

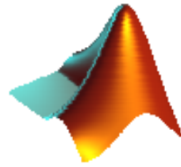
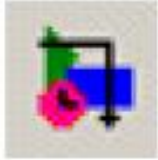
## CONTROL DE PROCESOS

Escuela de Ingeniería

# Guía para usar

# Control System Toolbox

---



# Control System Toolbox



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- Definición de funciones de transferencia

```
>> N=[1 2]; → vector
```

```
>> D=[1 3 5]; → vector
```

```
>> G=tf(N,D) → define la función G
```

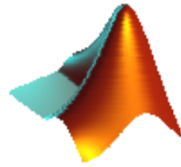
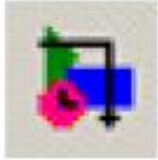
Transfer function:

$$s + 2$$

-----

$$s^2 + 3s + 5$$

```
>> G=tf([1 2],[1 3 5]) → Equivalente al comando anterior
```



# Control System Toolbox



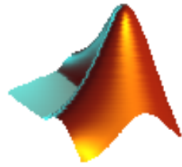
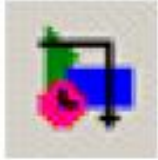
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- Definición de funciones de transferencia (forma simbólica)

```
>> s=tf('s')  
>> G=(s+1)/(s^2+2*s+5)
```

Transfer function:

$$\frac{s + 1}{s^2 + 2s + 5}$$



# Control System Toolbox



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- Definición de funciones de transferencia

```
>> Z = [-2]; → vector
```

```
>> P = [0 -1 -1]; → vector
```

```
>> k = 10
```

```
>> G = zpk(Z, P, k) → define la función G
```

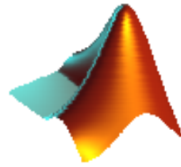
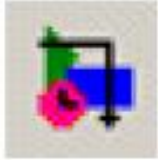
Zero/pole/gain:

```
10 (s+2)
```

```
-----
```

```
s (s+1)^2
```

```
>> G = zpk([-2], [0 -1 -1], 10) → Equivalente
```



# Control System Toolbox



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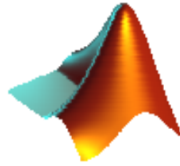
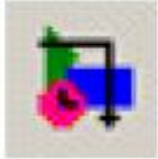
- Conversión de sistemas

```
>> G=tf([1 2],[1 3 5])
```

```
>> G=zpk(G) → expresa la función G en función de los polos, ceros y ganancia.
```

```
>> G=tf(G) → devuelve la conversión
```

---



# Control System Toolbox



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## Funciones de transferencia con tiempo muerto

Por ejemplo para crear una función de transferencia:

$$G(s) = \frac{1.2 \exp(-2.5s)}{10s + 1}$$

**Definición simbólica de la variable s de Laplace**

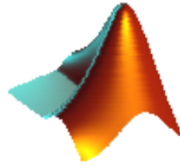
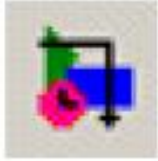
```
>> s = tf('s');
```

**Carga de la función de transferencia**

```
>> G = 1.2*exp(-2.5*s)/(10*s+1)
```

```
Transfer function:
```

```
          1.2  
exp(-2.5*s) * ----  
          10 s + 1
```



# Control System Toolbox



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## Aproximación de Padè para tiempo muerto *(opcional su uso)*

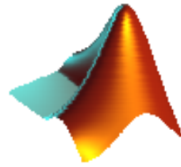
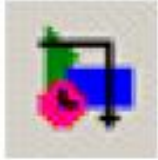
$$H(s) = \exp(-2.5s)$$

$H_a = \text{pade}(2.5,3)$  → Aproxima H con una función de orden 3

$s = \text{tf}('s');$

$H = \exp(-2.5*s);$  → H definida con s,

$H_a = \text{pade}(H,4)$  → Aproximación de Padè de orden 4



# Control System Toolbox



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```
>> G=tf([1 2],[1 3 5])
```

```
>> zero(G) → Muestra los ceros de la función
```

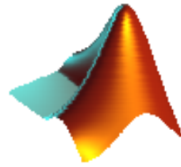
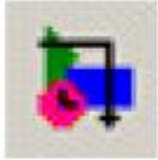
```
>> pole(G) → Muestra los polos de la función
```

