EENG307: Designing Controllers Using Bode Plots, Part 1[1]

Lecture 32

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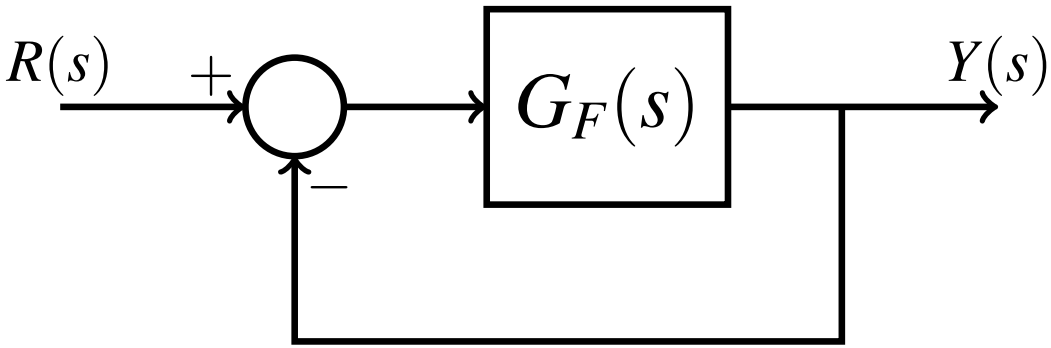
Transient Response Specifications

