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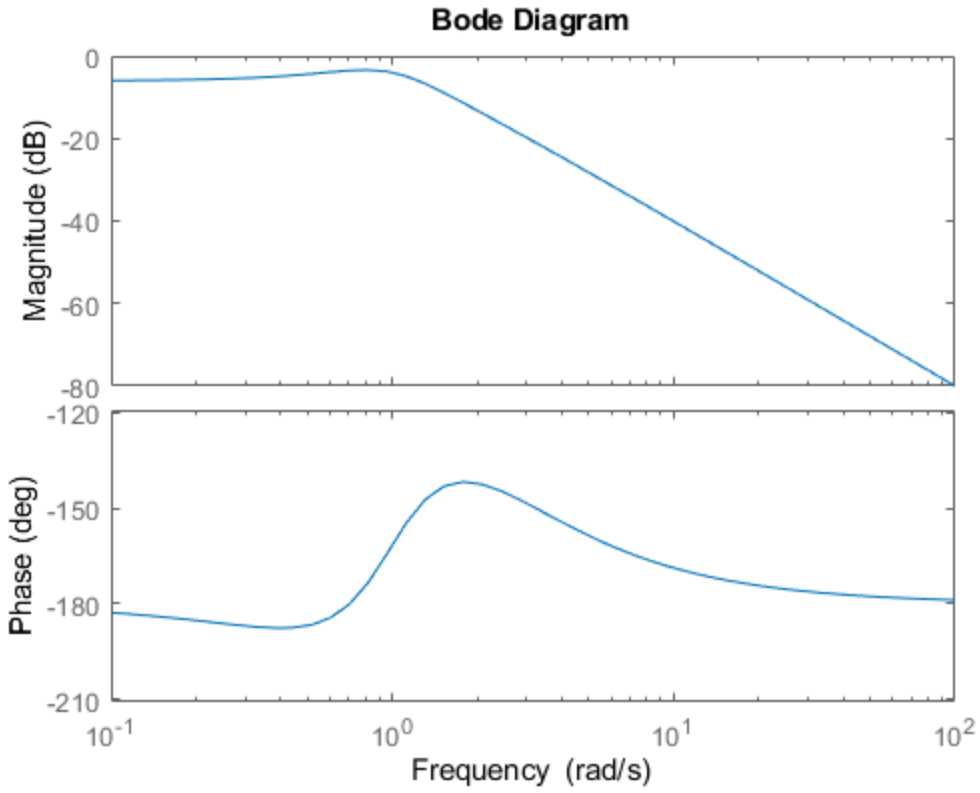
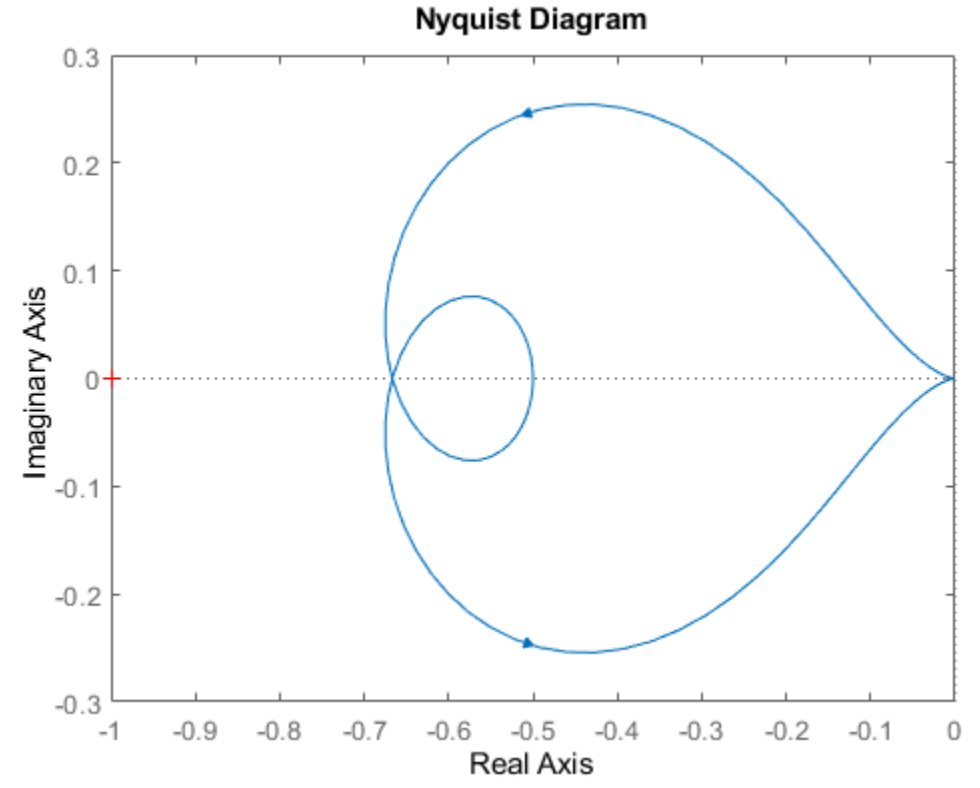
```
% Benjamin Stutzke
% ENAE 432
% Problem Set 11
```