```
>> [Z,GAIN]=zero(G) → muestra los ceros y la ganancia
```

```
>> pzmap(G) → grafica el diagrama de polos y ceros
```

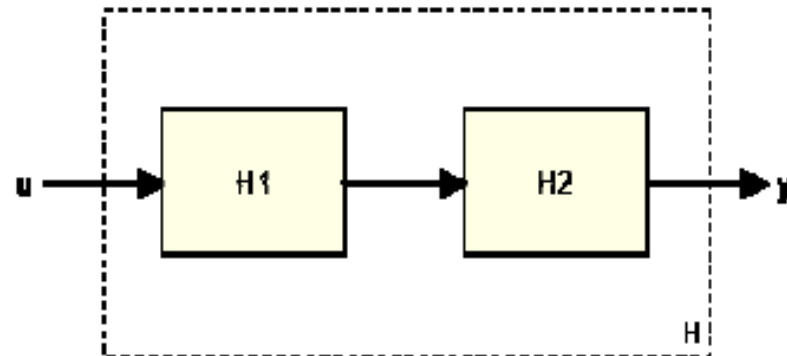
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# Control System Toolbox

- Conexión de Sistemas
  - Conexión en serie

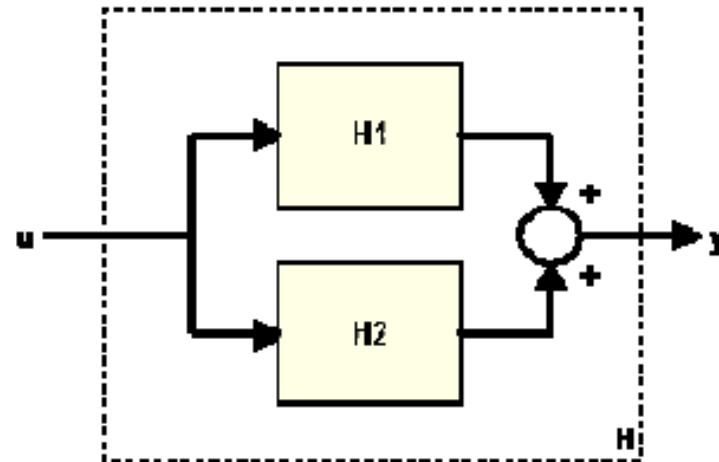


```
>>H=series(H1,H2)
```

```
>>H=H1*H2
```

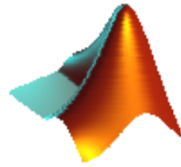
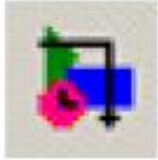
# Control System Toolbox

- Conexión de Sistemas
  - Conexión en paralelo



```
>>H=parallel(H1,H2)
```

```
>>H=H1+H2
```

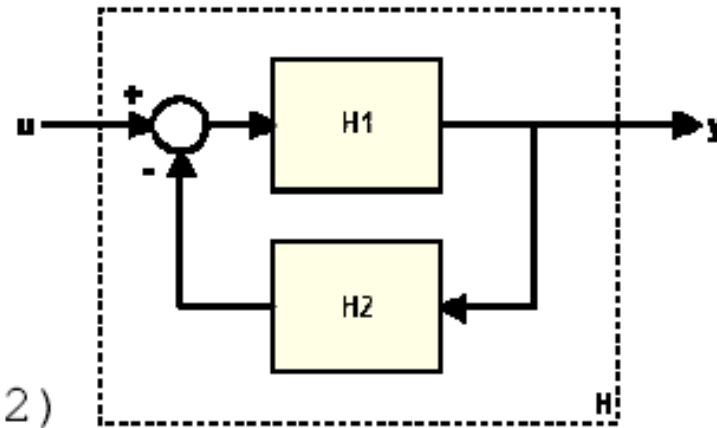


# Control System Toolbox

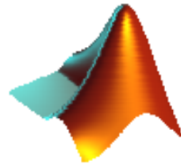
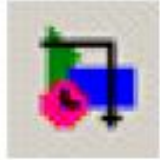


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- Conexión de Sistemas
  - Conexión en realimentación



- >> `H=feedback (H1, H2)`
- >> `H=feedback (H1, H2, +1)` → realimentación (+)
- >> `H=feedback (H1, 1)` → unitaria ( $H2=1$ )



# Control System Toolbox

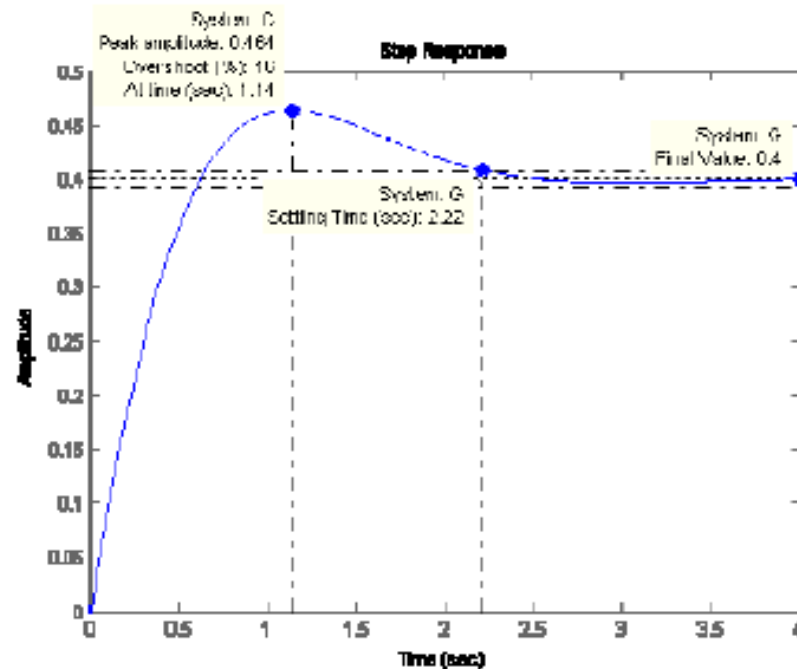


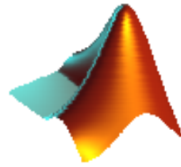
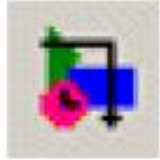
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- Análisis temporal

