Midterm PREP Script 1

Question 12 3

Quesition 20 4

Question 21 4

Question 22 4

Example 7.2 from Nise 5

Example 7.3 from Nise 6

Example 7.4 from Nise 6

Chapter 7 or 8 root Locus Plots 11

## Midterm PREP Script

Chapter 6 --- Stabability Question 1, Nise Textbook

clear all  
close all

s^5 +3s^4+5s^3 + 4s^2+s+3

polyVector = [1 3 5 4 1 3]  
RouthHurwitz(polyVector)

polyVector =  
  
 1 3 5 4 1 3  
  
  
 Routh-Hurwitz Table:  
  
rhTable =  
  
 1.0000 5.0000 1.0000  
 3.0000 4.0000 3.0000  
 3.6667 0 0  
 4.0000 3.0000 0  
 -2.7500 0 0  
 3.0000 0 0  
  
~~~~~> it is an unstable system! <~~~~~  
  
 Number of right hand side poles = 2  
  
 Given polynomial coefficients roots :  
  
sysRoots =  
  
 -1.6313 + 0.0000i  
 -0.9407 + 1.5042i  
 -0.9407 - 1.5042i  
 0.2563 + 0.7201i  
 0.2563 - 0.7201i  
  
  
ans =  
  
 1.0000 5.0000 1.0000  
 3.0000 4.0000 3.0000  
 3.6667 0 0  
 4.0000 3.0000 0  
 -2.7500 0 0  
 3.0000 0 0

Q2

v2 = [1 0 6 5 8 20]  
RouthHurwitz(v2)

v2 =  
  
 1 0 6 5 8 20  
  
  
 Routh-Hurwitz Table:  
  
rhTable =  
  
 1 6 8  
 0 5 20  
 -Inf -Inf 0  
 NaN NaN 0  
 NaN NaN 0  
 NaN NaN 0  
  
~~~~~> it is a stable system! <~~~~~  
  
 Number of right hand side poles = 0  
  
 Given polynomial coefficients roots :  
  
sysRoots =  
  
 0.6641 + 1.8230i  
 0.6641 - 1.8230i  
 -0.0000 + 2.0000i  
 -0.0000 - 2.0000i  
 -1.3283 + 0.0000i  
  
  
ans =  
  
 1 6 8  
 0 5 20  
 -Inf -Inf 0  
 NaN NaN 0  
 NaN NaN 0  
 NaN NaN 0

syms s  
(s+1)\*(s+2)\*(s+3)\*(s+4)

ans =  
   
(s + 1)\*(s + 2)\*(s + 3)\*(s + 4)

syms a b c EPS;

syms a b c EPS;  
ra=routh([1 a b c],EPS)

ra =  
   
[ 1, b]  
[ a, c]  
[ -(c - a\*b)/a, 0]  
[ c, 0]

## Question 12

K(s+2)/s(s-1)(s+3)

syms s K EPS;  
ra2 = routh([1 2 K-3 2],EPS)

ra2 =  
   
[ 1, K - 3]  
[ 2, 2]  
[ K - 4, 0]  
[ (2\*K - 8)/(K - 4), 0]

## Quesition 20

ra3 = routh([K+1 3 2+K],EPS)

ra3 =  
   
[ K + 1, K + 2]  
[ 3, 0]  
[ K + 2, 0]

## Question 21

ra4 = routh([1 5 4+K 6\*K],EPS)  
% solve(4 - K/5==0)  
% solve((6\*K\*(K - 20))/(5\*(K/5 - 4))==0)

ra4 =  
   
[ 1, K + 4]  
[ 5, 6\*K]  
[ 4 - K/5, 0]  
[ (6\*K\*(K - 20))/(5\*(K/5 - 4)), 0]

## Question 22

syms a b c EPS;  
ra5 = routh([1 K-b -a],EPS)

ra5 =  
   
[ 1, -a]  
[ K - b, 0]  
[ -a, 0]

## Example 7.2 from Nise

syms s  
Gs = 120\*(s+2)/((s+3)\*(s+4))  
CSlashR = simplify(Gs/(1+Gs))  
polyVector = [1 127 252]  
routh([1 127 252],EPS)  
limit(Gs,s,0)  
limit(s\*Gs,s,0)  
  
limit(s^2\*Gs,s,0)

Gs =  
   
(120\*s + 240)/((s + 3)\*(s + 4))  
   