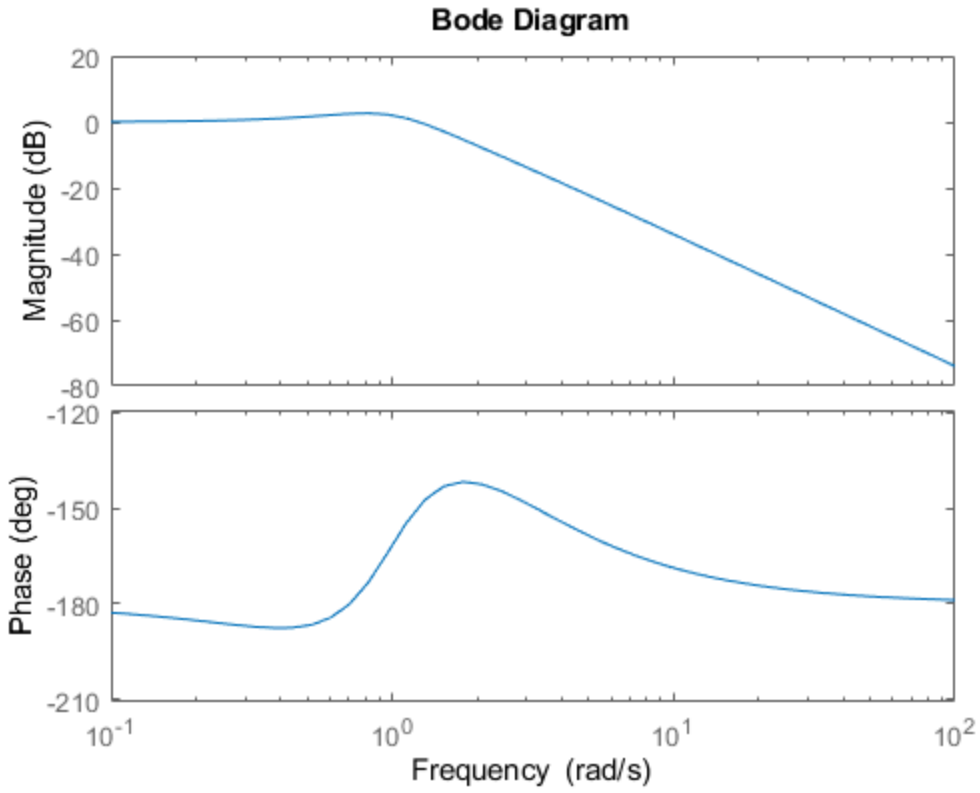
Question 1

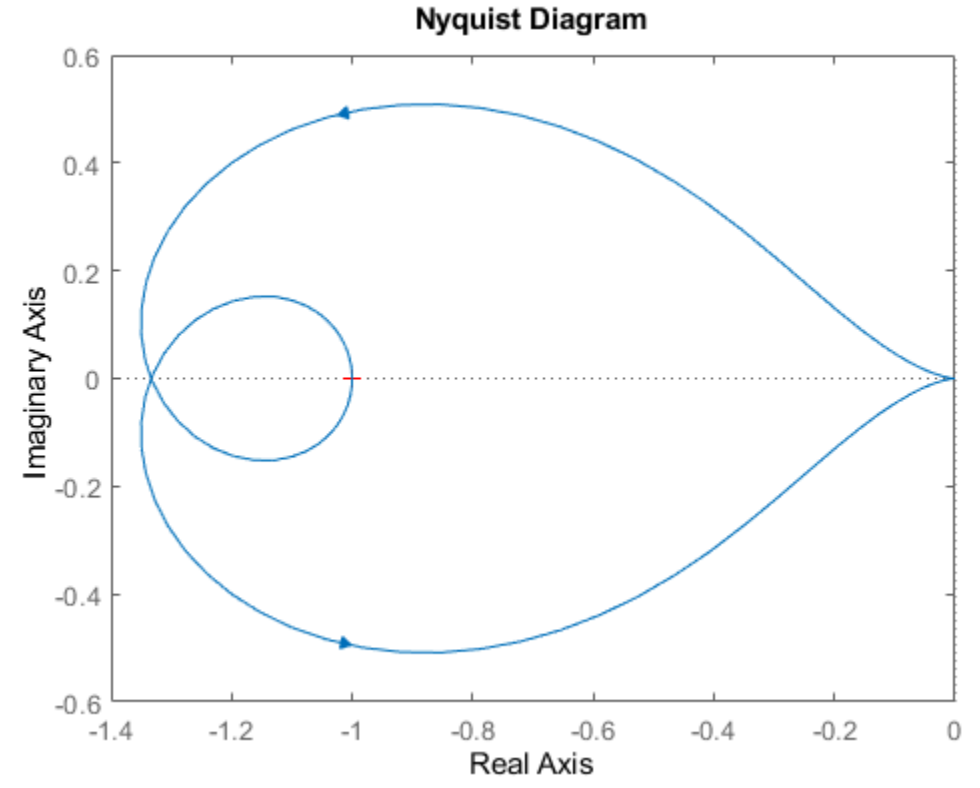
```
s = tf('s');
G = (s-1)/(s^3 + s^2 - s +2);
H = 2;

L0 = G;
L = G*H;
figure(1);
bode(L0);
figure(2);
nyquist(L0);

figure(3);
bode(L);
figure(4);
nyquist(L);

roots([1 1 -1 2])
figure(5);
rlocus(G)
```

