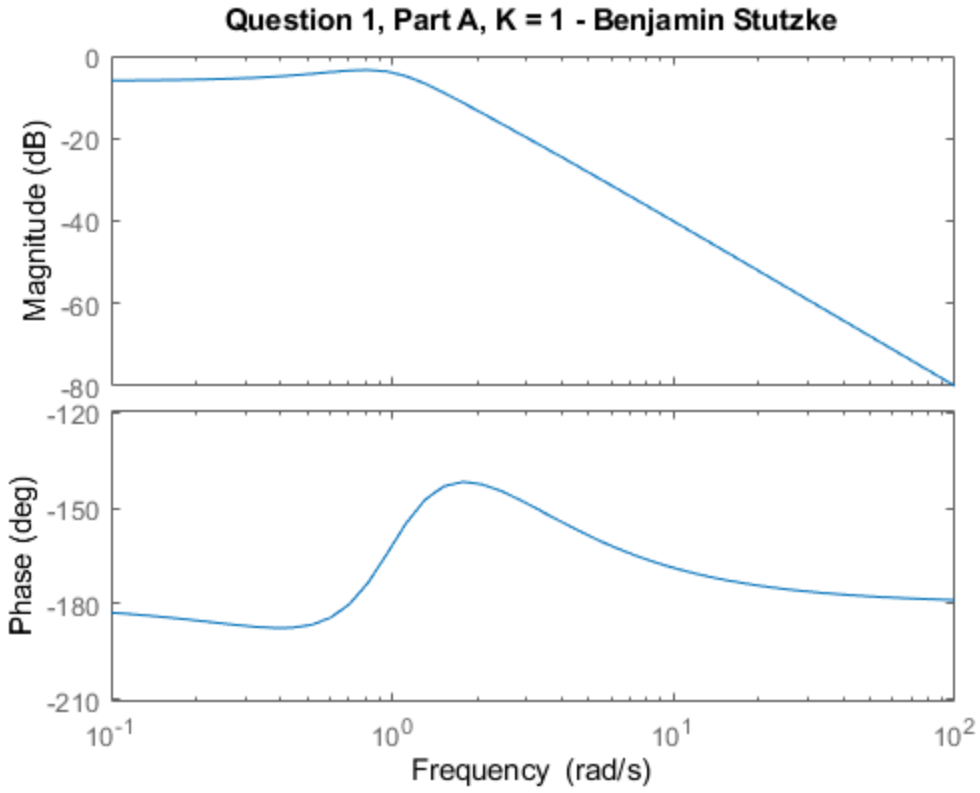
Table of Contents

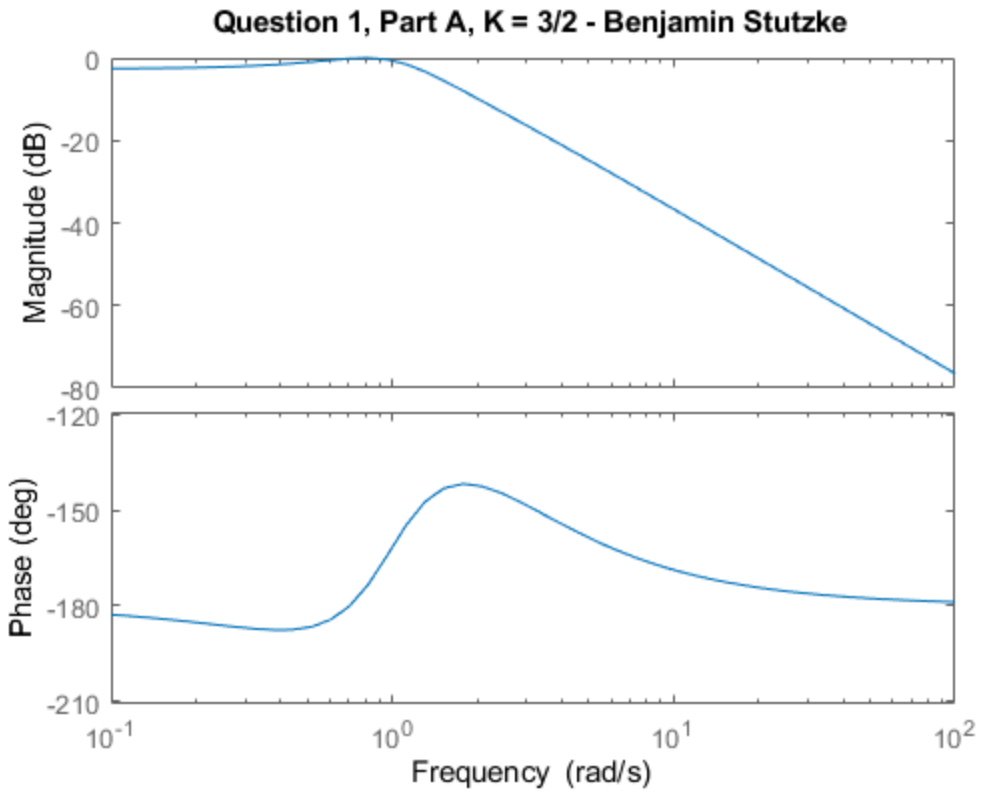

```
% Benjamin Stutzke
% ENAE 432 - 0102
% Problem Set 7
clear; close all;
```