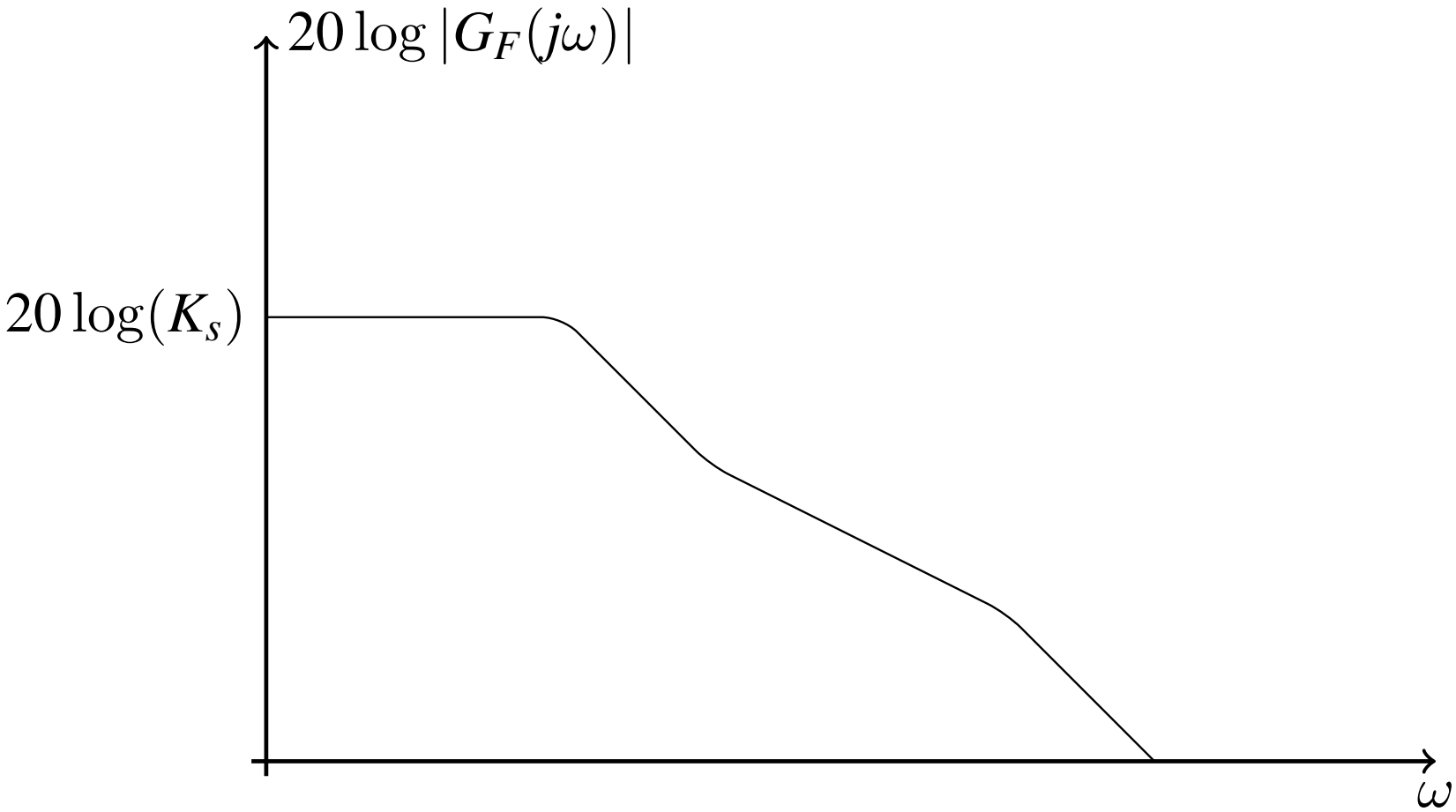


$$\frac{Y(s)}{R(s)} = T(s) = \frac{G_F(s)}{1+G_F(s)}$$

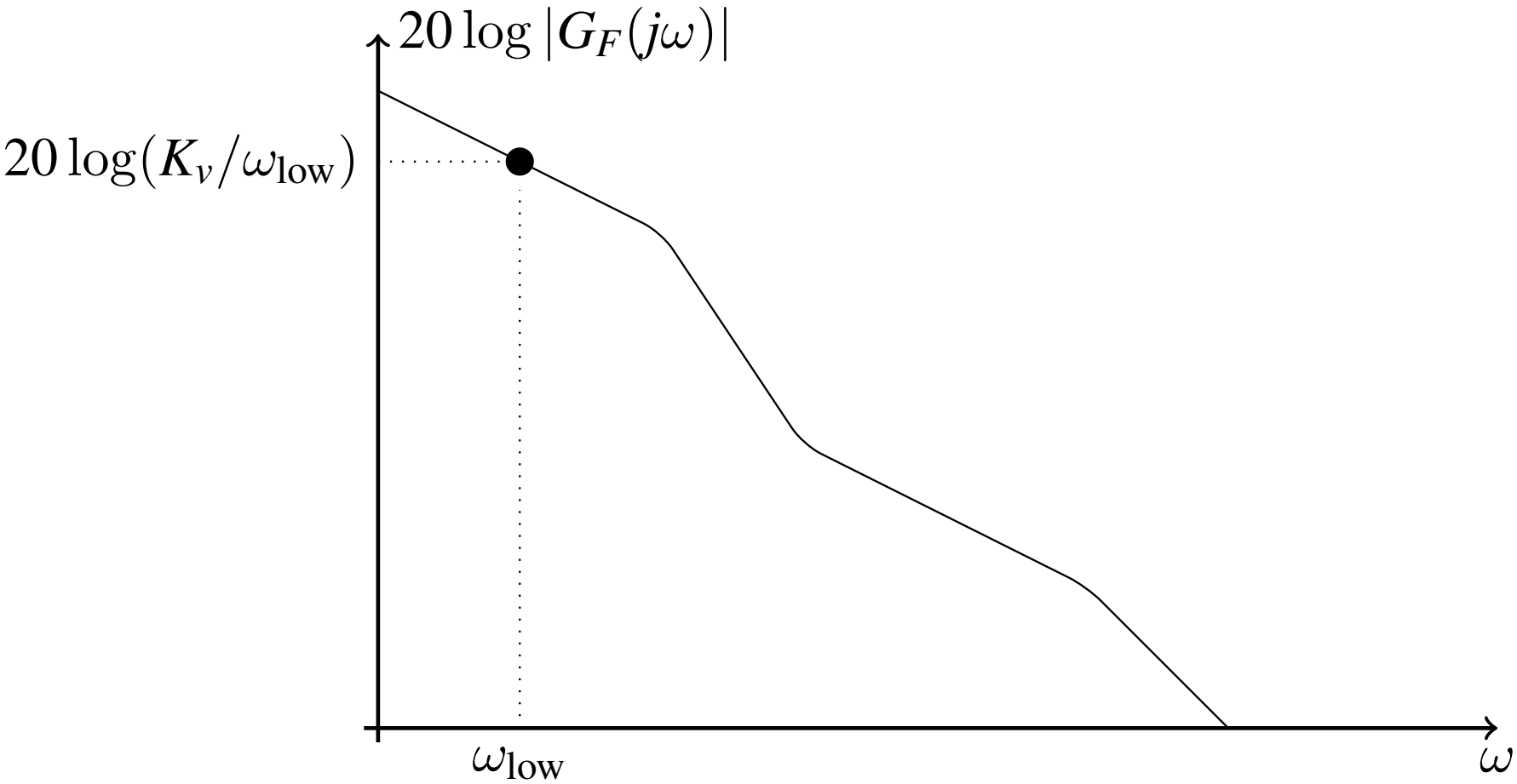
Closed Loop Step Response	Requirements on Open Loop Frequency $G_F(j\omega)$
$\%OS = e^{-\zeta\pi/\sqrt{1-\zeta^2}} \times 100\%$	Crossover frequency
settling time $t_s = \frac{4.6}{\zeta\omega_n}$	$\omega_{co,G} \approx \omega_n$
rise time $t_r = \frac{2.2}{\omega_n}$	Phase margin $\phi_{PM,G} \approx 100\zeta$

