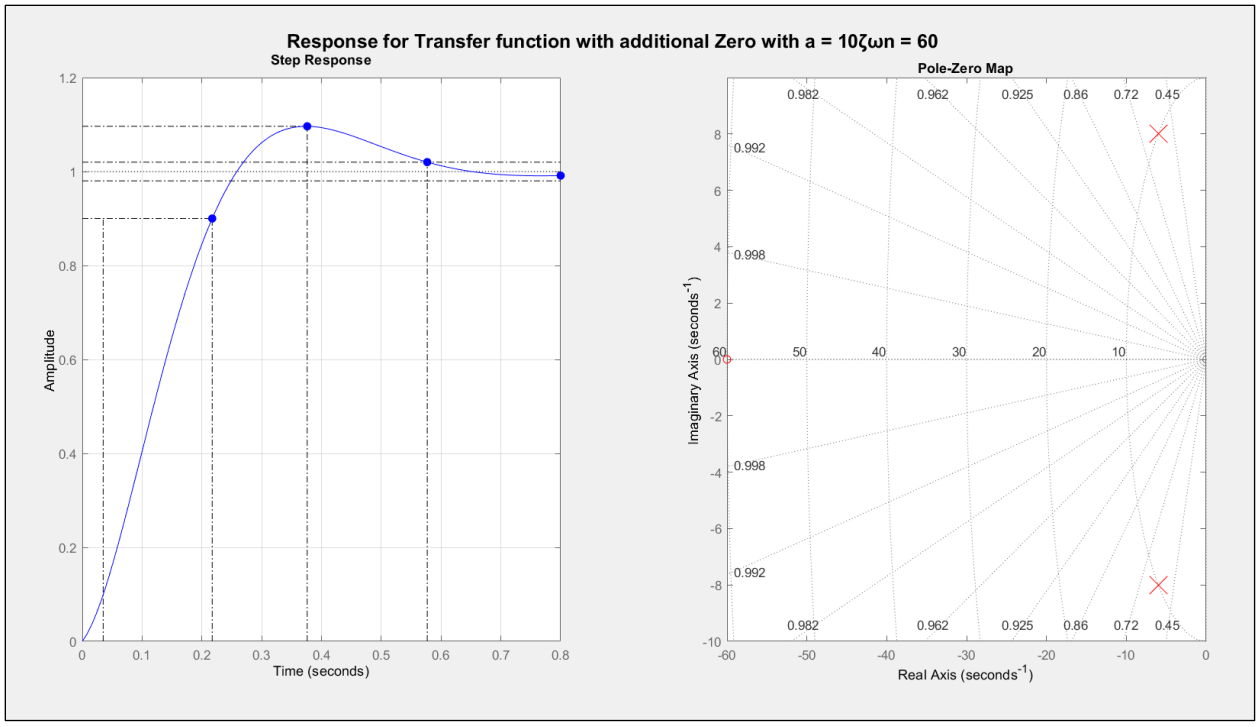

Fig-5

Plot for all cases of "a"

```
clc;
clear;
close all;
G = tf([0 0 100],[1 12 100])
G1 = tf([100 600], [6 72 600])
G2 = tf([100 1200],[12 144 1200])
G3 = tf([100 -600],[-6 -72 -600])
G4 = tf([100 6000],[60 720 6000])
hold on;
g = stepplot(G,'');
g1 = stepplot(G1,'--');
g2 = stepplot(G2,':.');
g3 = stepplot(G3,'.-');
stepplot(G4,'-.');
grid on
grid minor
hold off
legend('g','g1','g2','g3','g4')
```