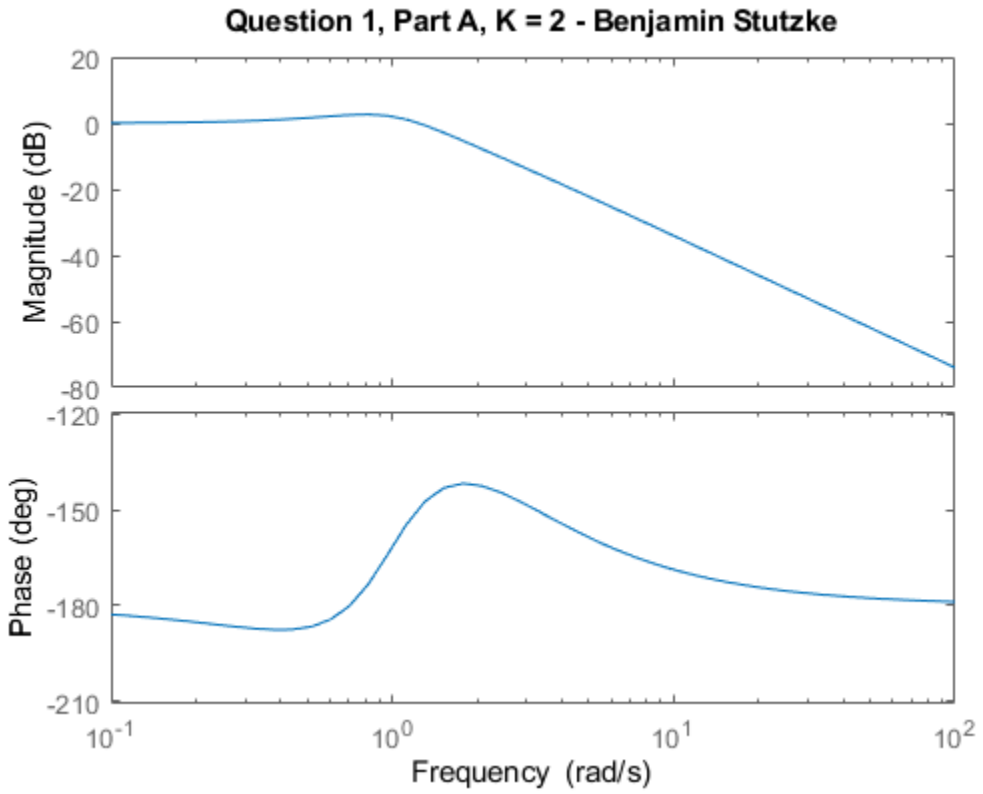
Question 1

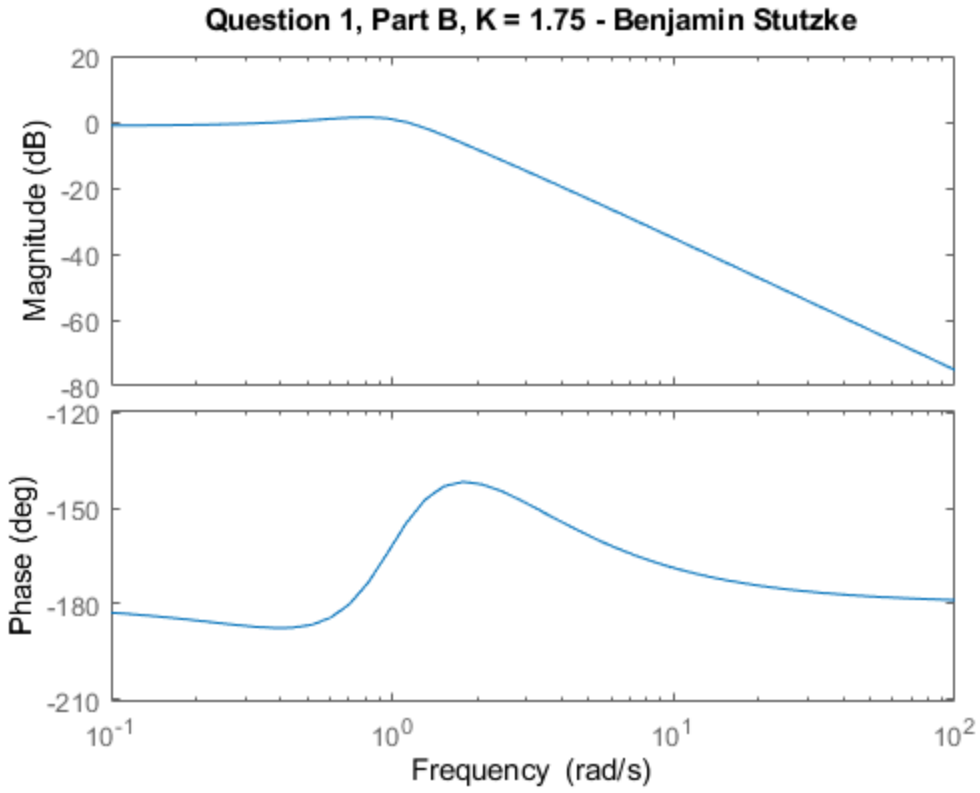
```
poles = roots([1 1 -1 2])
s = tf('s');

K = 1;
L = K*(s-1)/(s^3 +s^2 -s +2);
figure;
bode(L)
title("Question 1, Part A, K = 1 - Benjamin Stutzke");

K = 3/2;
L = K*(s-1)/(s^3 +s^2 -s +2);
figure;
bode(L)
title("Question 1, Part A, K = 3/2 - Benjamin Stutzke");

K = 2;
L = K*(s-1)/(s^3 +s^2 -s +2);
figure;
bode(L)
title("Question 1, Part A, K = 2 - Benjamin Stutzke");

K = 1.75;
L = K*(s-1)/(s^3 +s^2 -s +2);
figure;
bode(L)
title("Question 1, Part B, K = 1.75 - Benjamin Stutzke");

K = 3;
L = K*(s-1)/(s^3 +s^2 -s +2);
figure;
bode(L)
title("Question 1, Part B, K = 3 - Benjamin Stutzke");
```