```
>> G=tf([1 2],[1 3 5])
```

```
>> step(G)
```



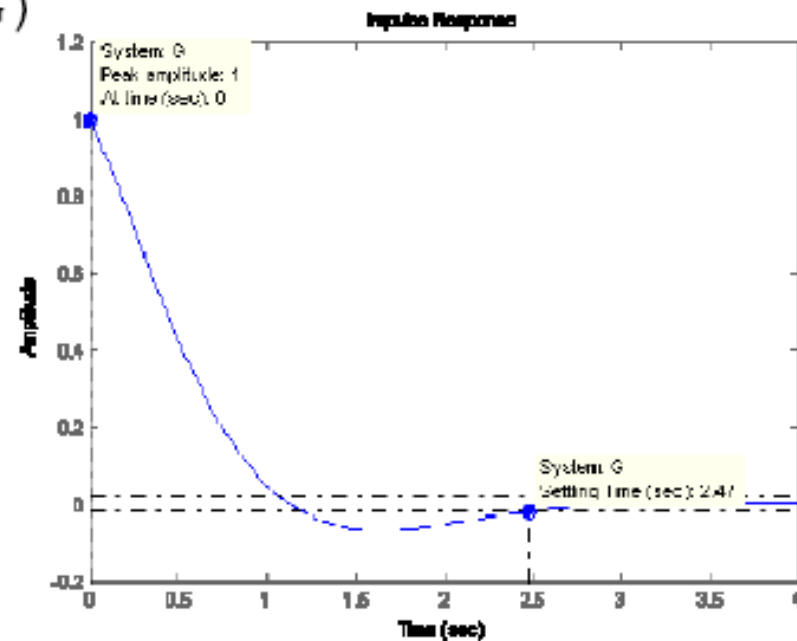


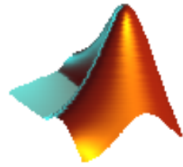
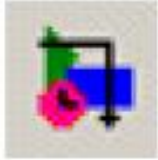
# Control System Toolbox

- Análisis temporal