   
CSlashR =  
   
(120\*s + 240)/(s^2 + 127\*s + 252)  
   
  
polyVector =  
  
 1 127 252  
  
   
ans =  
   
[ 1, 252]  
[ 127, 0]  
[ 252, 0]  
   
   
ans =  
   
20  
   
   
ans =  
   
0  
   
   
ans =  
   
0

## Example 7.3 from Nise

syms s  
Gs =100\*(s+2)\*(s+6)/(s\*(s+3)\*(s+4))  
CSlashR = simplify(Gs/(1+Gs))  
polyVector = [1 107 812 1200]  
routh(polyVector, EPS)  
%R(s) = 5\*1/s  
limit(5/(1+Gs),s,0)

Gs =  
   
((100\*s + 200)\*(s + 6))/(s\*(s + 3)\*(s + 4))  
   
   
CSlashR =  
   
(100\*s^2 + 800\*s + 1200)/(s^3 + 107\*s^2 + 812\*s + 1200)  
   
  
polyVector =  
  
 1 107 812 1200  
  
   
ans =  
   
[ 1, 812]  
[ 107, 1200]  
[ 85684/107, 0]  
[ 1200, 0]  
   
   
ans =  
   
0

## Example 7.4 from Nise

Gs = 10\*(s+20)\*(s+30)/((s\*(s+25)\*(s+35)))  
CSlashR = simplify(Gs/(1+Gs))  
polyVector = [1 70 1375 600]  
routh(polyVector, EPS)

Gs =  
   
((10\*s + 200)\*(s + 30))/(s\*(s + 25)\*(s + 35))  
   
   
CSlashR =  
   
(10\*s^2 + 500\*s + 6000)/(s^3 + 70\*s^2 + 1375\*s + 6000)  
   
  
polyVector =  
  
 1 70 1375 600  
  
   
ans =  
   
[ 1, 1375]  
[ 70, 600]  
[ 9565/7, 0]  
[ 600, 0]

Gs = 10\*(s+20)\*(s+30)/((s^2\*(s+25)\*(s+35)\*(s+50)))  
CSlashR = simplify(Gs/(1+Gs))  
polyVector = [1 110 3875 43760 500 6000]  
routh(polyVector, EPS)

Gs =  
   
((10\*s + 200)\*(s + 30))/(s^2\*(s + 25)\*(s + 35)\*(s + 50))  
   
   
CSlashR =  
   
(10\*s^2 + 500\*s + 6000)/(s^5 + 110\*s^4 + 3875\*s^3 + 43760\*s^2 + 500\*s + 6000)  
   
  
polyVector =  
  
 1 110 3875 43760 500 6000  
  
   
ans =  
   
[ 1, 3875, 500]  
[ 110, 43760, 6000]  
[ 38249/11, 4900/11, 0]  
[ 1673237240/38249, 6000, 0]  
[ -1316030750/41830931, 0, 0]  
[ 6000, 0, 0]

G1(s) = 500\*(s+2)\*(s+5)/((s+8)\*(s+10)\*(s+12))  
G2(s) = 500\*(s+5)\*(s+5)\*(s+6)/(s\*(s+8)\*(s+10)\*(s+12))  
G3(s) = 500\*(s+2)\*(s+4)\*(s+5)\*(s+6)\*(s+7)/(s^2\*(s+8)\*(s+10)\*(s+12))  
Func1 = (simplify(G1(s)/(1+G1(s))))  
Func2 = (simplify(G2(s)/(1+G2(s))))  
Func3 = (simplify(G3(s)/(1+G3(s))))

G1(s) =  
   
((500\*s + 1000)\*(s + 5))/((s + 8)\*(s + 10)\*(s + 12))  
   
   
G2(s) =  
   
((500\*s + 2500)\*(s + 5)\*(s + 6))/(s\*(s + 8)\*(s + 10)\*(s + 12))  
   
   
G3(s) =  
   
((500\*s + 1000)\*(s + 4)\*(s + 5)\*(s + 6)\*(s + 7))/(s^2\*(s + 8)\*(s + 10)\*(s + 12))  
   
   
Func1 =  
   
(500\*s^2 + 3500\*s + 5000)/(s^3 + 530\*s^2 + 3796\*s + 5960)  
   
   
Func2 =  
   
(500\*(s + 5)^2\*(s + 6))/(s^4 + 530\*s^3 + 8296\*s^2 + 43460\*s + 75000)  
   
   
Func3 =  
   
(500\*s^5 + 12000\*s^4 + 111500\*s^3 + 498000\*s^2 + 1058000\*s + 840000)/(501\*s^5 + 12030\*s^4 + 111796\*s^3 + 498960\*s^2 + 1058000\*s + 840000)

[n1,d1] = numden(Func1)  
routh(sym2poly(d1), EPS)  
[n2,d2] = numden(Func2)  
routh(sym2poly(d2), EPS)  
[n3,d3] = numden(Func3)  
routh(sym2poly(d3), EPS)  
  