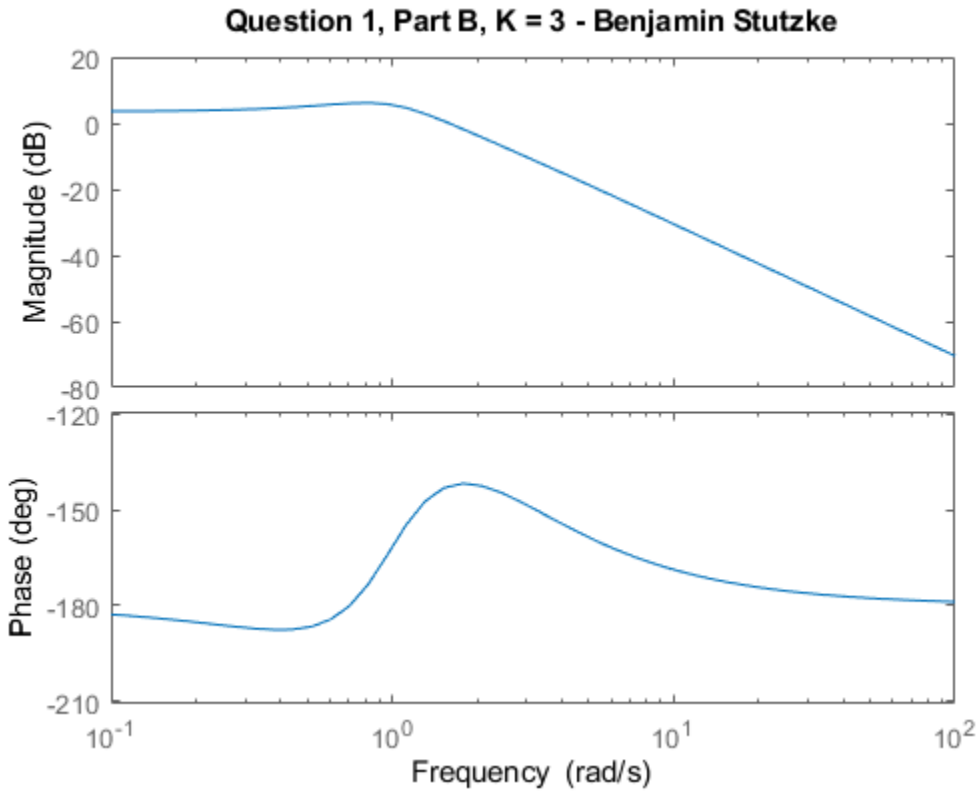
```
poles =

  -2.0000 + 0.0000i
   0.5000 + 0.8660i
   0.5000 - 0.8660i
```




Question 1, Part A, K = 3/2 - Benjamin Stutzke
Magnitude (dB)
0
-20
-40
-60
-80
Phase (deg)
-120
-150
-180
-210
10^{-1}
10^{0}
10^{1}
10^{2}
Frequency (rad/s)


Question 1, Part A, K = 2 - Benjamin Stutzke
Magnitude (dB)
20
0
-20
-40
-60
-80
Phase (deg)
-120
-150
-180
-210
10^{-1}
10^{0}
10^{1}
10^{2}
Frequency (rad/s)