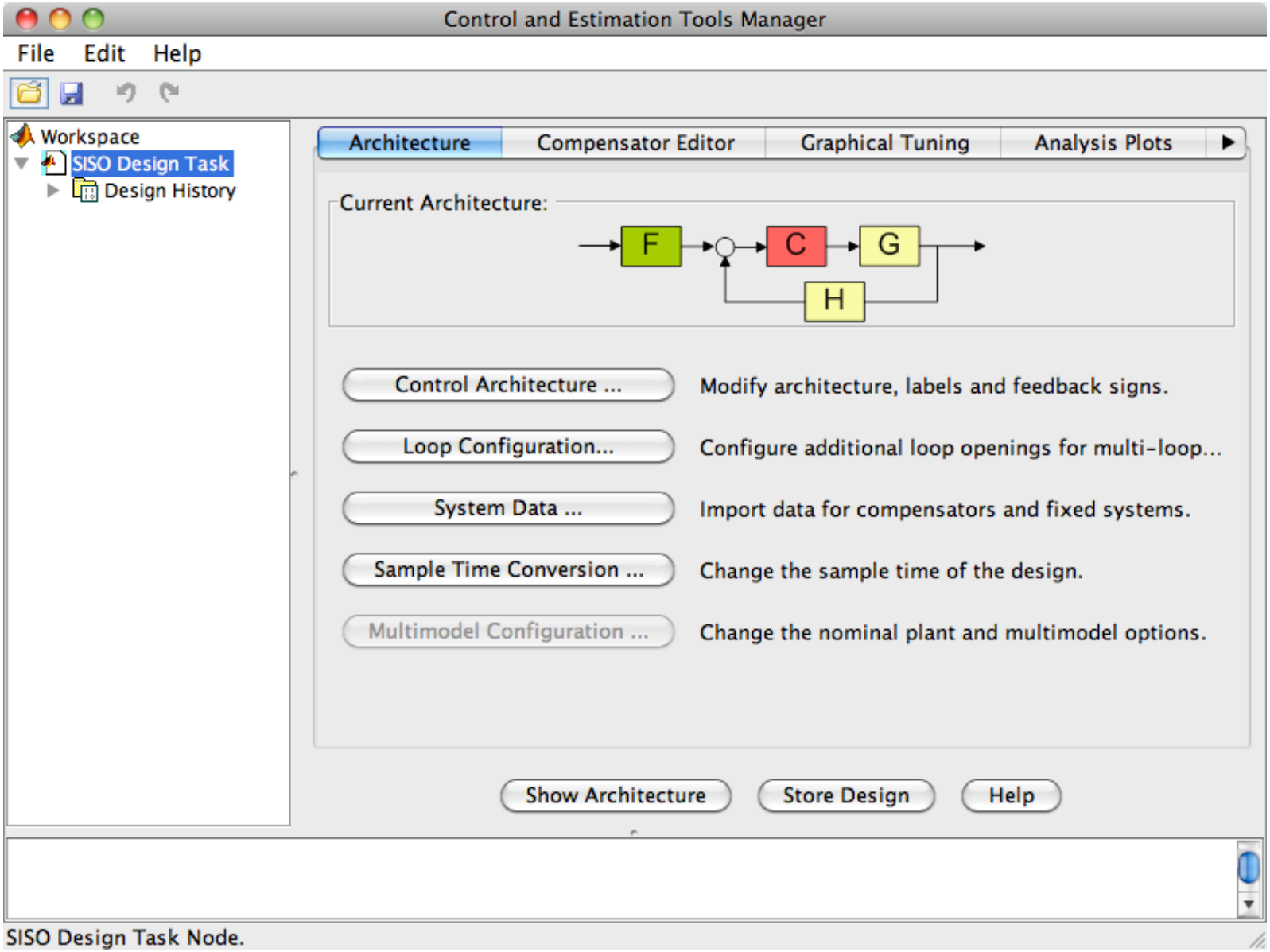
System Type	Steady State Error to a... Step Input	Ramp Input	Error Constants
0	$e_{ss} = \frac{A}{1+K_s}$	$e_{ss} = \infty$	$K_s = \lim_{s\to 0} G_F(s) = G_F(0)$
1	$e_{ss} = 0$	$e_{ss} = \frac{A}{K_v}$	$K_v = \lim_{s\to 0} sG_F(s)$

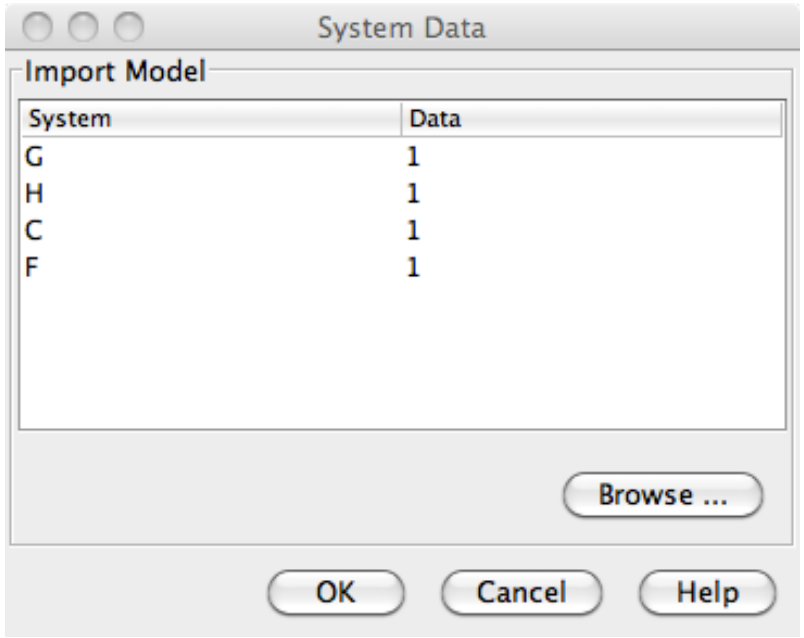
Open Loop Frequency Response Specifications When K_s =finite and $K_v = 0$

