UNIVERSITY OF ENGINEERING AND TECHNOLOGY PESHAWAR, ABBOTTABAD CAMPUS
DEPARTMENT OF ELECTRONIC ENGINEERING

- COMPLEX EGINEERING DESIGN PROBLEM PRESENTATION
- COURSE TITLE: CONTROL SYSTEMS(ELE-361)
- CEP TITLE: DESIGNING A CONTROLLER

<u>GROUP MEMBERS</u>

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Design Statement

Design a controller for a position-control system represented by the block diagram in figure 1.

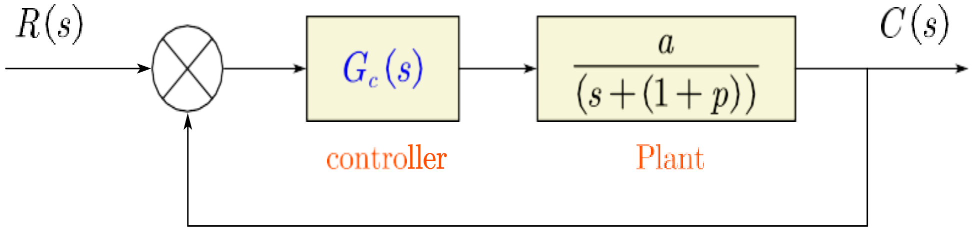


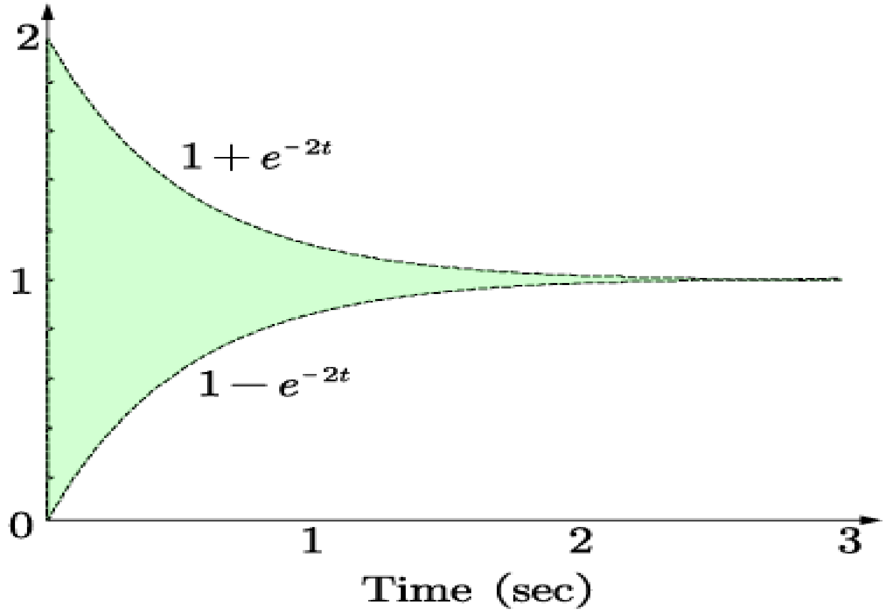
Figure 1: Block Diagram

The transfer function of the plant has been mathematically modelled, and can be expressed as:

- $G(s)= a/(s+1+p)$
- For $0<a<10$ and $0<p<1$

Design Requirement

- The compensated system should have the step response that settle inside the following envelope of : $1\pm e^{(-2t)}$



a) Steady State value=1
b) % Overshoot <15%
c) Settling Time<1sec
d) Peak Value <1.5
e) Peak Time < 0.5
f) steady-State error=0