```
>> G=tf([1 2],[1 3 5])
```

```
>> impulse(G)
```





# Control System Toolbox



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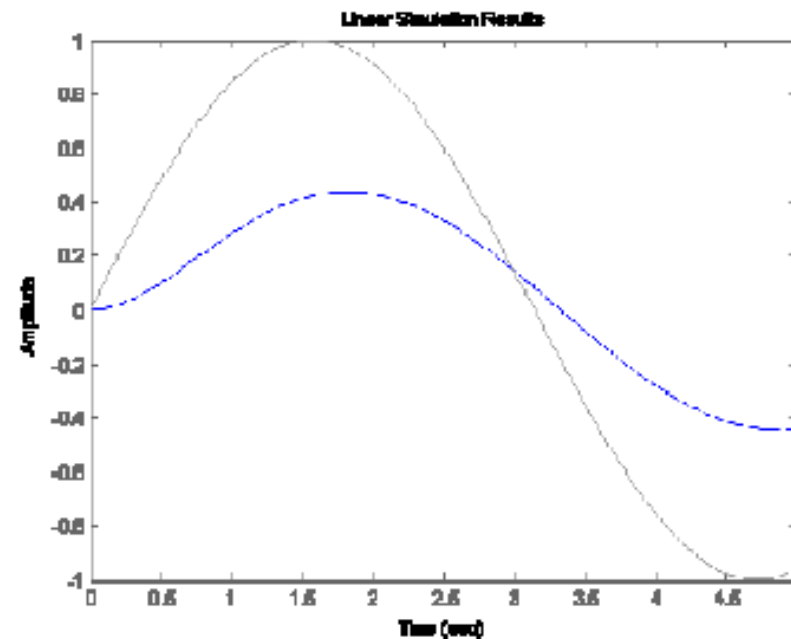
- Análisis temporal

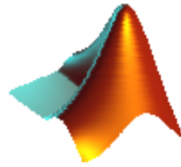
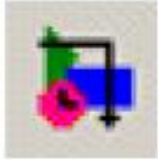
```
>> G=tf([1 2],[1 3 5])
```

```
>> t=0:0.1:5;
```

```
>> u=sin(t);
```

```
>> lsim(G,u,t)
```





# Control System Toolbox



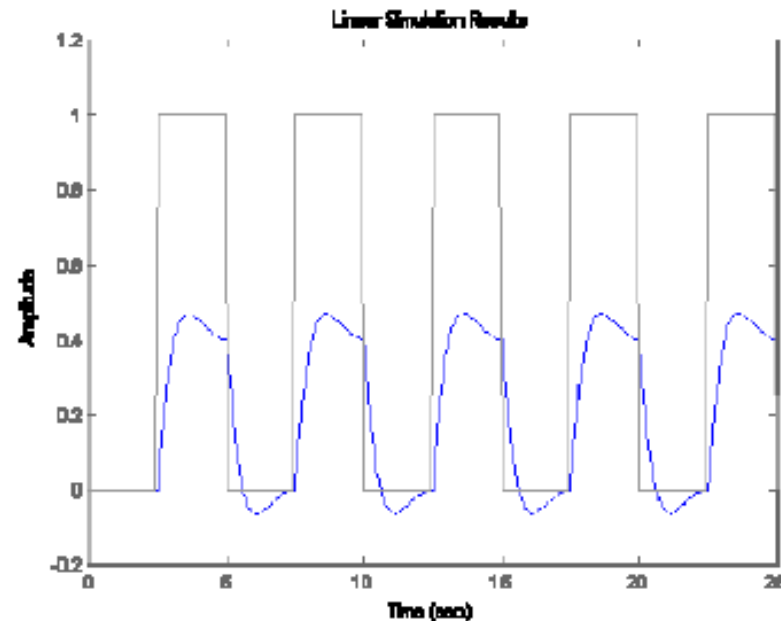
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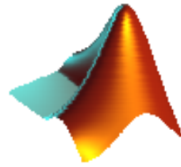
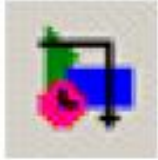
- Análisis temporal