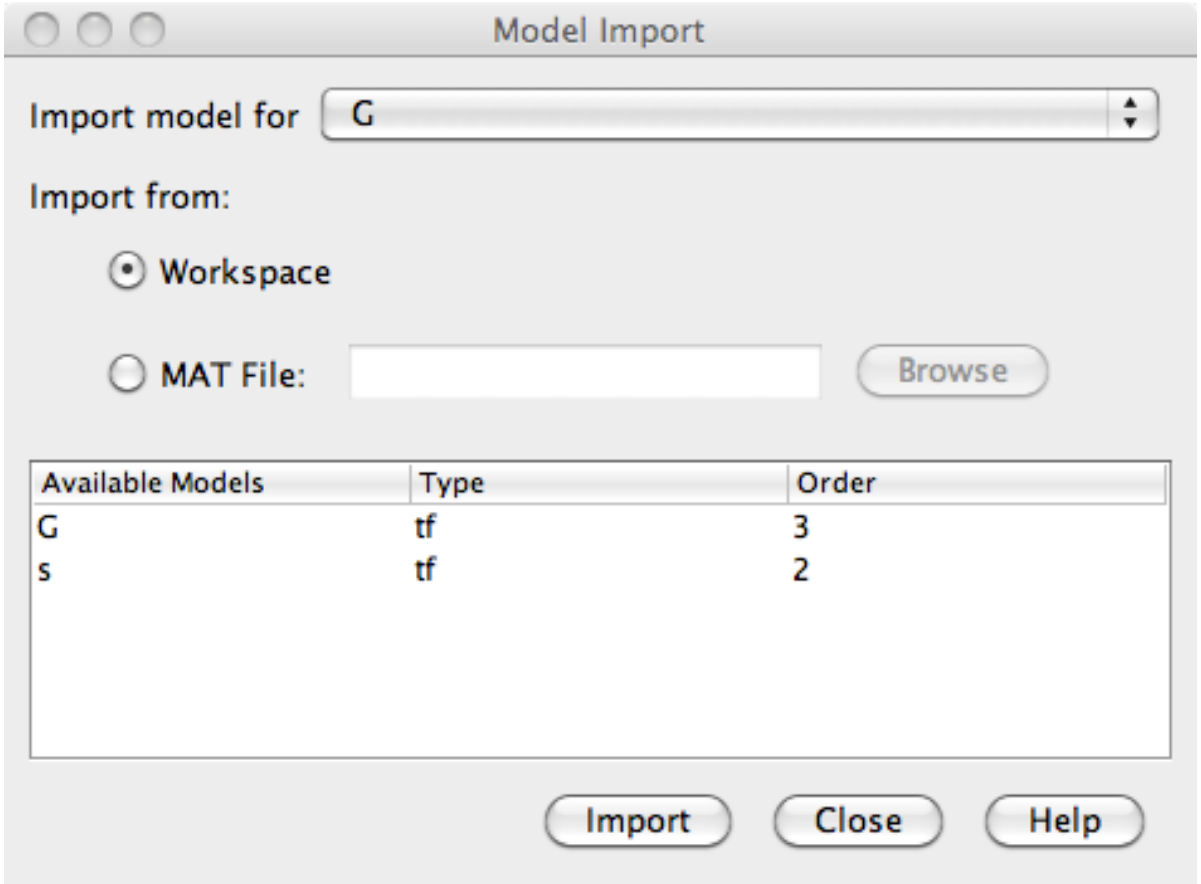


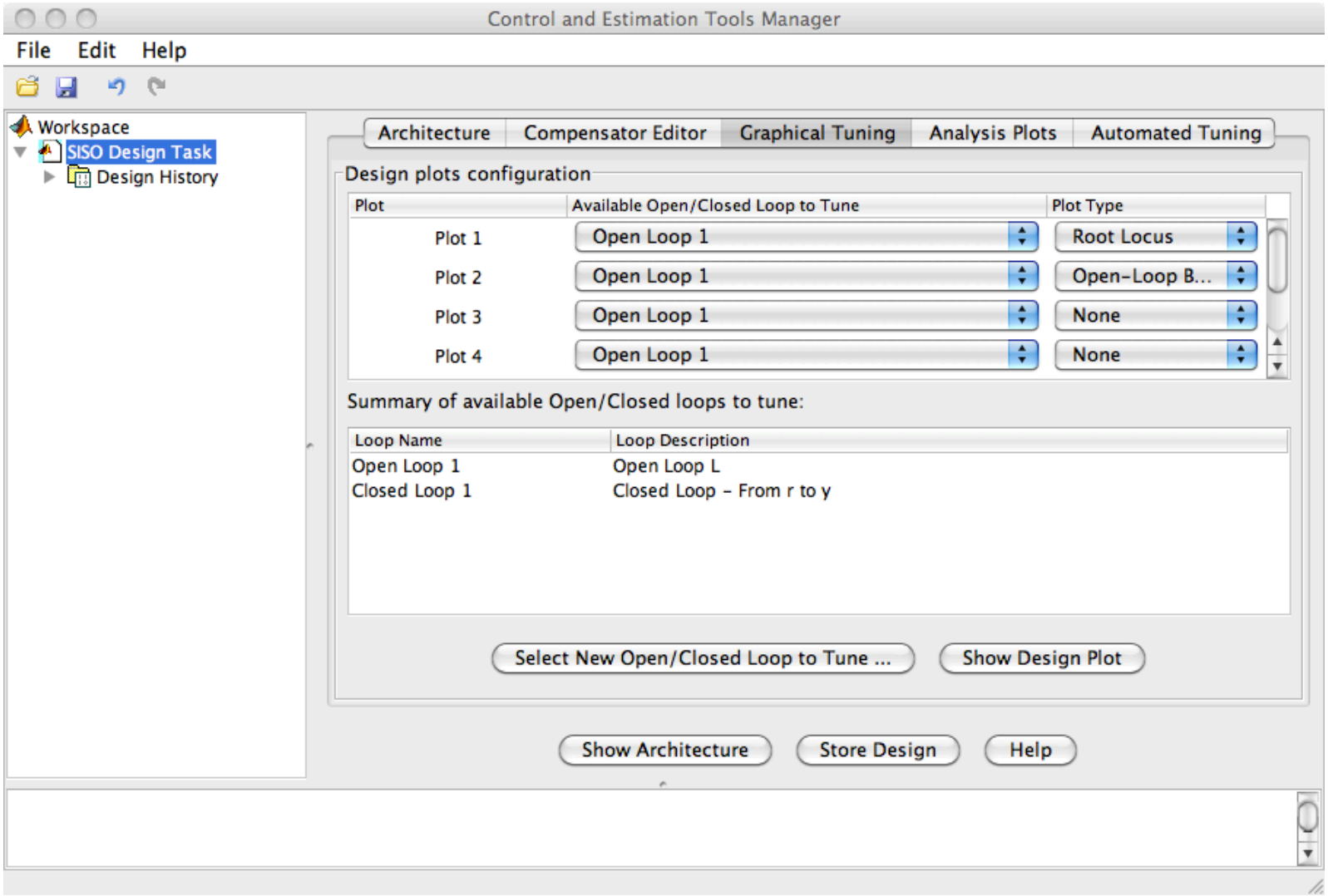
Open Loop Frequency Response Specifications When $K_s = \infty$ K_v =finite