Setting Transfer Function Parameters

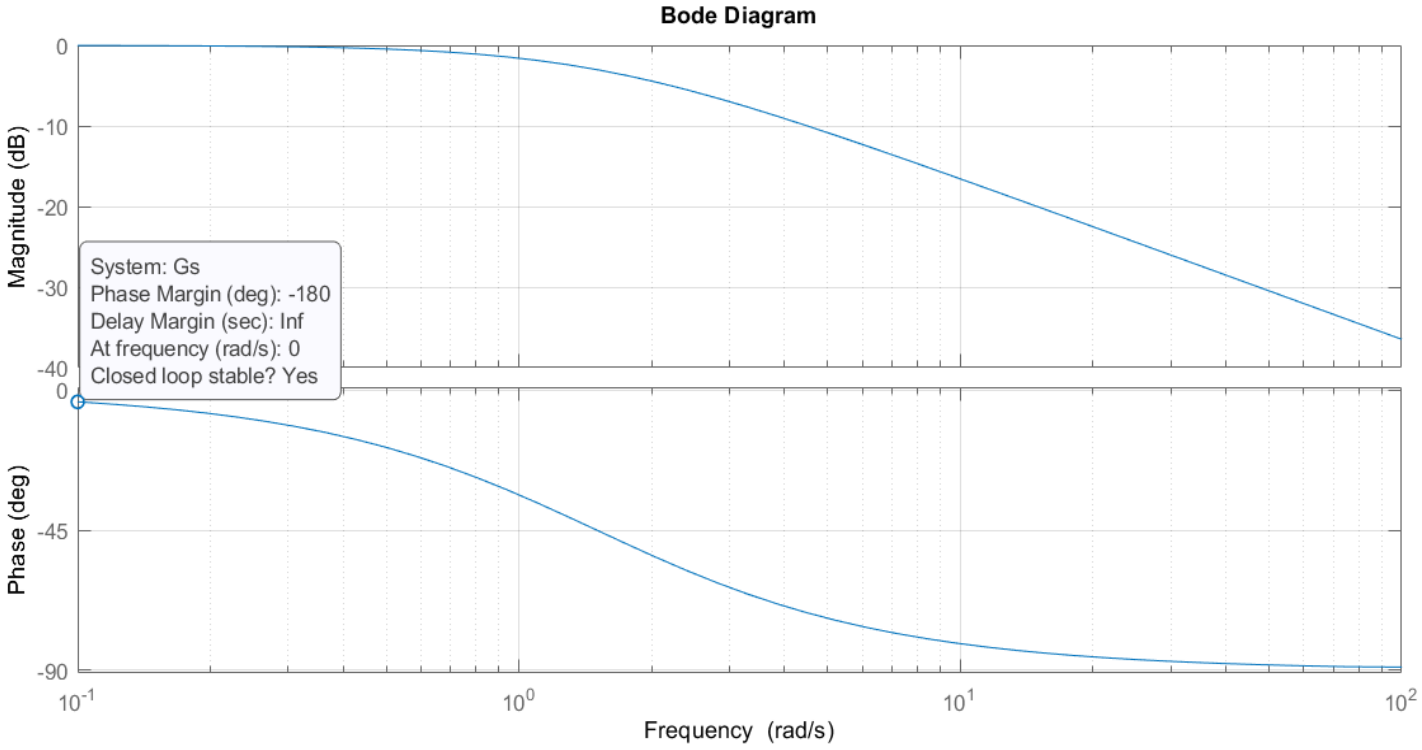
- The following values are chosen:
  - $a=5$
  - $p=0.5$
- Now the transfer function is:

  $G(s)= 5/(s+1.5)$
- The system is first order and type zero.