Kp = limit(G1(s),s,0)  
Kv = limit(s\*G2(s),s,0)  
Ka = limit(s^2\*G3(s),s,0)

n1 =  
   
500\*s^2 + 3500\*s + 5000  
   
   
d1 =  
   
s^3 + 530\*s^2 + 3796\*s + 5960  
   
   
ans =  
   
[ 1, 3796]  
[ 530, 5960]  
[ 200592/53, 0]  
[ 5960, 0]  
   
   
n2 =  
   
500\*(s + 5)^2\*(s + 6)  
   
   
d2 =  
   
s^4 + 530\*s^3 + 8296\*s^2 + 43460\*s + 75000  
   
   
ans =  
   
[ 1, 8296, 75000]  
[ 530, 43460, 0]  
[ 8214, 75000, 0]  
[ 52871740/1369, 0, 0]  
[ 75000, 0, 0]  
   
   
n3 =  
   
500\*s^5 + 12000\*s^4 + 111500\*s^3 + 498000\*s^2 + 1058000\*s + 840000  
   
   
d3 =  
   
501\*s^5 + 12030\*s^4 + 111796\*s^3 + 498960\*s^2 + 1058000\*s + 840000  
   
   
ans =  
   
[ 501, 111796, 1058000]  
[ 12030, 498960, 840000]  
[ 36497564/401, 410230000/401, 0]  
[ 3318939408360/9124391, 840000, 0]  
[ 22481158689222000/27657828403, 0, 0]  
[ 840000, 0, 0]  
   
   
Kp =  
   
125/24  
   
   
Kv =  
   
625/8  
   
   
Ka =  
   
875

Try

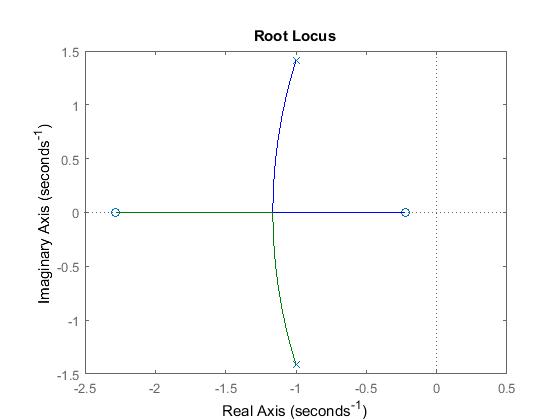
numg=1000\*[1 8];  
deng=poly([-7 -9]);  
G=tf(numg,deng);  
Kp=dcgain(G)  
estep=1/(1+Kp)  
T=feedback(G,1);  
poles=pole(T)

Kp =  
  
 126.9841  
  
  
estep =  
  
 0.0078  
  
  
poles =  
  
 1.0e+03 \*  
  
 -1.0080  
 -0.0080

## Chapter 7 or 8 root Locus Plots

Root Locus Plot

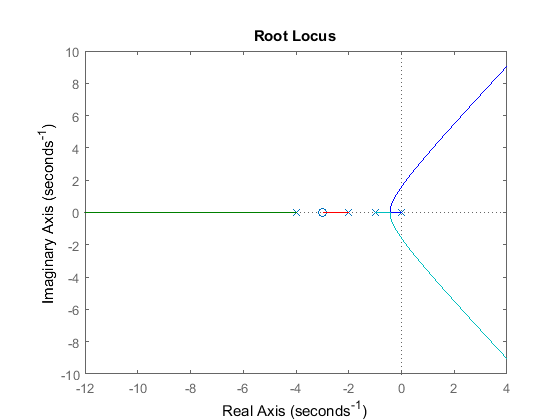
h = tf([2 5 1],[1 2 3]);  
rlocus(h)  
snapnow;



Example from textbook

syms s  
x = s\*(s+1)\*(s+2)\*(s+4)  
den = sym2poly(x)  
num = (s+3)  
num = sym2poly(num)  
h = tf([num],[den])  
rlocus(h)

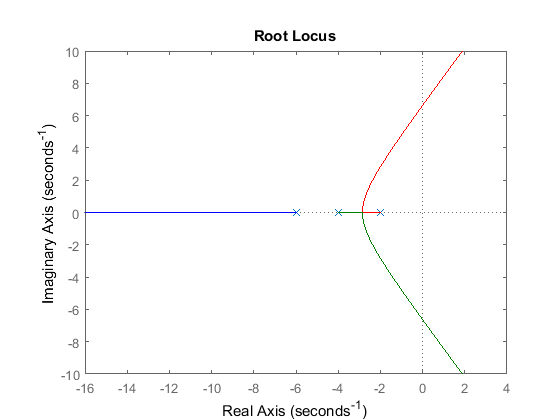
x =  
   
s\*(s + 1)\*(s + 2)\*(s + 4)  
   
  
den =  
  
 1 7 14 8 0  
  
   
num =  
   
s + 3  
   
  
num =  
  
 1 3  
  
  
h =  
   
 s + 3  
 --------------------------  
 s^4 + 7 s^3 + 14 s^2 + 8 s  
   
Continuous-time transfer function.