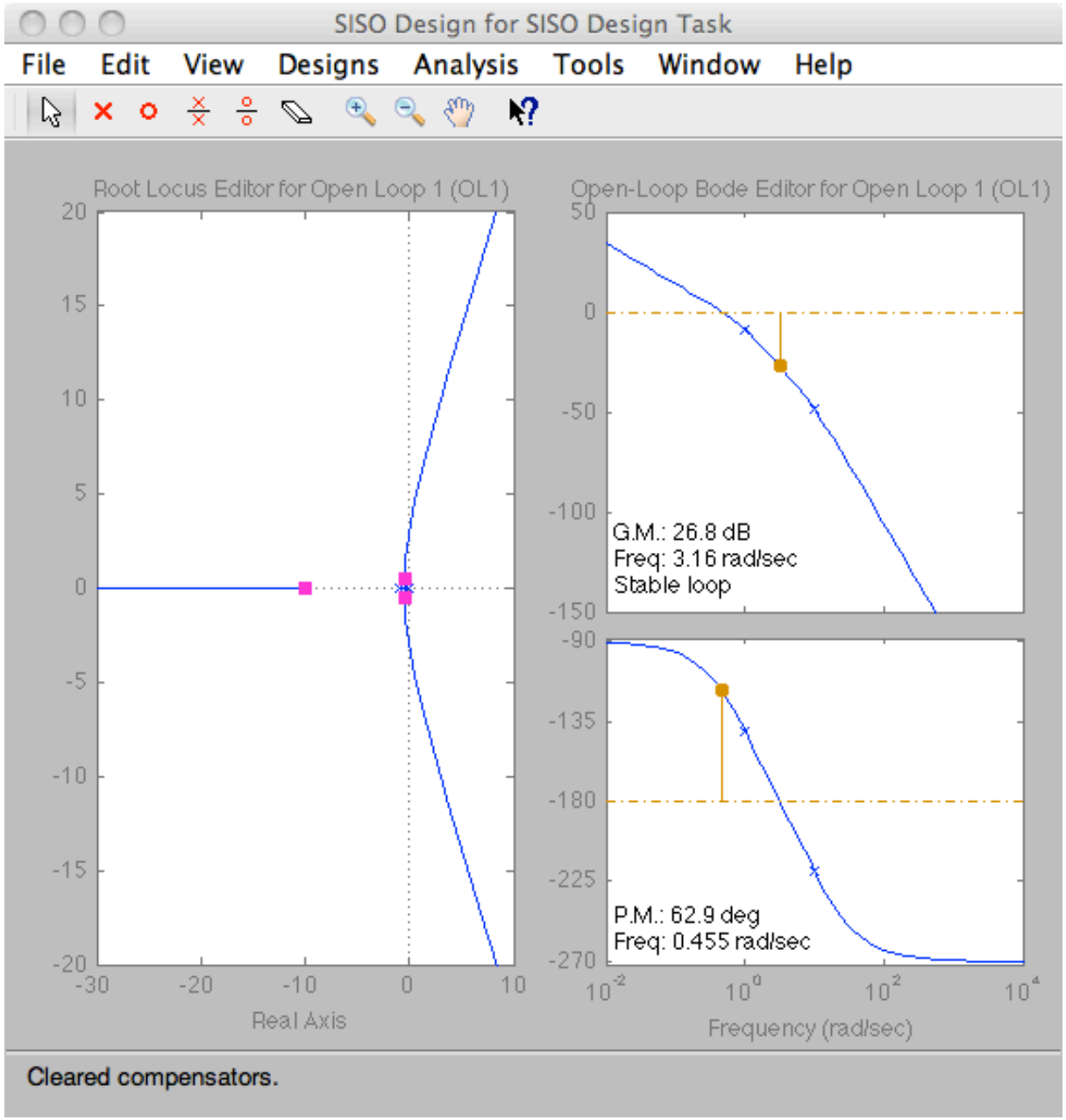


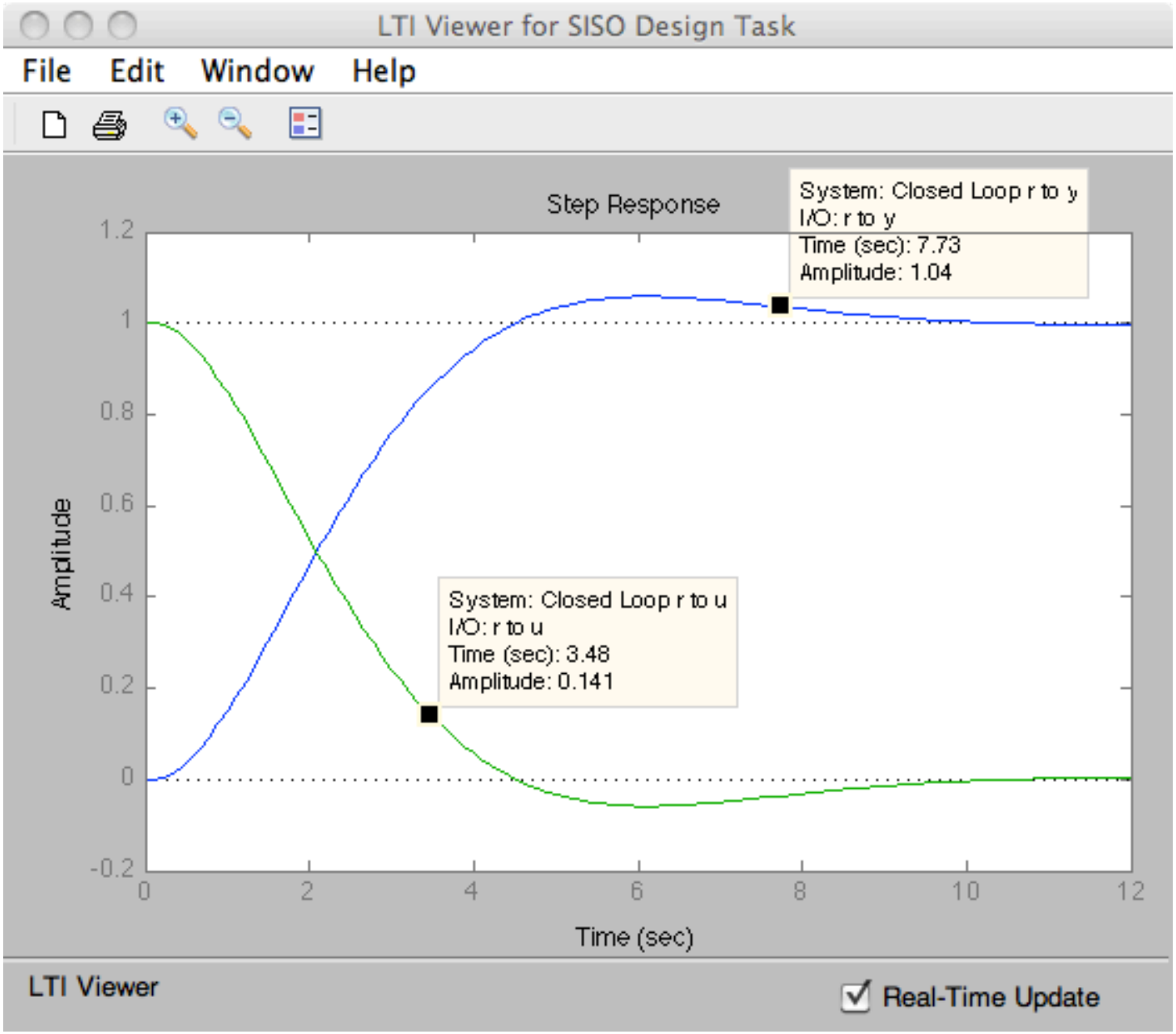

Control and Estimation Tools Manager
File
Edit
Help
Workspace
SISO Design Task
Design History
Architecture
Compensator Editor
Graphical Tuning
Analysis Plots
Current Architecture:
F
C
G
H
Control Architecture ...
Modify architecture, labels and feedback signs.
Loop Configuration...
Configure additional loop openings for multi-loop...
System Data ...
Import data for compensators and fixed systems.
Sample Time Conversion ...
Change the sample time of the design.
Multimodel Configuration ...
Change the nominal plant and multimodel options.
Show Architecture
Store Design
Help
SISO Design Task Node.