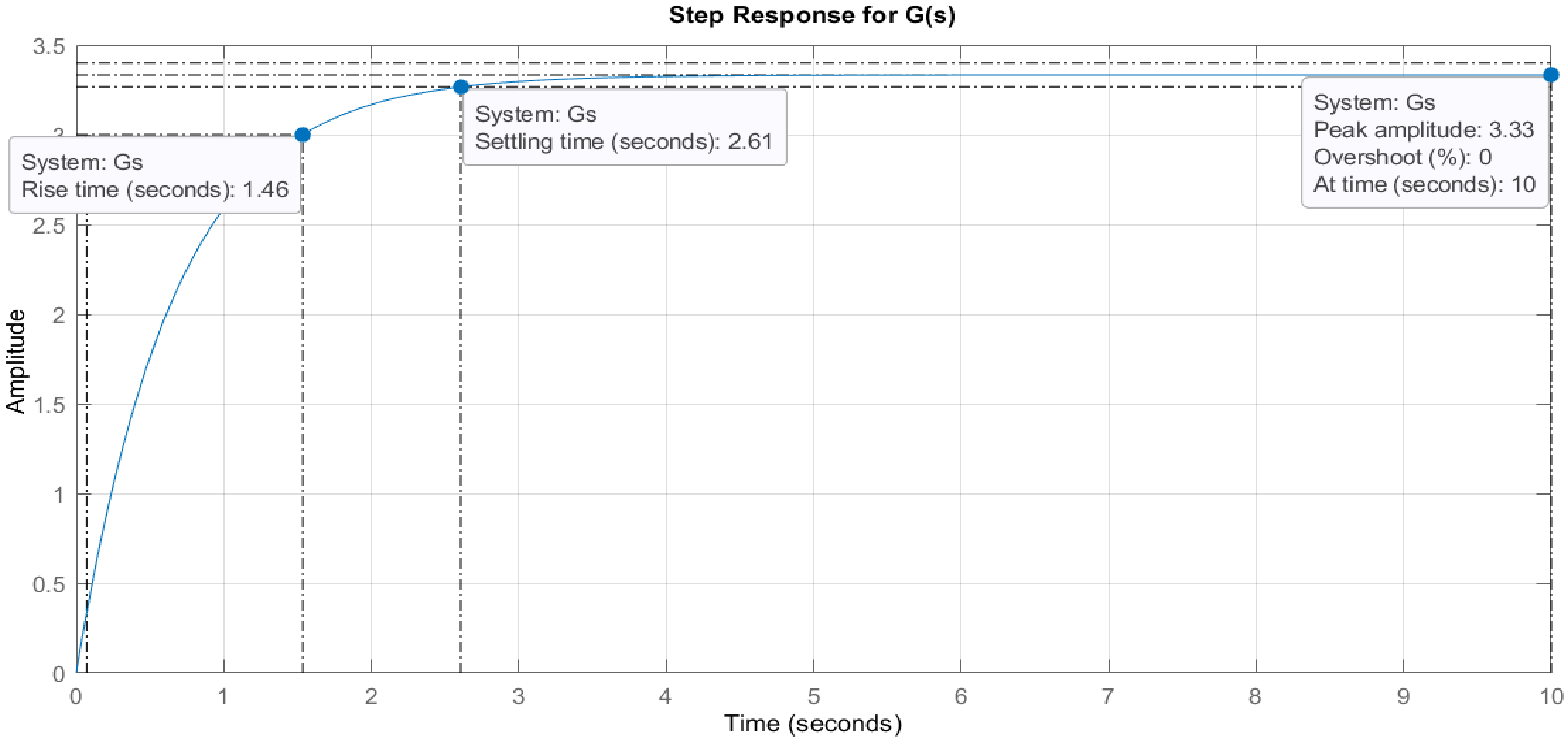
Open Loop Bode Plot

- MATLAB Code:

```
a=5;p=0.5;
k=0.3;
t=0:0.001:10;
s=tf('s');
Gs=(a*k)/(s+1+p)
bode(Gs)
grid on
```



Step Response of G(s)



Controller Selection

- PI controller is used in order to meet the requirements
- PI controller adds a pole at origin and a zero
- PI controller can address the steady-state error and improve the settling time while maintaining stability.