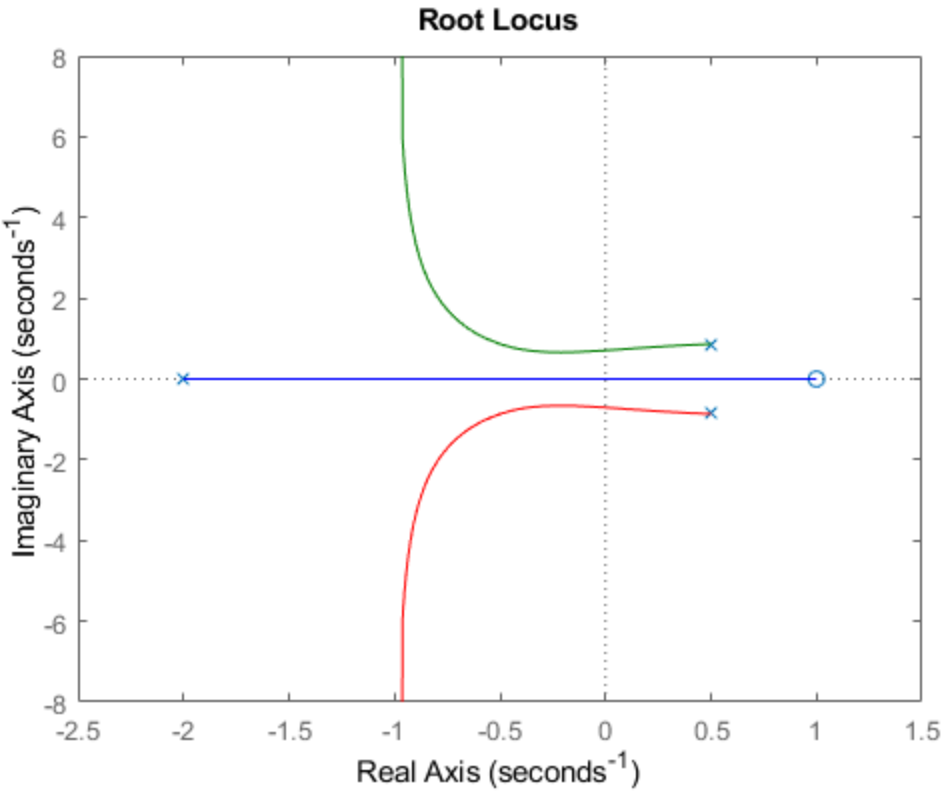
```
ans =

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


Bode Diagram
Magnitude (dB)
0
-20
-40
-60
-80
Phase (deg)
-120
-150
-180
-210
10^{-1}
10^{0}
10^{1}
10^{2}
Frequency (rad/s)


Nyquist Diagram
Imaginary Axis
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-1
-0.9
-0.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