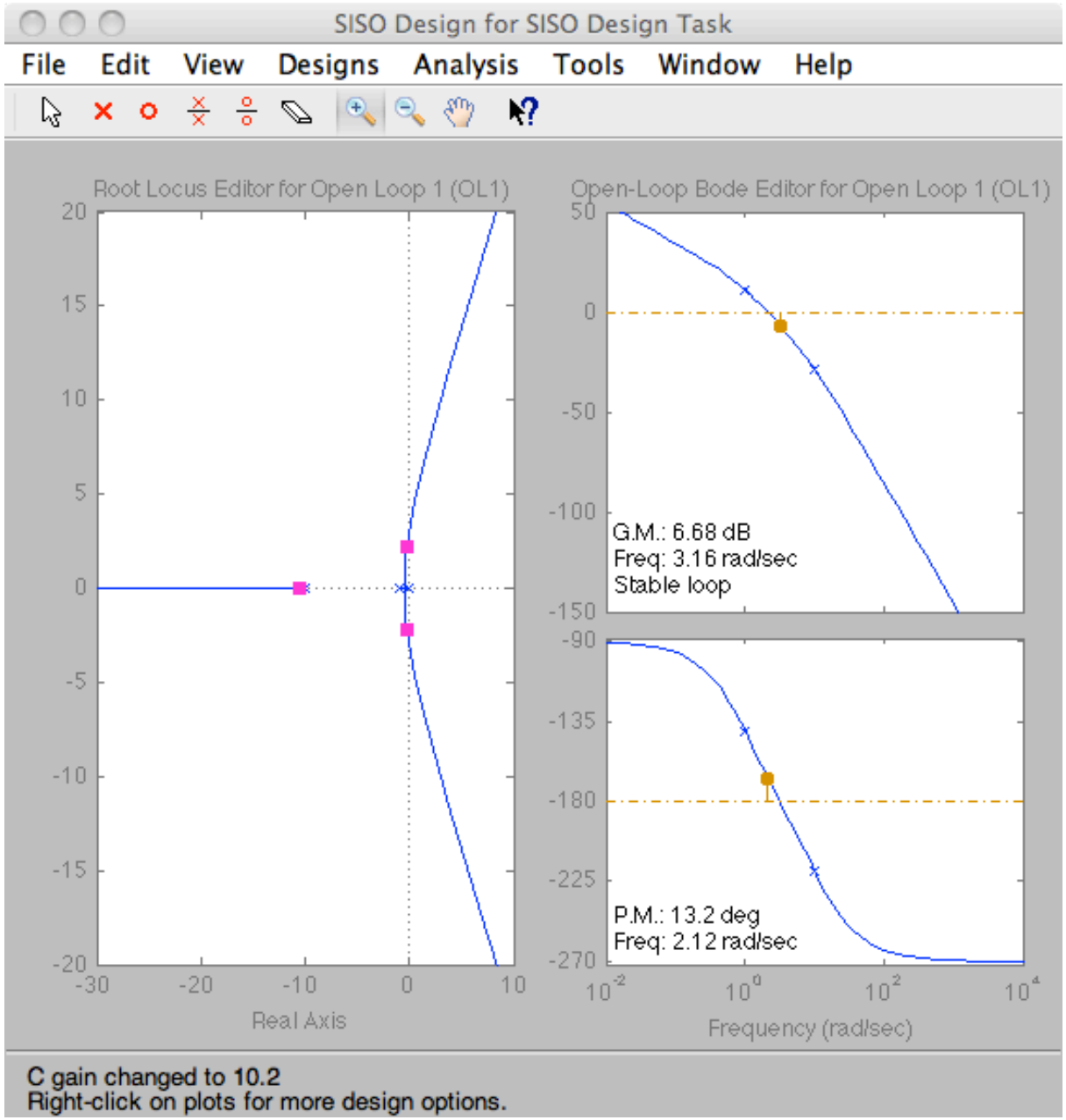

System Data
Import Model
System
Data
G
1
H
1
C
1
F
1
Browse ...
OK
Cancel
Help

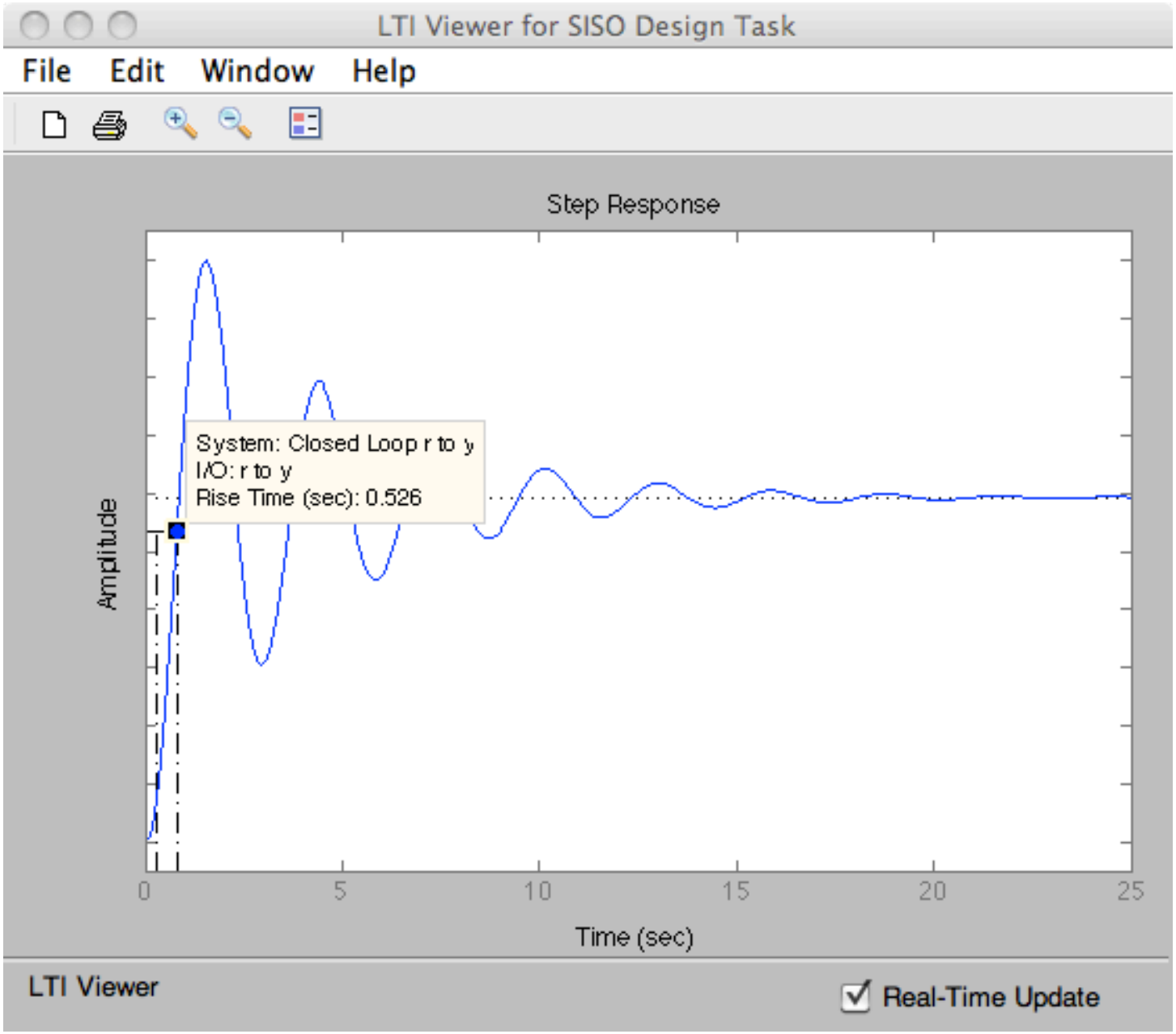

Model Import
Import model for
G
Import from:
Workspace
MAT File:
Browse
Available Models
Type
Order
G
tf
3
s
tf
2
Import
Close
Help


Control and Estimation Tools Manager
File Edit Help
Workspace
SISO Design Task
Design History
Architecture
Compensator Editor
Graphical Tuning
Analysis Plots
Automated Tuning
Design plots configuration
Plot
Available Open/Closed Loop to Tune
Plot Type
Plot 1
Open Loop 1
Root Locus
Plot 2
Open Loop 1
Open-Loop B...
Plot 3
Open Loop 1
None
Plot 4
Open Loop 1
None
Summary of available Open/Closed loops to tune:
Loop Name
Loop Description
Open Loop 1
Open Loop L
Closed Loop 1
Closed Loop - From r to y
Select New Open/Closed Loop to Tune ...
Show Design Plot
Show Architecture
Store Design
Help


SISO Design for SISO Design Task
File Edit View Designs Analysis Tools Window Help
Root Locus Editor for Open Loop 1 (OL1)
Real Axis