Controller Parameters Calculation

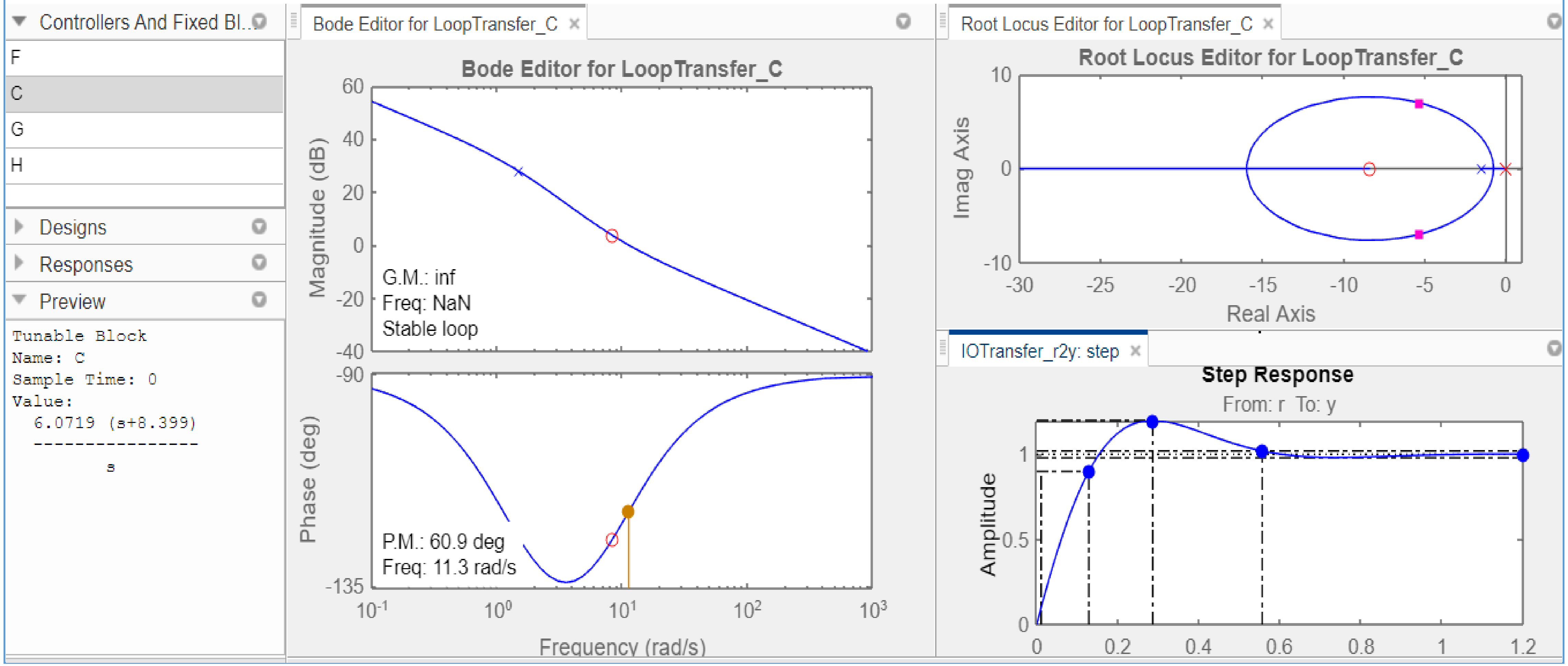
- **Using MATLAB:**

```
pos=15
Ts=0.2
zeta=(-log(pos/100))/(sqrt(pi^2+log(pos/100)^2))
Pm=atan(2*zeta/(sqrt(-2*zeta^2+sqrt(1+4*zeta^4))))*(180/pi)
Wbw=(4/(Ts*zeta))*sqrt((1-2*zeta^2)+sqrt(4*zeta^4-4*zeta^2+2))
```