Real Axis


Bode Diagram
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)

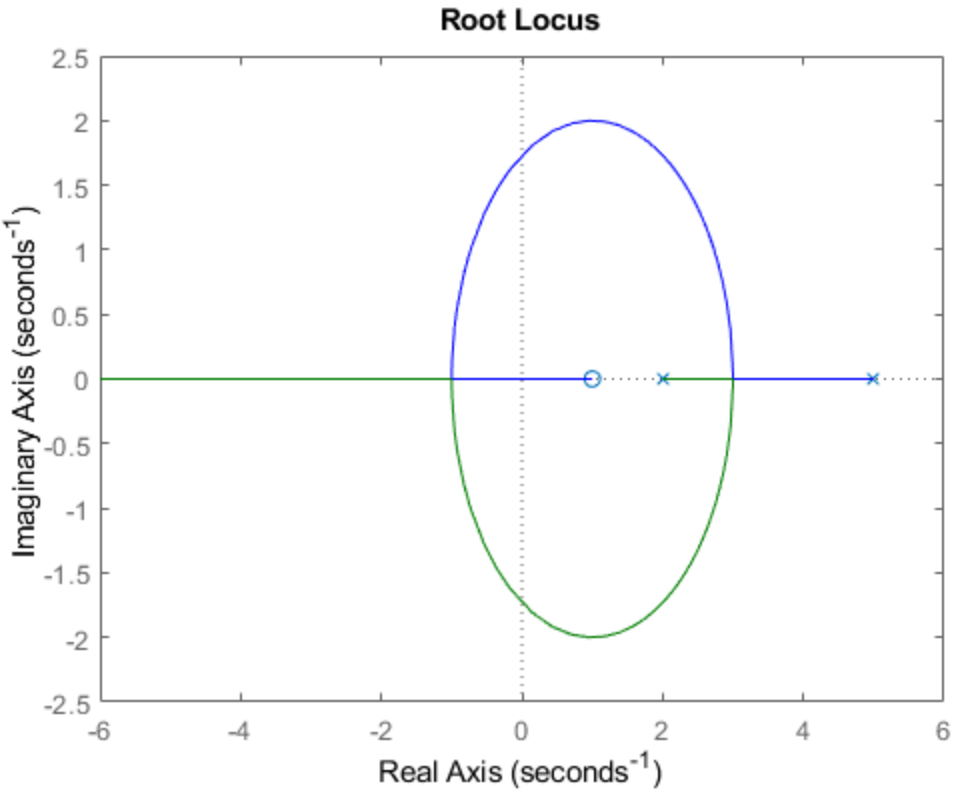

Nyquist Diagram
Imaginary Axis
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-1.4
-1.2
-1
-0.8
-0.6
-0.4
-0.2
0
Real Axis



Question 2

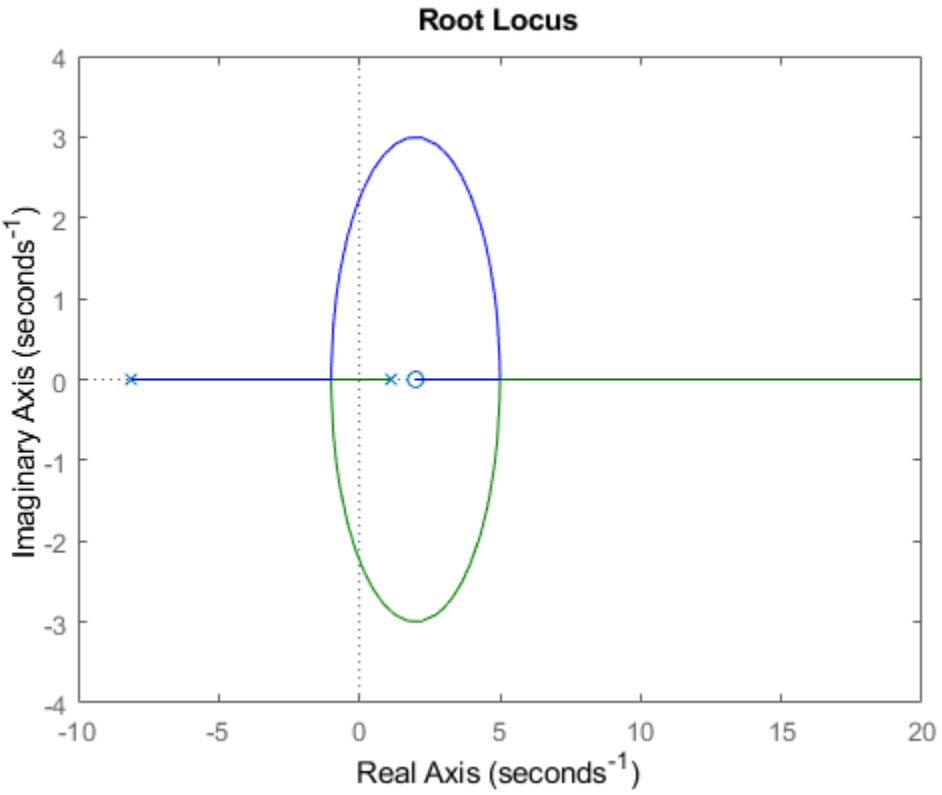
```
s = tf('s');
K = 2.25;
p = 2;
G = 4*(s-1)/(s-5);
H = K/(s-p);
Yd = 1/s;