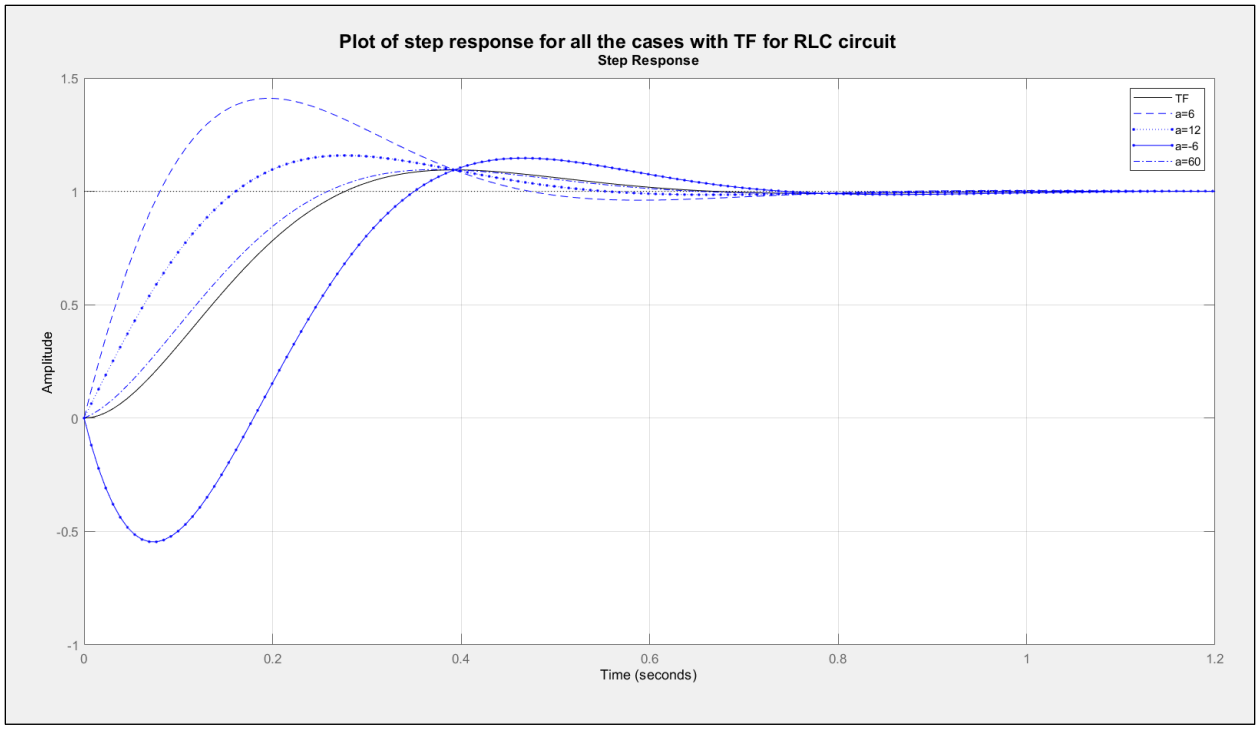

Fig-6:

Unit step response for several zero locations

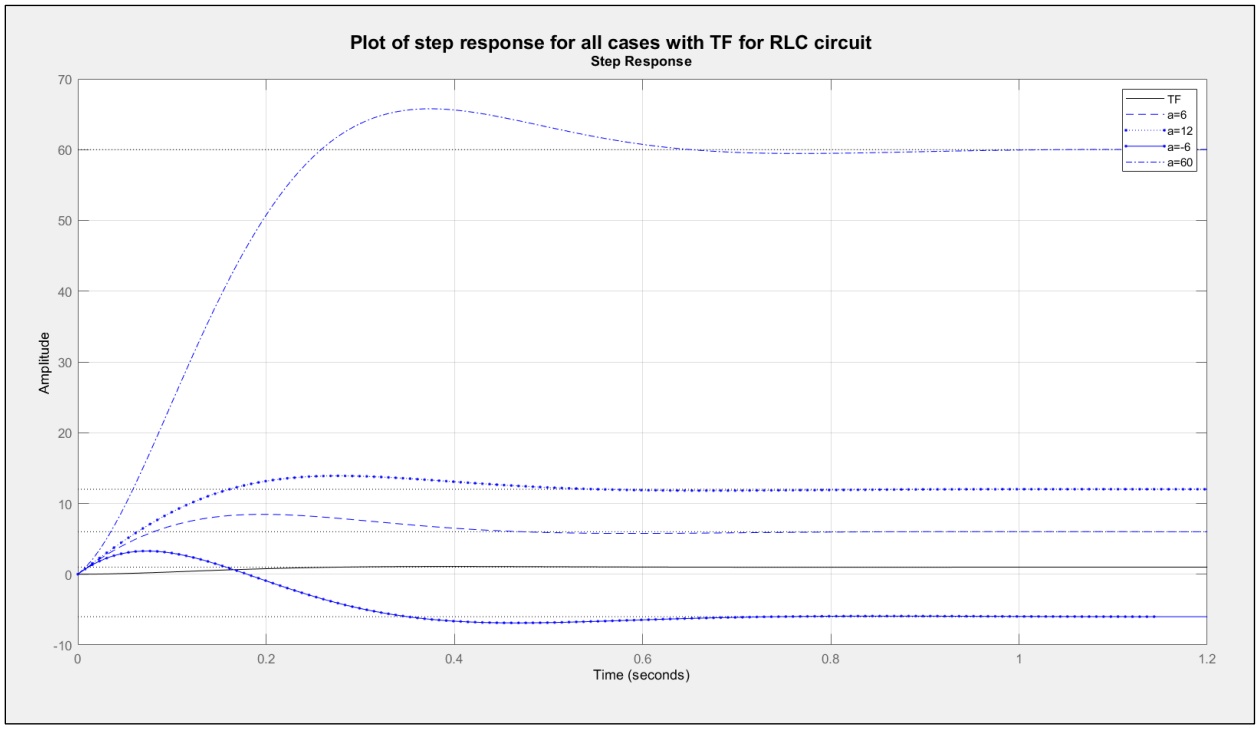

Fig-7:

Response for several zero locations with normalising the TF

Simulink Circuit Diagram.

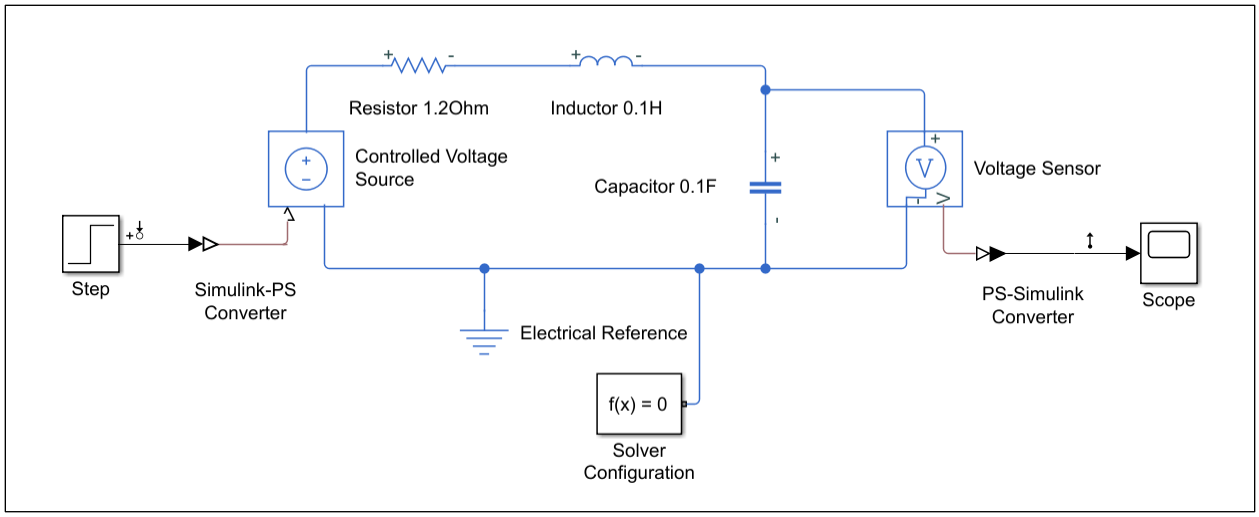

Fig-8:

The above figure depicts series RLC circuit simulation in Simulink

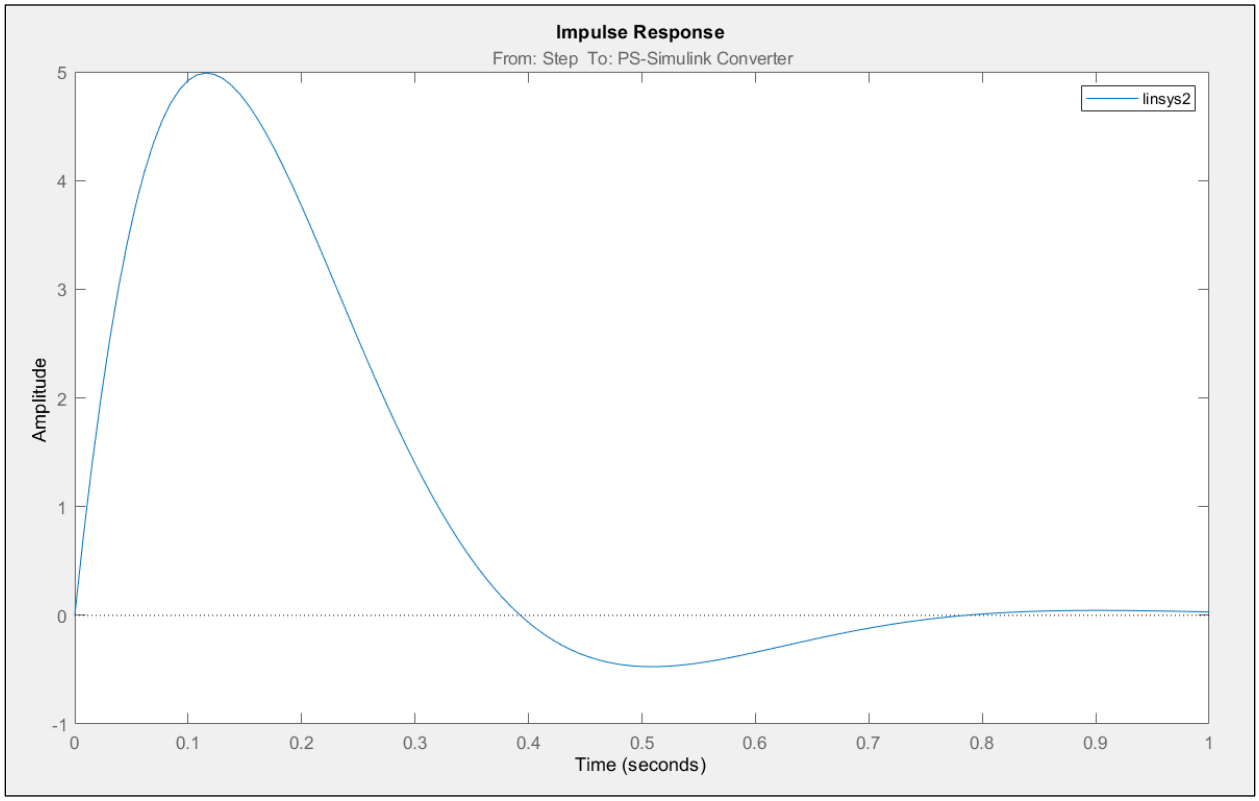

Fig-9:

Impulse response for the series RLC circuit

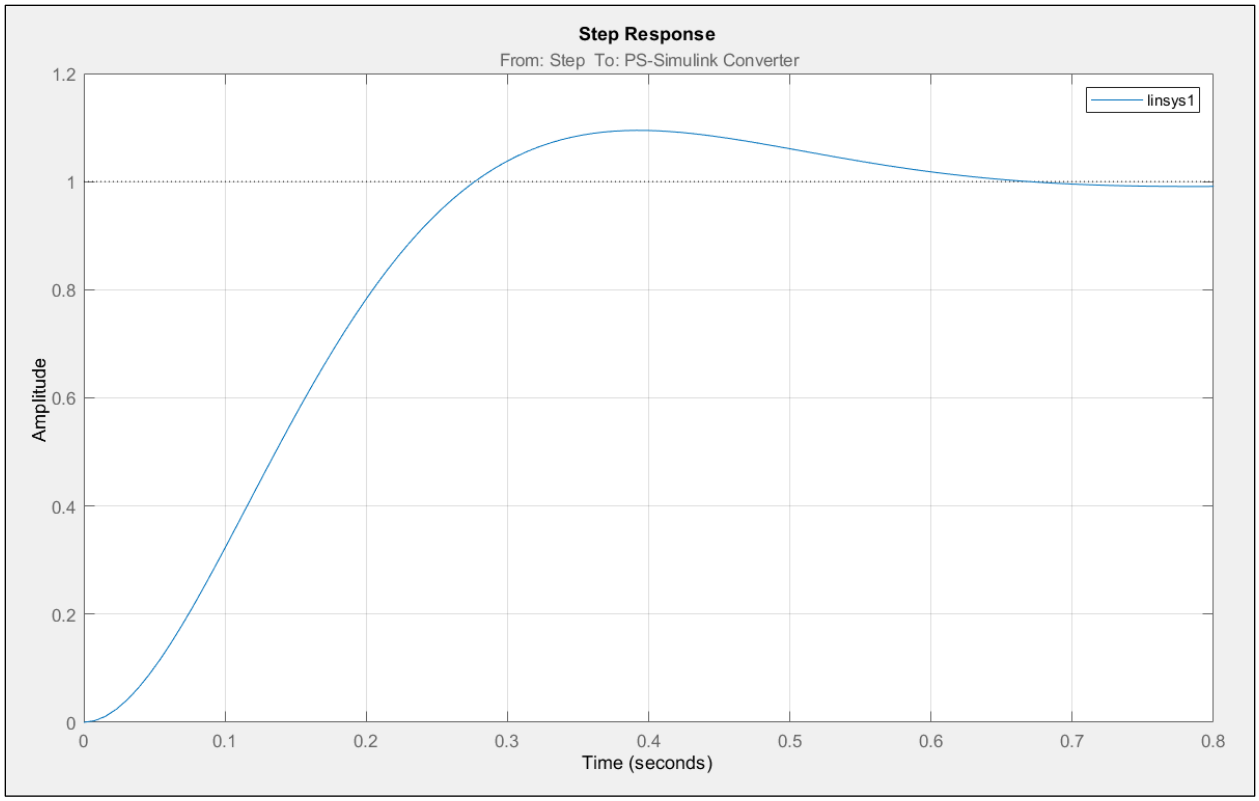

Fig-10:

Step response for the series RLC circuit

Simulink Block Diagram and plots.

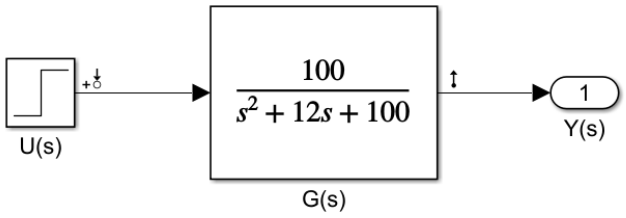

Fig-8:

Simulink closed loop block diagram for the series RLC Circuit.

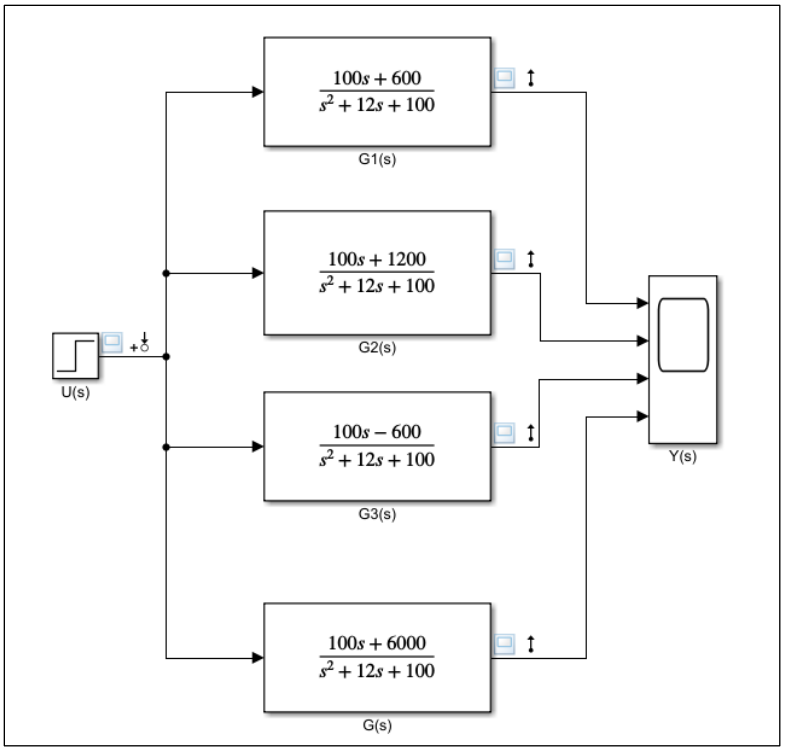

Fig-9:

Structure of Control system in Simulink for different cases of "a"

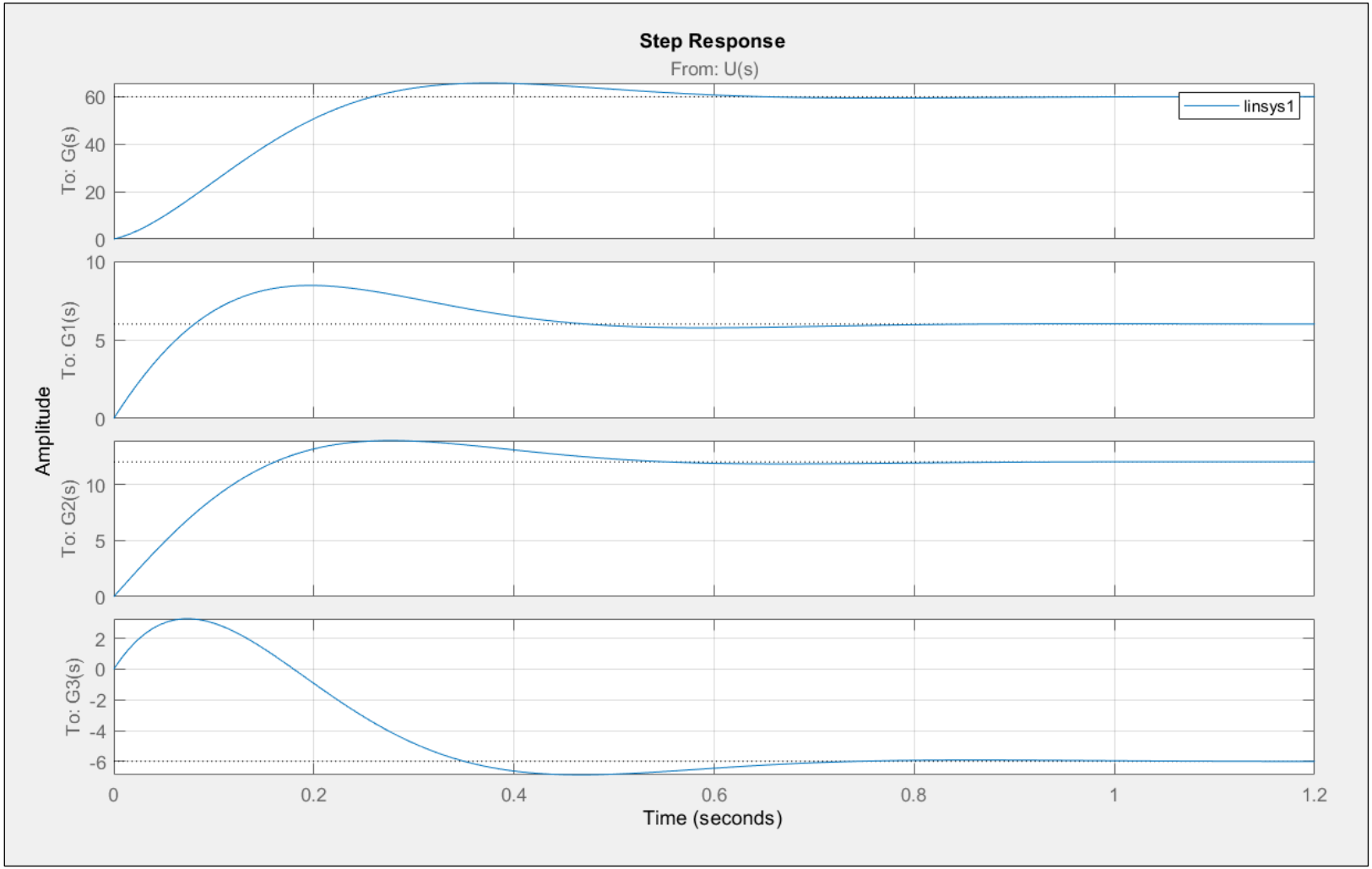

Fig-10:

Step response plot of all TFs of fig-9

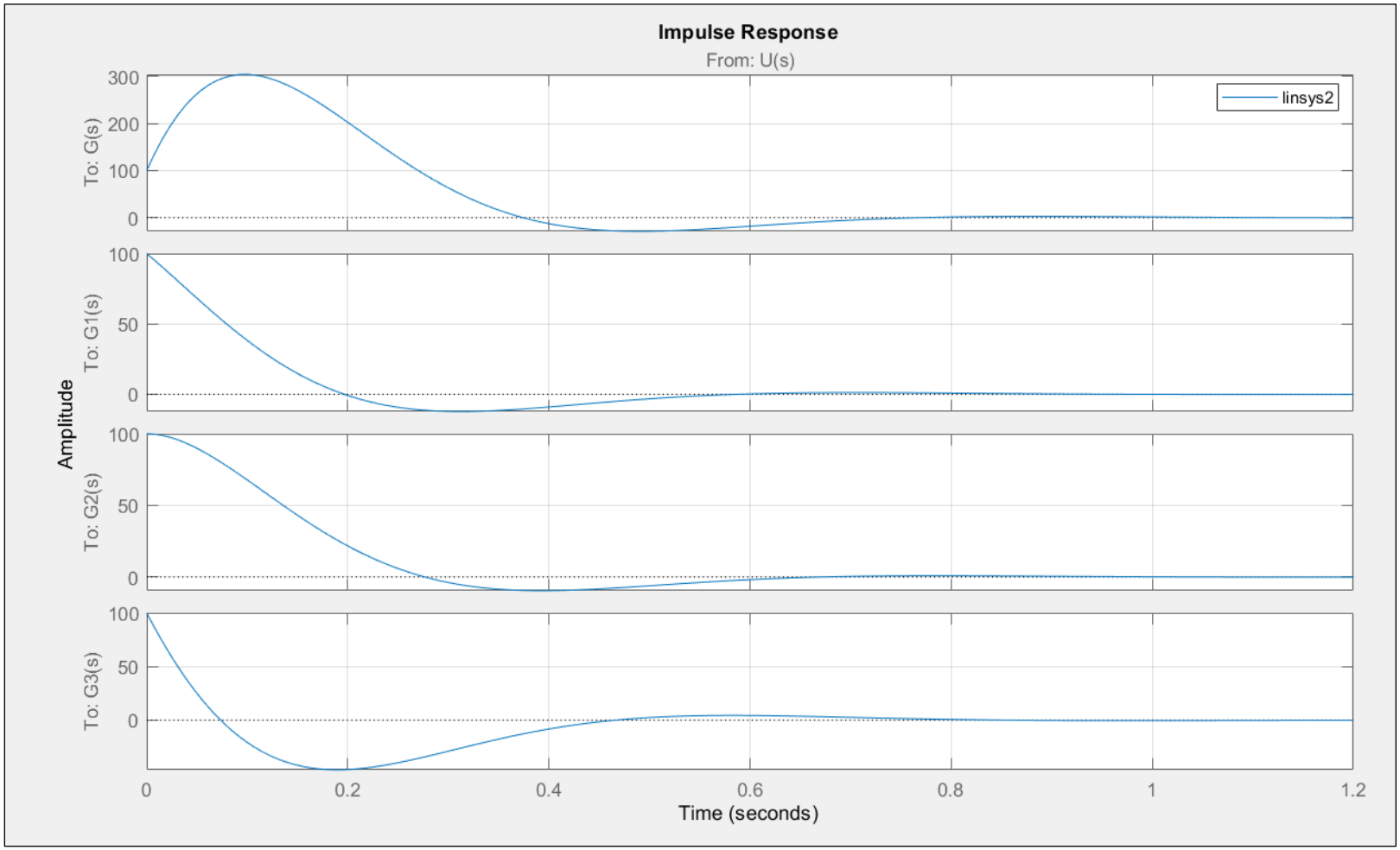

Fig-11:

Impulse response plot of all TFs of fig-9 from Linear Analysis tool in Simulink

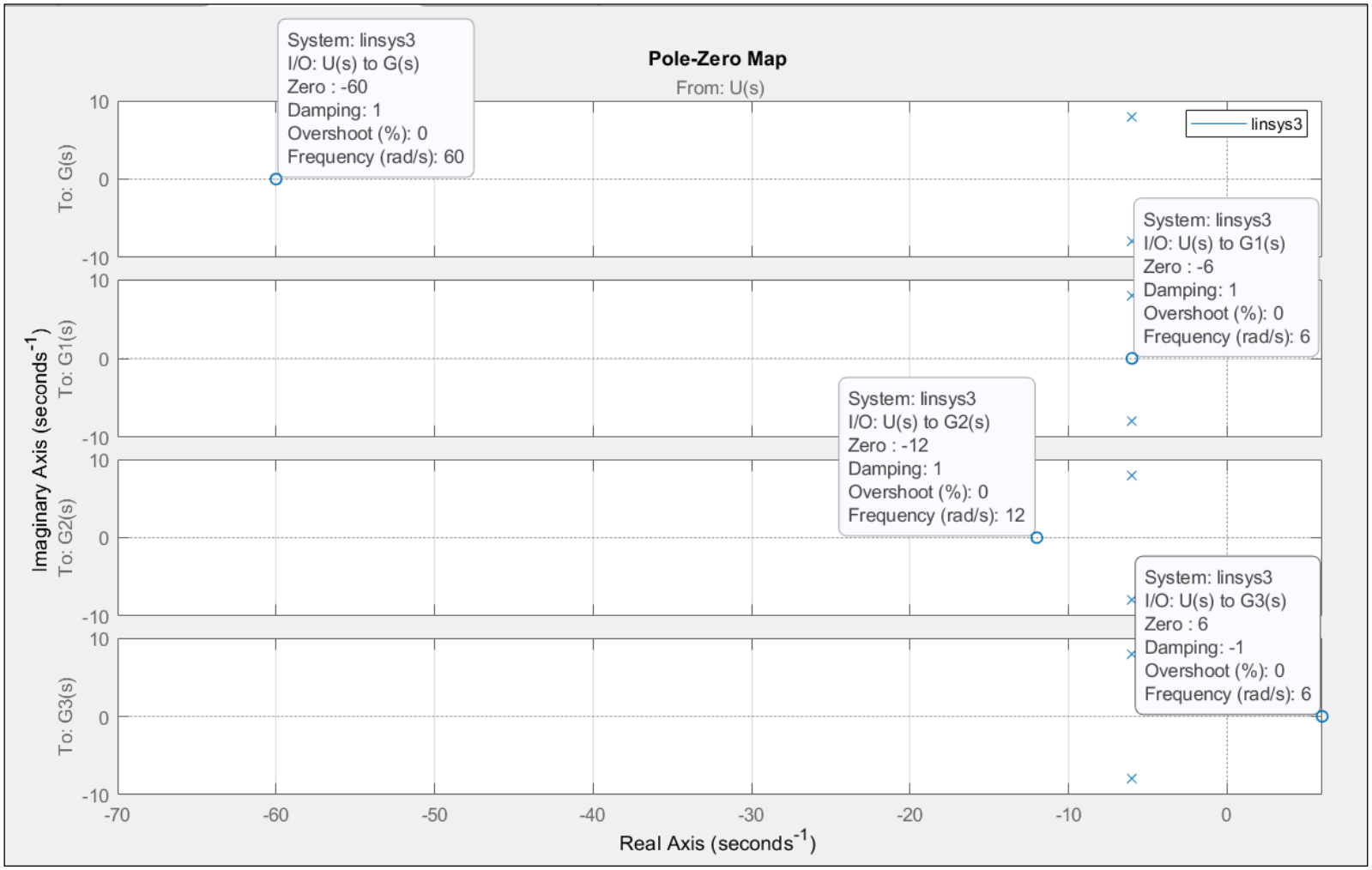

Fig-12:

Pole-Zero plot of all TFs of fig-9 from Linear Analysis tool in Simulink