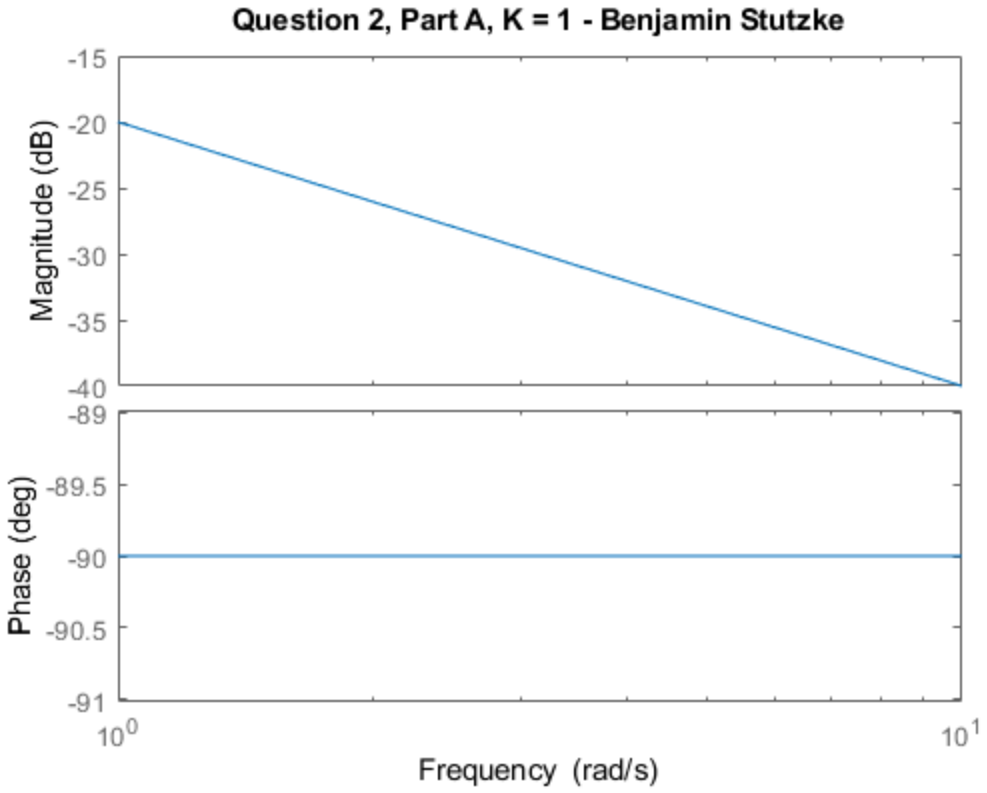

Question 1, Part B, K = 1.75 - Benjamin Stutzke
Magnitude (dB)
20
0
-20
-40
-60
-80
Phase (deg)
-120
-150
-180
-210
10^{-1}
10^{0}
10^{1}
10^{2}
Frequency (rad/s)

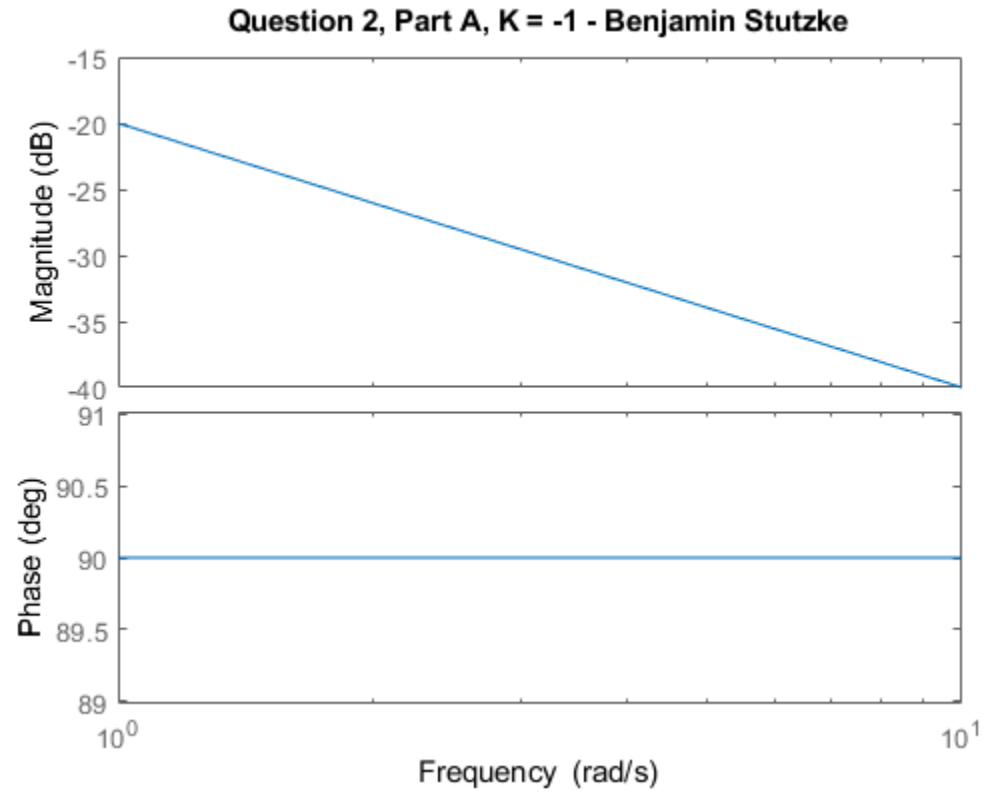

Question 1, Part B, K = 3 - Benjamin Stutzke
Magnitude (dB)
20
0
-20
-40
-60
-80
Phase (deg)
-120
-150
-180
-210
10^{-1}
10^{0}
10^{1}
10^{2}
Frequency (rad/s)

