enae432 hw10

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problem 1

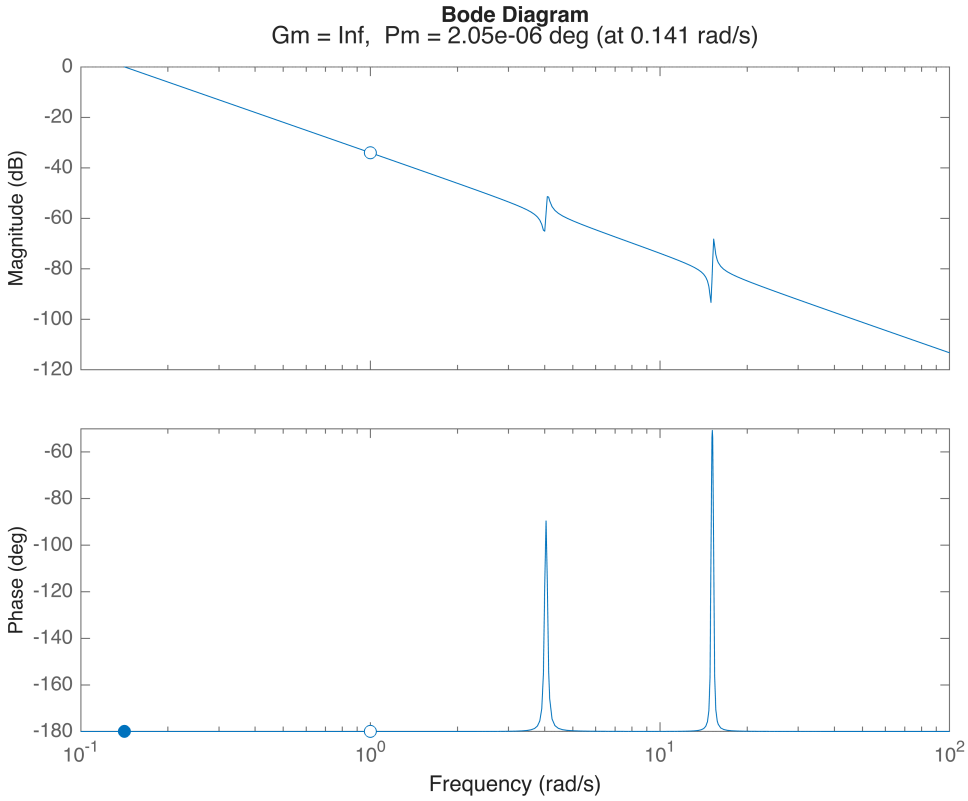
```
s  = zpk('s');
```

part b

```
n = 2;
eta = [ 0.01, 0.005 ];
omega = [ 4, 15 ];
rho = [ 0.04, 0.04 ];
I = 50;

G = (I*s^2*(1-
s^2*(rho(1)*(s^2+2*eta(1)*omega(1)*s+omega(1)^2)^-1+rho(2)*(s^2+2*eta(2)*ome
ga(2)*s+omega(2)^2)^-1)))^(-1)
```

```
G =

    0.021739 (s^2 + 0.08s + 16) (s^2 + 0.15s + 225)
  ---------------------------------------------------
  s^2 (s^2 + 0.08331s + 16.66) (s^2 + 0.1567s + 234.8)

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

```
margin(G)
```



part d

```
syms alpha_sym K_sym;

omega_c = 0.4;
phi_max = deg2rad(50);

alpha = double(solve(phi_max == asin((1-alpha_sym)/(1+alpha_sym)),
alpha_sym))
```

```
alpha =
0.1325
```

```
tau = 1/(omega_c*sqrt(alpha))
```

```
tau =
6.8687
```

```
K = double(solve(1 == abs(K_sym*(tau*omega_c*1j)/
(I*(omega_c*1j)^2*(alpha*tau*omega_c*1j+1))), K_sym))
```

```
K =
3.0986
```

```
G_0 = 1/(I*s^2)
```

```
G_0 =

  0.02
  ----
  s^2

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

```
H_0 = K*(tau*s+1)/(alpha*tau*s+1)
```

```
H_0 =

  23.39 (s+0.1456)
  ----------------
     (s+1.099)

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

```
L_0 = H_0*G_0
```

```
L_0 =

  0.46781 (s+0.1456)
  ------------------
    s^2 (s+1.099)

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

```
T_0 = feedback(L_0, 1)
```

```
T_0 =

           0.46781 (s+0.1456)
  ----------------------------------
  (s+0.2959) (s^2 + 0.8031s + 0.2302)

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

```
stepinfo(T_0)
```

```
ans = struct with fields:
          RiseTime: 2.6351
    TransientTime: 17.4347
     SettlingTime: 17.4347
      SettlingMin: 0.9139
      SettlingMax: 1.2789
        Overshoot: 27.8858
       Undershoot: 0
             Peak: 1.2789
         PeakTime: 7.0038
```

problem 2

part a