- **Results:**

```
zeta =0.5969
Pm =59.1718
Wbw =  48.4571
```

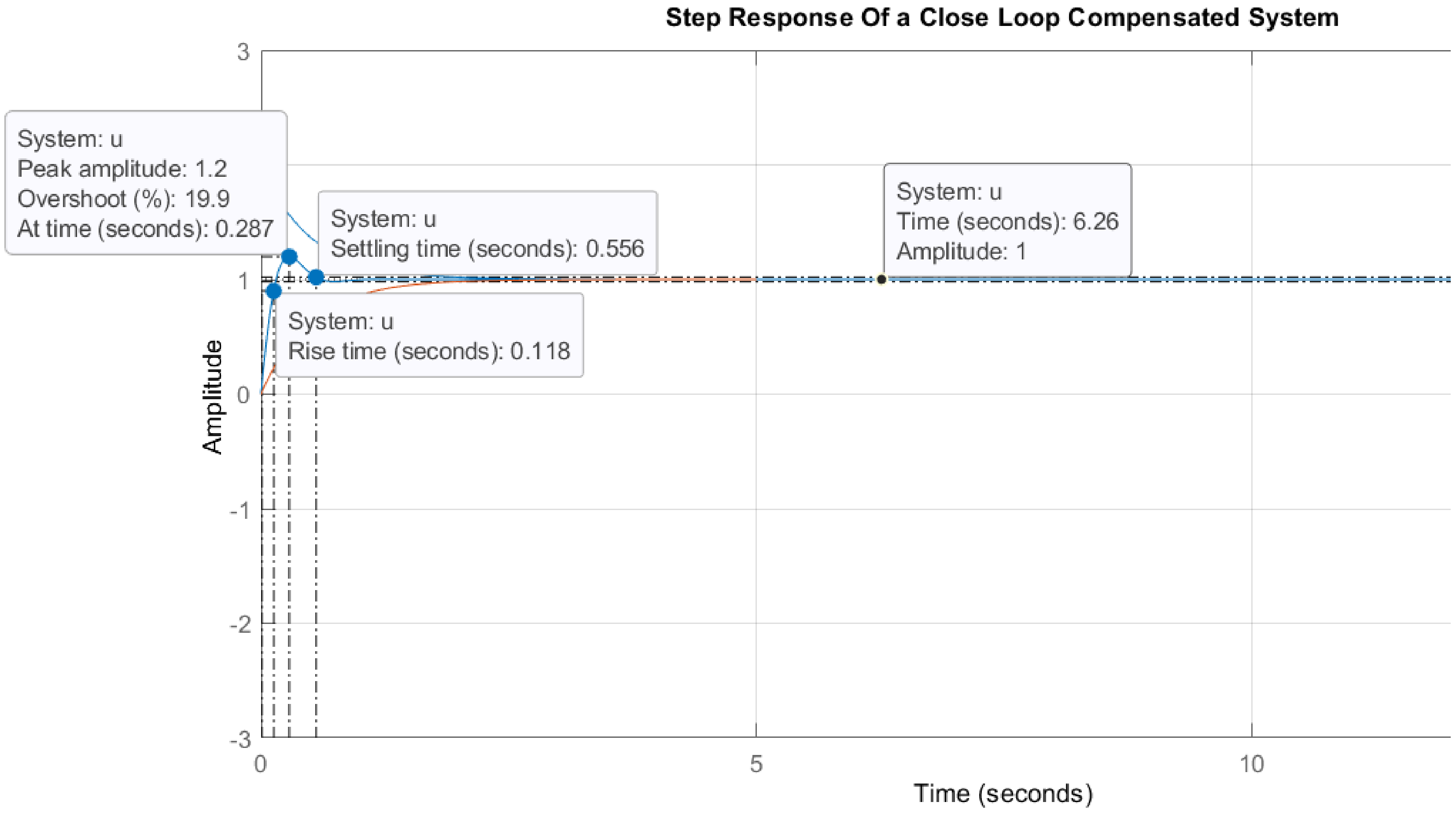
PI Controller Tuning SISO Tool



Step Response of Close Loop Compensated System

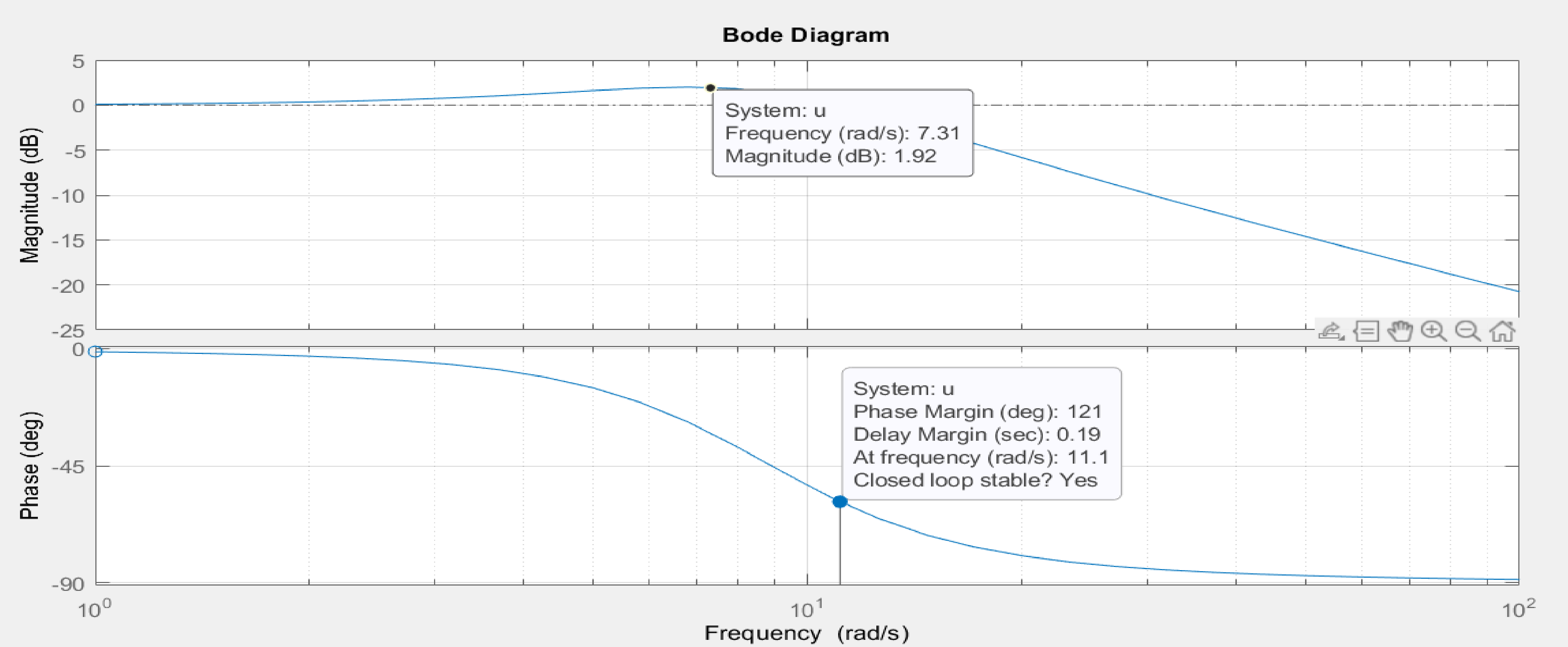
Step Response

```
t=0:0.01:5;
s=tf('s');
u=feedback(G*C,1);
step(u)
hold on
e=1+exp(-2*t);
plot(t,e)
hold on
d=1-exp(-2*t);
plot(t,d)
axis([0 15 -3 3])
```



Close Loop Frequency Response

```
u=feedback(G*C,1);bode(u)
```



Thankyou