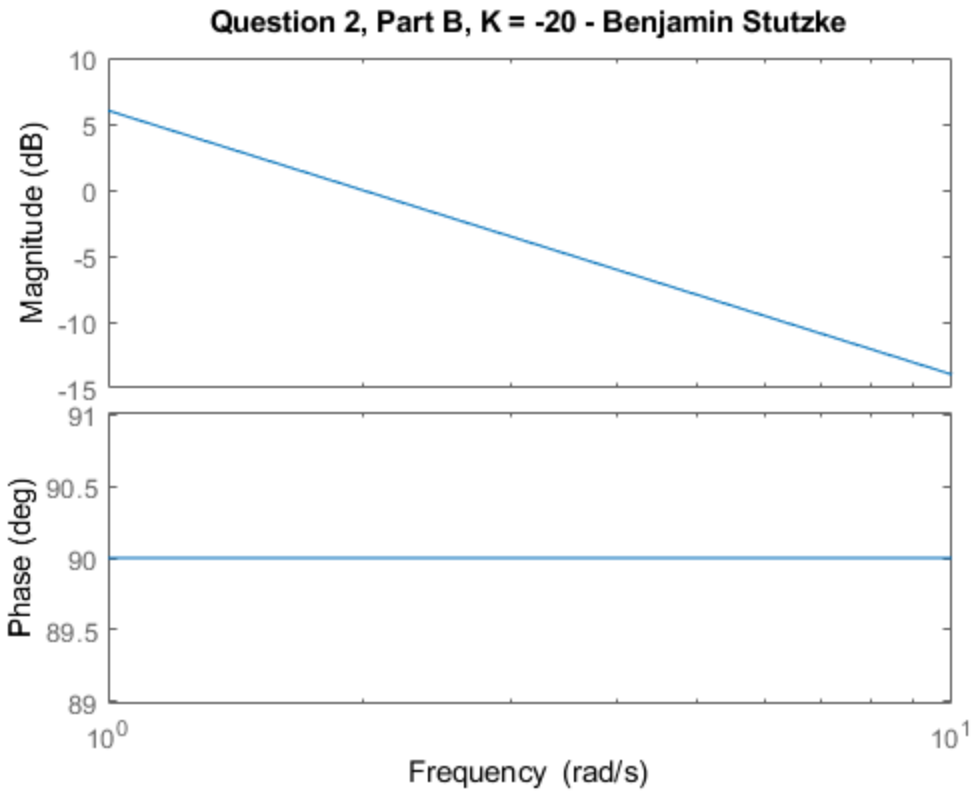
Question 2

```
s = tf('s');
K = 1;

L = K/(10*s)
figure;
bode(L);
title("Question 2, Part A, K = 1 - Benjamin Stutzke");

K = -1;
L = K/(10*s)
figure;
bode(L);
title("Question 2, Part A, K = -1 - Benjamin Stutzke");

K = -20;
L = K/(10*s)
figure;
bode(L);
title("Question 2, Part B, K = -20 - Benjamin Stutzke");
```

```
L =

   1
  ----
  10 s

Continuous-time transfer function.


L =

   -1
  ----
  10 s

Continuous-time transfer function.


L =

  -20
  ----
  10 s

Continuous-time transfer function.
```


Question 2, Part A, K = 1 - Benjamin Stutzke
Magnitude (dB)
-15
-20
-25
-30
-35
-40
Phase (deg)
-89
-89.5
-90
-90.5
-91
10^0
10^1
Frequency (rad/s)


Question 2, Part A, K = -1 - Benjamin Stutzke
Magnitude (dB)
-15
-20
-25
-30
-35
-40
Phase (deg)
91
90.5
90
89.5
89
10^0
10^1
Frequency (rad/s)