```
L = H_0*G
```

```
L =

    0.50849 (s+0.1456) (s^2 + 0.08s + 16) (s^2 + 0.15s + 225)
  ------------------------------------------------------------
  s^2 (s+1.099) (s^2 + 0.08331s + 16.66) (s^2 + 0.1567s + 234.8)

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

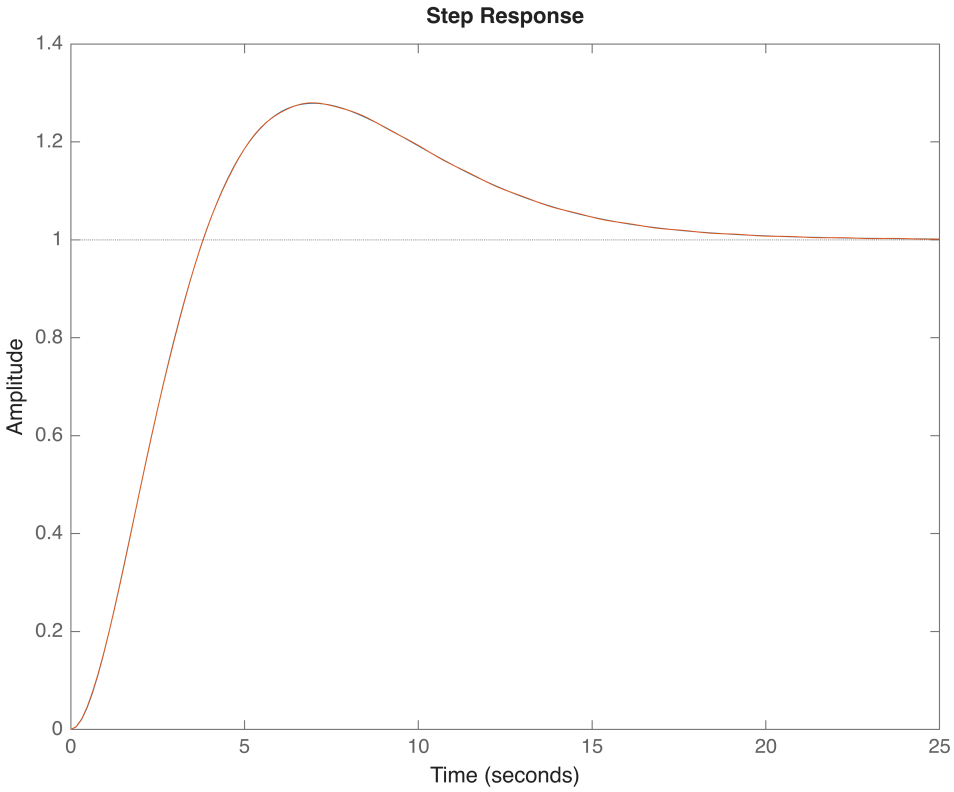
```
T = feedback(L, 1)
```

```
T =

               0.50849 (s+0.1456) (s^2 + 0.08s + 16) (s^2 + 0.15s + 225)
  ------------------------------------------------------------------------------
  (s+0.2957) (s^2 + 0.8021s + 0.2301) (s^2 + 0.0844s + 16.68) (s^2 + 0.1568s + 234.8)

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

```
stepinfo(T)
```

```
ans = struct with fields:
         RiseTime: 2.6441
    TransientTime: 17.4976
     SettlingTime: 17.4976
      SettlingMin: 0.9142
      SettlingMax: 1.2797
        Overshoot: 27.9669
       Undershoot: 0
             Peak: 1.2797
         PeakTime: 7.0086
```

```
stepplot(T_0, T)
```



part b

```
w = logspace(-2,2,1000);
[magG,~]  = bode(G, w);  magG  = squeeze(magG);
[magG_0,~] = bode(G_0,w);  magG_0 = squeeze(magG_0);

Delta = (magG./magG_0) - 1;

[magL_0,~] = bode(H_0*G_0, w);  magL_0 = squeeze(magL_0);
T_0jw = magL_0 ./ (1 + magL_0);

M = abs(Delta).*T_0jw;
[Msup,idx] = max(M)
```

```
Msup =
0.0347
idx =
654
```

```
wsup = w(idx)
```

```
wsup =
4.1173
sup_ω |Δ·T0| = 3.471e-02  at  ω = 4.12  rad/s
```

part c

```
idx1 = find( abs(w-4)==min(abs(w-4)), 1 );
d1 = Delta(idx1);
omega_c_max = 4/sqrt(abs(d1))
```

```
omega_c_max =
5.5126
```

part d

```
Td = feedback(G, 1+L);

magTd = squeeze(bode(Td,w));

mask = magTd <= 0.1;
w_mask = w(mask);
low_freq_end  = max(w_mask(w_mask<0.4))
```