$$ $$

x = (s+2)\*(s+4)\*(s+6)  
den = sym2poly(x)  
h = tf([1],[den])  
rlocus(h)

x =  
   
(s + 2)\*(s + 4)\*(s + 6)  
   
  
den =  
  
 1 12 44 48  
  
  
h =  
   
 1  
 ------------------------  
 s^3 + 12 s^2 + 44 s + 48  
   
Continuous-time transfer function.

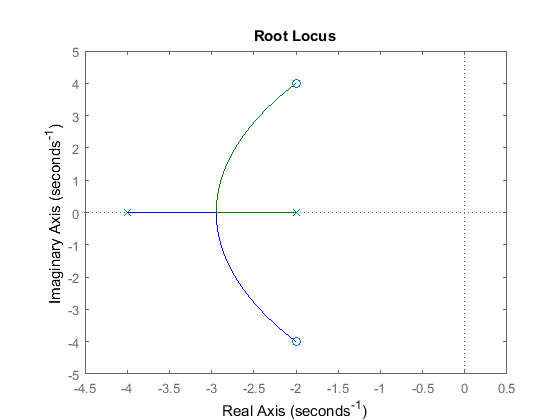


syms s K EPS  
x =s^4+ 7\*s^3+14\*s^2+(8+K)\*s+3\*K  
polyVec = [1 7 14 8+K 3\*K]  
xD = routh(polyVec, EPS)  
xD = simplify(xD)

x =  
   
s^4 + 7\*s^3 + 14\*s^2 + (K + 8)\*s + 3\*K  
   
   
polyVec =  
   
[ 1, 7, 14, K + 8, 3\*K]  
   
   
xD =  
   
[ 1, 14, 3\*K]  
[ 7, K + 8, 0]  
[ 90/7 - K/7, 3\*K, 0]  
[ (K^2/7 + (65\*K)/7 - 720/7)/(K/7 - 90/7), 0, 0]  
[ (3\*K\*(K/7 - 90/7)\*(K^2 + 65\*K - 720))/((K - 90)\*(K^2/7 + (65\*K)/7 - 720/7)), 0, 0]  
   
   
xD =  
   
[ 1, 14, 3\*K]  
[ 7, K + 8, 0]  
[ 90/7 - K/7, 3\*K, 0]  
[ (K^2 + 65\*K - 720)/(K - 90), 0, 0]  
[ 3\*K, 0, 0]

polyVec = [1 6 8]  
routh(polyVec,EPS)  
% stable function  
rlocus(tf([1 4 20],[1 6 8]))

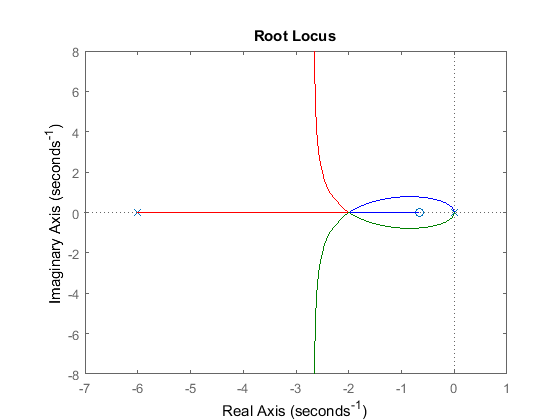
polyVec =  
  
 1 6 8  
  
   
ans =  
   
[ 1, 8]  
[ 6, 0]  
[ 8, 0]



Question 8--4

num= tf([1 2/3])  
den = tf([1 6 0 0])  
  
sys = tf([1 2/3], [1 6 0 0])  
rlocus(sys)

num =  
   
 From input 1 to output:  
 1  
   
 From input 2 to output:  
 0.6667  
   
Static gain.  
  
  
den =  
   
 From input 1 to output:  
 1  
   
 From input 2 to output:  
 6  
   
 From input 3 to output:  
 0  
   
 From input 4 to output:  
 0  
   
Static gain.  
  
  
sys =  
   
 s + 0.6667  
 -----------  
 s^3 + 6 s^2  
   
Continuous-time transfer function.



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