```
>> G=tf([1 2],[1 3 5])  
>> [u,t] = gensig('square',5);  
>> lsim(G,u,t)
```

Tipos:

- 'square'
- 'sin'
- 'pulse'



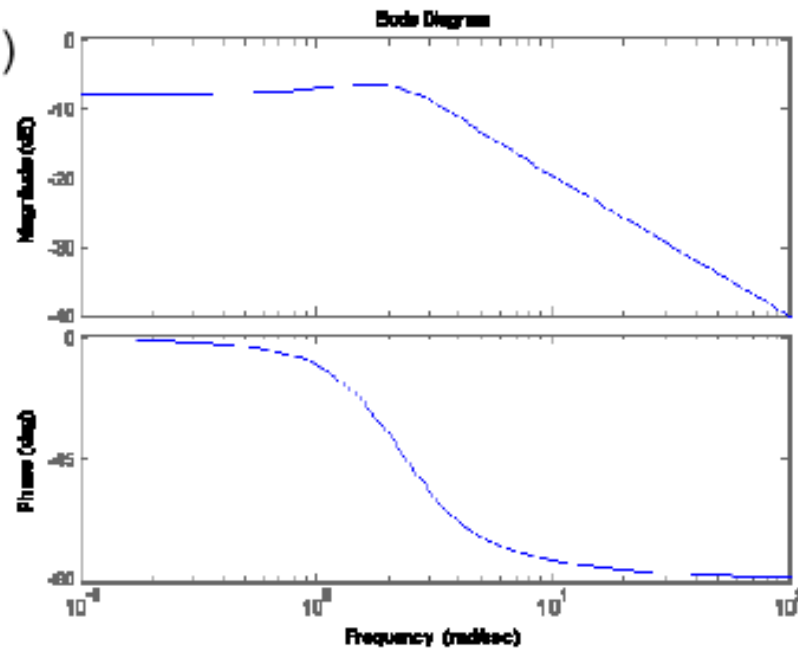


# Control System Toolbox

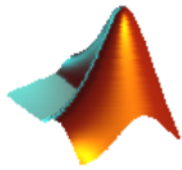
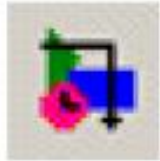
- Análisis en frecuencia

```
>> G=tf([1 2],[1 3 5])
```

```
>> bode(G)
```





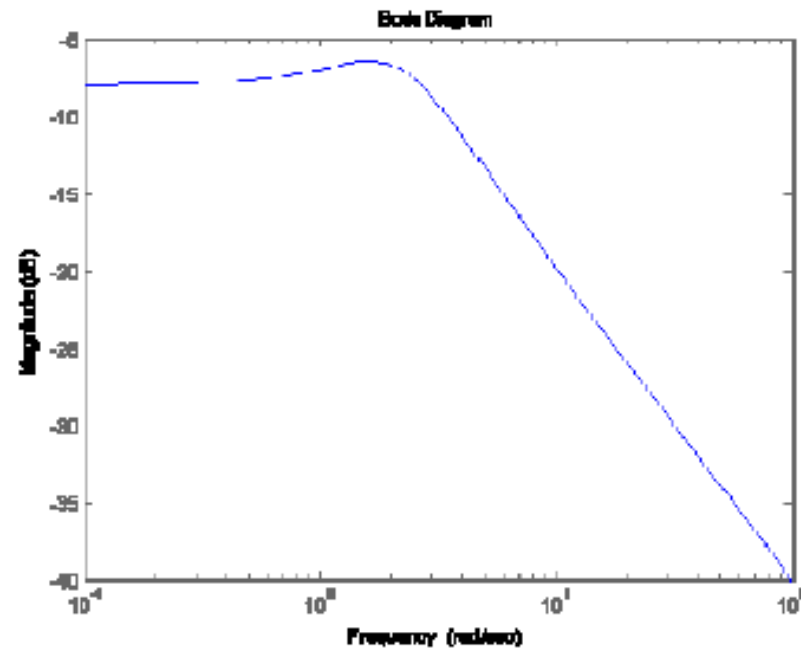


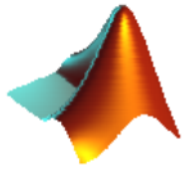
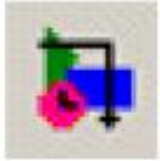
# Control System Toolbox

- Análisis en frecuencia

```
>> G=tf([1 2],[1 3 5])
```

```
>> bodemag(G)
```



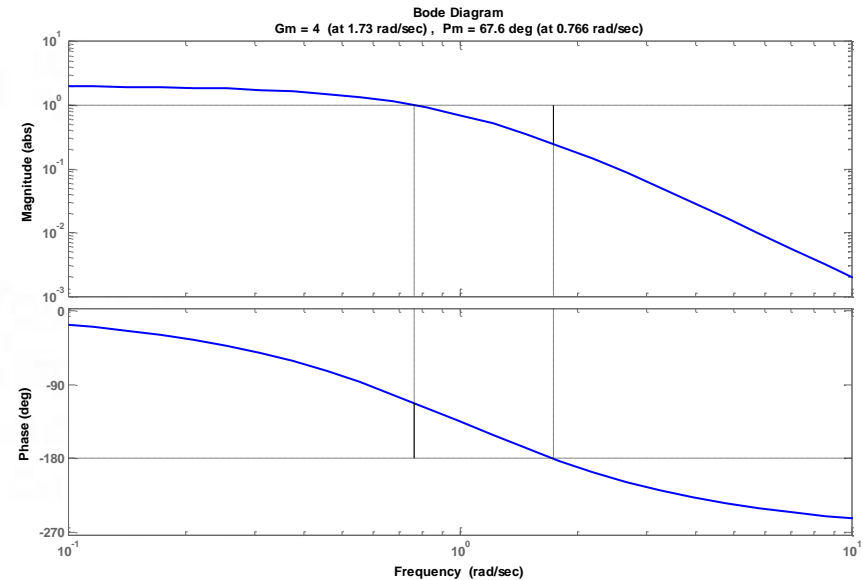


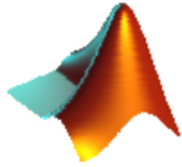
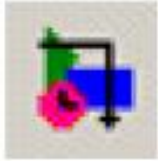
# Control System Toolbox

- Análisis en frecuencia