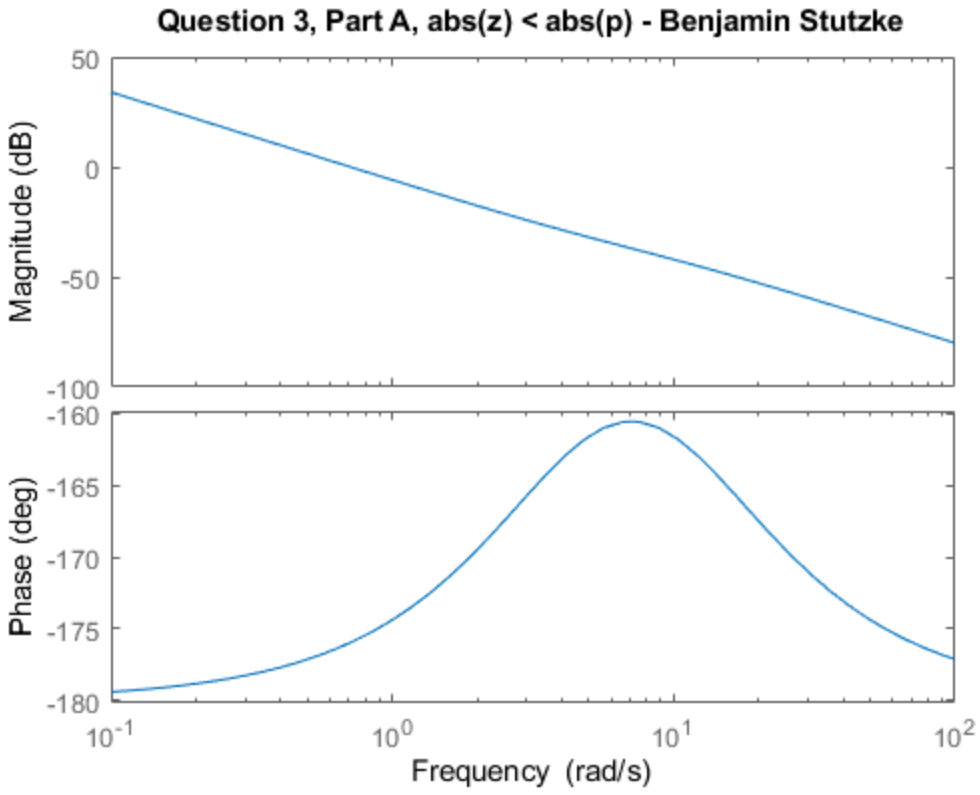
Question 3

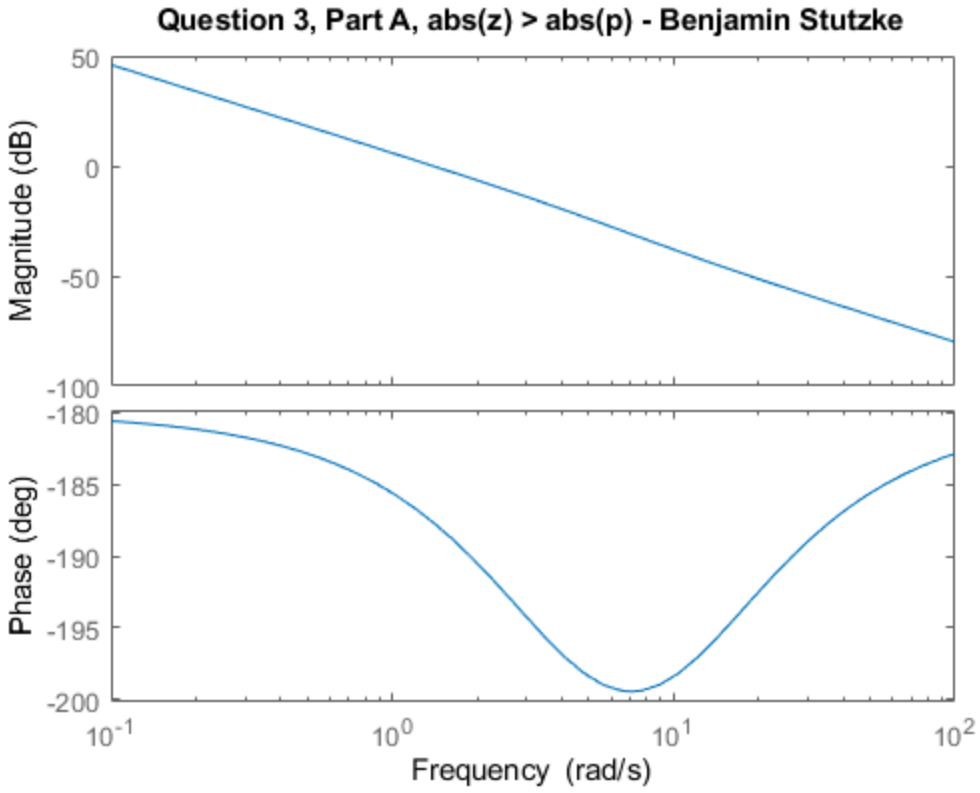
```
s = tf('s');
G = 1/(s^2);
K = 1;

z = -5;
p = -10;
H = K*(s-z)/(s-p);
L = G*H
figure;
bode(L);
title("Question 3, Part A, abs(z) < abs(p) - Benjamin Stutzke");

z = -10;
p = -5;
H = K*(s-z)/(s-p);
L = G*H
figure;
bode(L);
title("Question 3, Part A, abs(z) > abs(p) - Benjamin Stutzke");

z = -1;
p = -5;
H = K*(s-z)/(s-p);
```

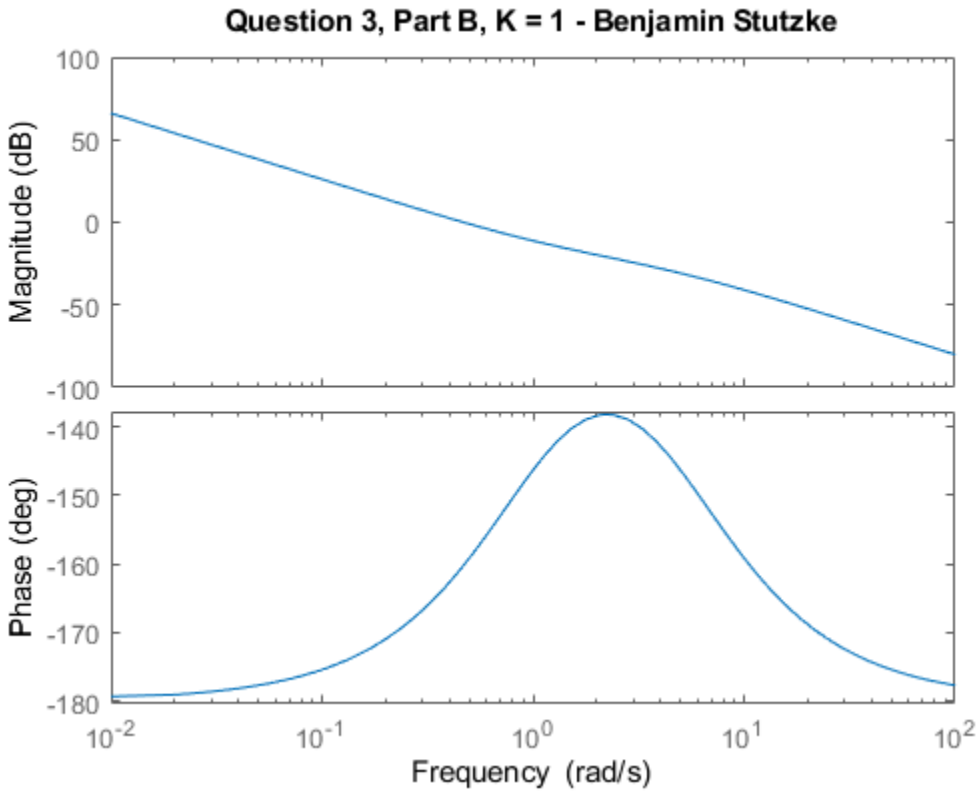
```
L = G*H
figure;
bode(L)
title("Question 3, Part B, K = 1 - Benjamin Stutzke");

K = 10.93;
H = K*(s-z)/(s-p);
L = G*H
figure;
bode(L)
title("Question 3, Part B, K = 10.93 - Benjamin Stutzke");

error = 1e-5;
for omega = 0.01:0.0000001:100000
    s = omega*sqrt(-1);
    S = 1/((K*(s-z) + (s^2)*(s-p)) / ((s^2)*(s-p)));
    mag = 20*log10(abs(S));
    if abs((mag + 3)) < error
        omega
        break;
    end
end
```