Open-Loop Bode Editor for Open Loop 1 (OL1)
G.M.: 26.8 dB
Freq: 3.16 rad/sec
Stable loop
P.M.: 62.9 deg
Freq: 0.455 rad/sec
Frequency (rad/sec)
Cleared compensators.


LTI Viewer for SISO Design Task
File Edit Window Help
Step Response
System: Closed Loop r to y
I/O: r to y
Time (sec): 7.73
Amplitude: 1.04
System: Closed Loop r to u
I/O: r to u
Time (sec): 3.48
Amplitude: 0.141
Amplitude
Time (sec)
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
0
2
4
6
8
10
12
LTI Viewer
Real-Time Update


SISO Design for SISO Design Task
File Edit View Designs Analysis Tools Window Help
Root Locus Editor for Open Loop 1 (OL1)
Real Axis
Open-Loop Bode Editor for Open Loop 1 (OL1)
G.M.: 6.68 dB
Freq: 3.16 rad/sec
Stable loop
P.M.: 13.2 deg
Freq: 2.12 rad/sec
Frequency (rad/sec)
C gain changed to 10.2
Right-click on plots for more design options.


LTI Viewer for SISO Design Task
File
Edit
Window
Help
Step Response
System: Closed Loop r to y
I/O: r to y
Rise Time (sec): 0.526
Amplitude
0
5
10
15
20
25
Time (sec)
LTI Viewer
Real-Time Update