```
low_freq_end =
0.1876
```

```
high_freq_start = min(w_mask(w_mask>0.4))
```

```
high_freq_start =
0.4422
```

part e

```
Tnoise = feedback(L,1);
magTnoise = squeeze(bode(Tnoise,w));

mask_n = magTnoise <= 0.1;
noise_cut = min(w(mask_n))
```

```
noise_cut =
2.1200
```

problem 3

part a

```
syms K_sym;
s_0 = -2+3j;

z = -1*(2+3/tan(deg2rad(180)+atan(3/-2)+pi+3*atan(3/3)))
```

```
z =
-2.6000
```

```
K = double(solve(1 == abs(4*K_sym*(s_0-z)/(s_0*(s_0+5)^3)), K_sym))
```

```
K =
22.5000
```

part b

```
L = 4*K*(s-z)/(s*(s+5)^3)
```

```
L =

  90 (s+2.6)
  ----------
  s (s+5)^3

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

```
T = feedback(L, 1)
```

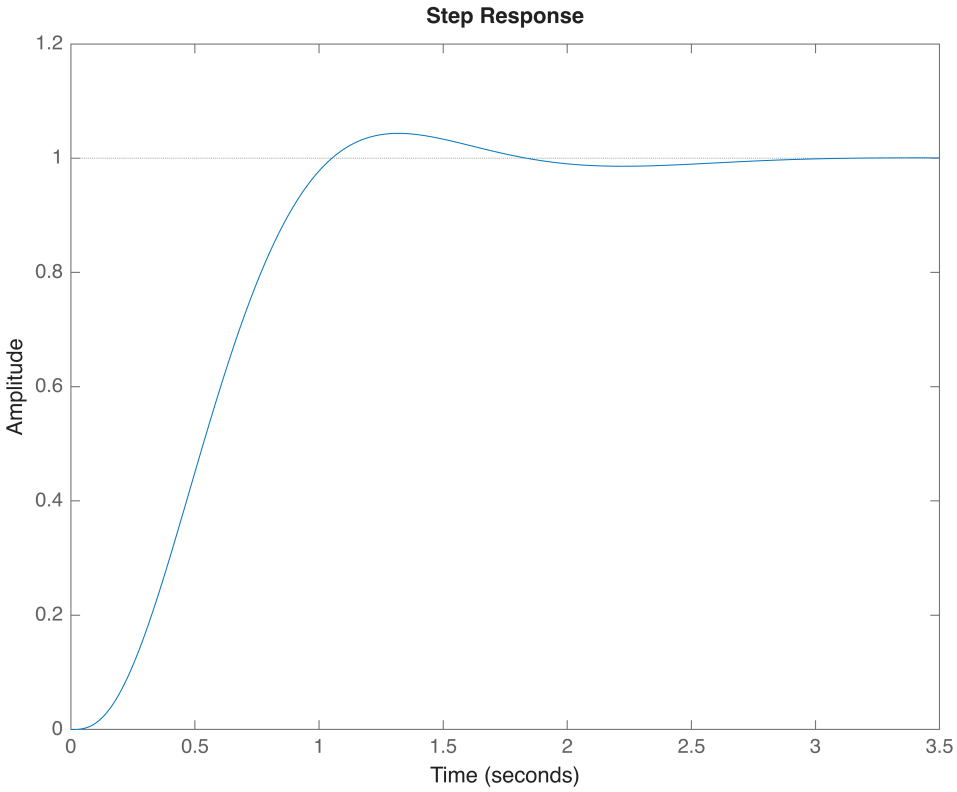
```
T =

         90 (s+2.6)
  --------------------------
  (s+9) (s+2) (s^2 + 4s + 13)

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

```
pole(T)
```

```
ans = 4×1 complex
  -9.0000 + 0.0000i
  -2.0000 + 3.0000i
  -2.0000 - 3.0000i
  -2.0000 + 0.0000i
```

part c

```
step(T)
```




```
stepinfo(T)
```

```
ans = struct with fields:
         RiseTime: 0.6382
    TransientTime: 1.6284
     SettlingTime: 1.6284
      SettlingMin: 0.9031
      SettlingMax: 1.0435
        Overshoot: 4.3489
       Undershoot: 0
             Peak: 1.0435
         PeakTime: 1.3201
```

part d

```
K_new = K*7
```

```
K_new =
157.5000
```

```
L_new = 4*K_new*(s-z)/(s*(s+5)^3)
```

```
L_new =

  630 (s+2.6)
  -----------
   s (s+5)^3

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

```
T_new = feedback(L_new, 1)
```

```
T_new =

                 630 (s+2.6)
  ----------------------------------------
  (s+12.96) (s+2.54) (s^2 - 0.4958s + 49.78)

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

```
pole(T_new)
```

```
ans = 4×1 complex
 -12.9559 + 0.0000i
   0.2479 + 7.0508i
   0.2479 - 7.0508i
  -2.5400 + 0.0000i
```