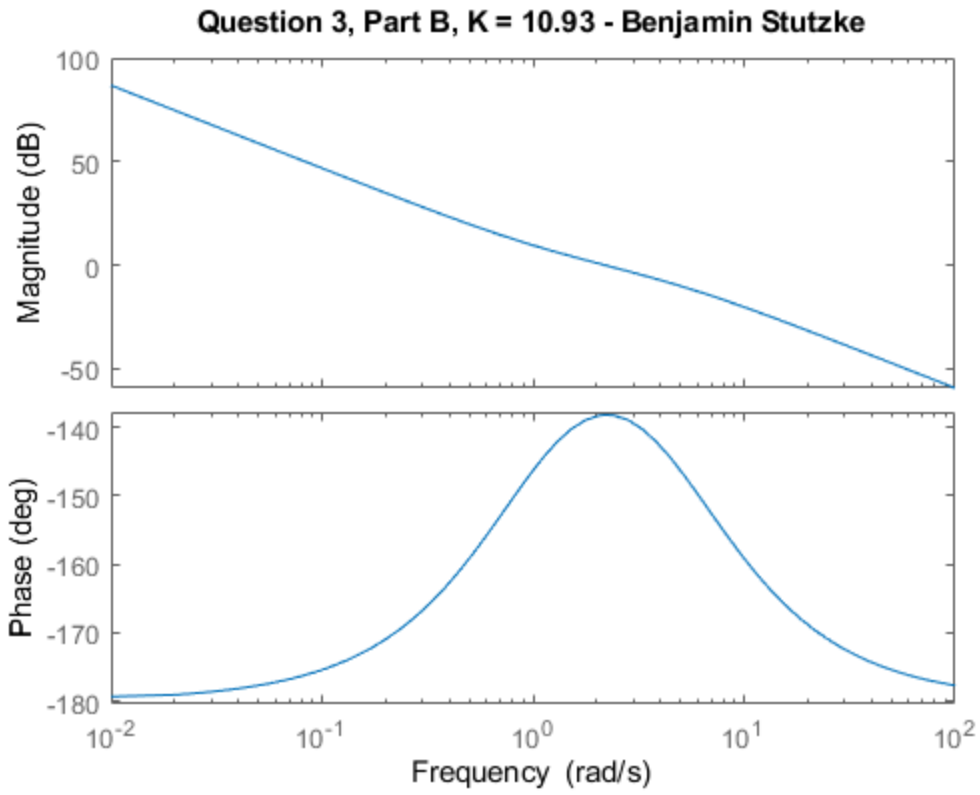
```
L =

     s + 5
  ------------
  s^3 + 10 s^2

Continuous-time transfer function.


L =

    s + 10
  -----------
  s^3 + 5 s^2

Continuous-time transfer function.


L =

     s + 1
  -----------
  s^3 + 5 s^2

Continuous-time transfer function.


L =

  10.93 s + 10.93
```

```
  ---------------
    s^3 + 5 s^2

Continuous-time transfer function.


omega =

    1.2959
```




Question 3, Part A, abs(z) > abs(p) - Benjamin Stutzke
Magnitude (dB)
50
0
-50
-100
Phase (deg)
-180
-185
-190
-195
-200
10^{-1}
10^{0}
10^{1}
10^{2}
Frequency (rad/s)


Question 3, Part B, K = 1 - Benjamin Stutzke
Magnitude (dB)
100
50
0
-50
-100
Phase (deg)
-140
-150
-160
-170
-180
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
Frequency (rad/s)