```
>> g1 = 2 / (s+1)^3;  
>> margin(g1)
```

Genera el diagrama de Bode indicando los márgenes de ganancia y de Fase





# Control System Toolbox



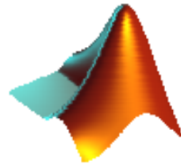
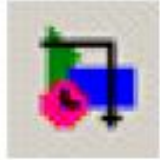
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- Análisis en frecuencia

```
>> g1 = 2/(s+1)^3;  
>> [MG,MF,wc,w1] = margin(g1)
```

Devuelve los valores de los márgenes de ganancia y de Fase y de la frecuencia crítica y la frecuencia  $w_1$

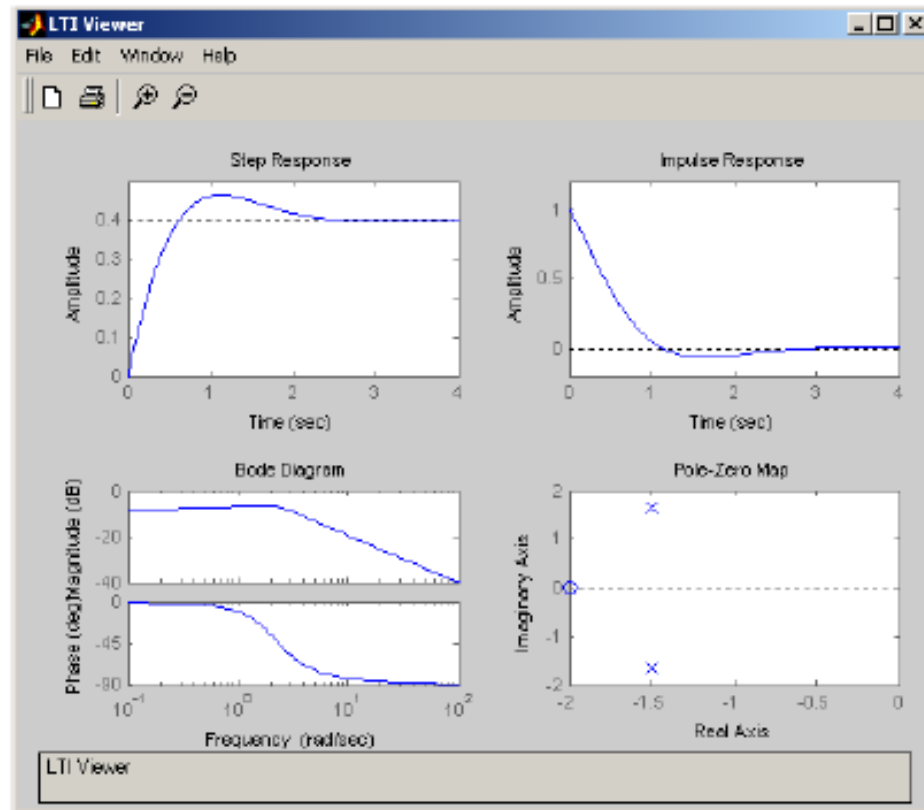
```
MG =  
  
4.0006  
  
MF =  
  
67.6058  
  
wc =  
  
1.7322  
  
w1 =  
  
0.7663
```

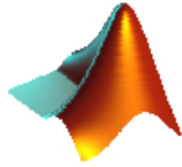
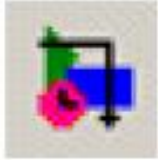


# Control System Toolbox

- Interfaz de análisis de modelos LTI

>> ltiview





# Control System Toolbox



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