L = minreal(G*H)
T = minreal(L/(1+L))
R = minreal(H/(1+L))
U = minreal(R*Yd)

rlocus(L)


L =

     9 s - 9
  --------------
  s^2 - 7 s + 10

Continuous-time transfer function.
```

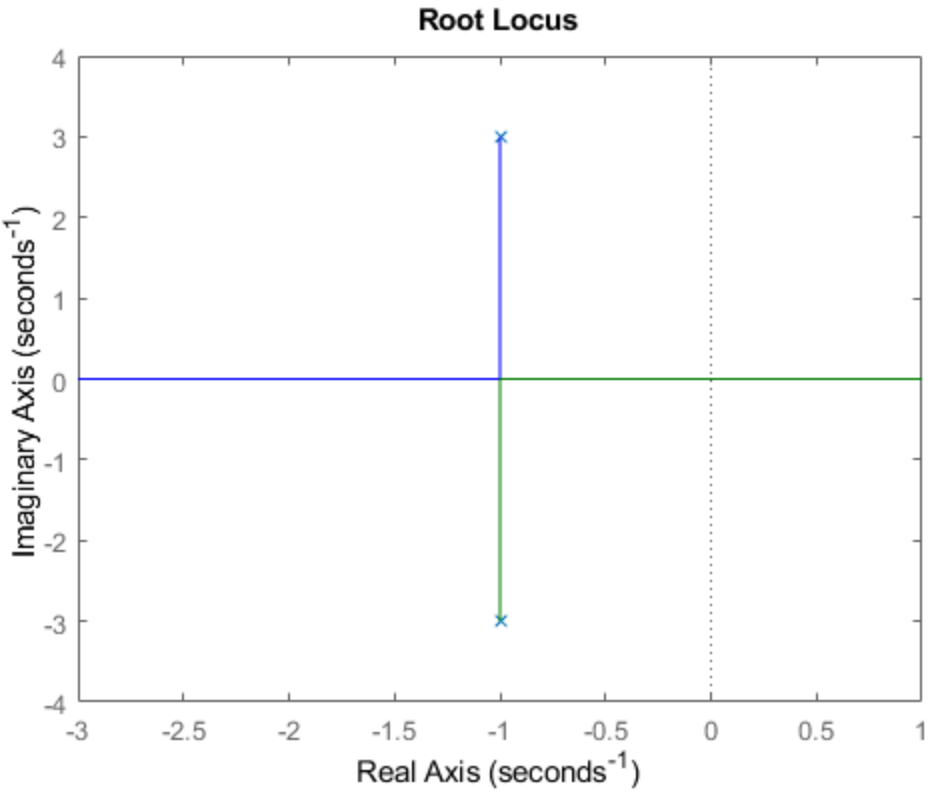
```
T =

     9 s - 9
  -------------
  s^2 + 2 s + 1

Continuous-time transfer function.


R =

  2.25 s - 11.25
  --------------
  s^2 + 2 s + 1

Continuous-time transfer function.


U =

  2.25 s - 11.25
  ---------------
  s^3 + 2 s^2 + s

Continuous-time transfer function.
```



Question 3

```
s = tf('s');
p = 5;

Lp = p*(s-2)/(-s*(s-2)-9*(s-1));
figure;
rlocus(Lp)

z = 1;
Lz = z*(-9/((s-5)*(s-2)+9*s));
figure;
rlocus(Lz)
```





Question 4

```
s = tf('s');
Ts = 0.02;
H = (20*(5*s+1)^5)/(((s+3)^3)*((s^2) + (2*s) + 15));

[Ah, Bh, Ch, Dh] = ssdata(canon(H))
Ad = expm(Ah .* Ts)

I = eye(length(Ad));

Bd = inv(Ah)*(Ad - I)*Bh

fprintf("Tustin: \n");
% Tustin
[Ad, Bd, Cd, Dd] = ssdata(c2d(H, Ts, 'tustin'))


Ah =

   -1.0000    3.7417         0         0         0
   -3.7417   -1.0000         0         0         0
         0         0   -3.0000    3.0132    1.6931
         0         0         0   -3.0000   -4.4960
         0         0         0    0.0000   -3.0000
```

```
Bh =

   1.0e+03 *

    2.2236
   -0.9808
    0.4243
   -1.3944
   -2.4813


Ch =

  -63.3197  -37.9240  -17.7780   70.3614  167.5515


Dh =

       62500


Ad =

    0.9775    0.0733         0         0         0
   -0.0733    0.9775         0         0         0
         0         0    0.9418    0.0568    0.0293
         0         0         0    0.9418   -0.0847
         0         0         0    0.0000    0.9418


Bd =

   43.2653
  -21.0437
    6.6651
  -24.9232
  -48.1665

Tustin:

Ad =

    4.7802   -2.2862    1.0939   -0.5237    0.4013
    4.0000         0         0         0         0
         0    2.0000         0         0         0
         0         0    1.0000         0         0
         0         0         0    0.2500         0


Bd =

   256
     0
```

```
     0
     0
     0

Cd =

  -44.1456   42.8331  -31.1869   20.1951  -19.6262

Dd =

   5.6555e+04
```

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