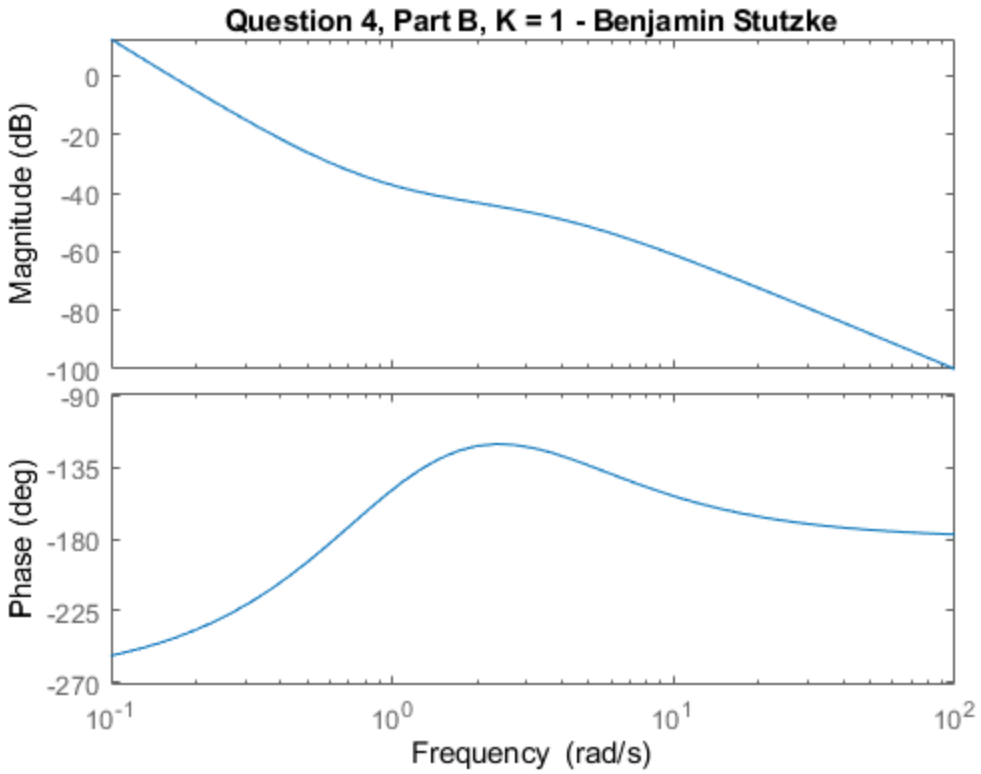


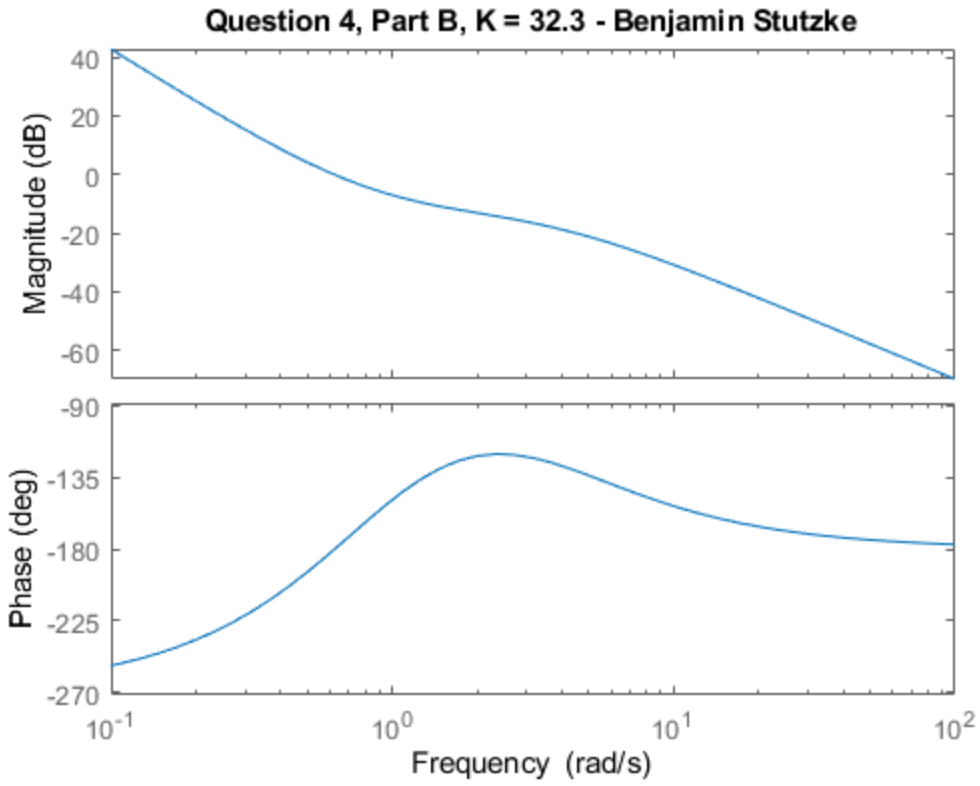
Question 4

```
poles = roots([1 9 26 24 0])
K = 1;
s = tf('s');

H = (K/(24*s)) - (K/(4*(s+2))) + 16*K/(3*(s+3)) - 81*K/(8*(s+4)) + K
G = 1/(10*(s^2))
L = G*H

figure;
bode(L)
title("Question 4, Part B, K = 1 - Benjamin Stutzke");

K = 32.3;
H = (K/(24*s)) - (K/(4*(s+2))) + 16*K/(3*(s+3)) - 81*K/(8*(s+4)) + K
G = 1/(10*(s^2))
L = G*H

figure;
bode(L)
title("Question 4, Part B, K = 32.3 - Benjamin Stutzke");


poles =
```

```
         0
   -4.0000
   -3.0000
   -2.0000


H =

  2304 s^4 + 9216 s^3 + 13824 s^2 + 9216 s + 2304
  -----------------------------------------------
    2304 s^4 + 20736 s^3 + 59904 s^2 + 55296 s

Continuous-time transfer function.


G =

    1
  ------
  10 s^2

Continuous-time transfer function.


L =

  2304 s^4 + 9216 s^3 + 13824 s^2 + 9216 s + 2304
  -----------------------------------------------
  23040 s^6 + 207360 s^5 + 599040 s^4 + 552960 s^3

Continuous-time transfer function.


H =

  7.442e04 s^4 + 2.977e05 s^3 + 4.465e05 s^2 + 2.977e05 s + 7.442e04
  ------------------------------------------------------------------
              2304 s^4 + 20736 s^3 + 59904 s^2 + 55296 s

Continuous-time transfer function.


G =

    1
  ------
  10 s^2

Continuous-time transfer function.


L =

  7.442e04 s^4 + 2.977e05 s^3 + 4.465e05 s^2 + 2.977e05 s + 7.442e04
```

```
  ------------------------------------------------------------------
           23040 s^6 + 207360 s^5 + 599040 s^4 + 552960 s^3

Continuous-time transfer function.
```





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