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DEPARTMENT OF ELECTRONICS & TELECOMMUNICATION ENGINEERING

Academic Year 2021-22

REPORT

On

"ROOT LOCUS AND NQUIST PLOT USING MATLAB"

Submitted By

USN	Name of the Student	Marks Awarded Max Marks: 05
1BY20ET048	S VARSHA	
Signature of faculty		

Course: Control Systems

Course Code: 18EC43

Course Outcome: Perform in a group the model of control systems using MATLAB simulators

Under the guidance of

Mrs Saritha I G

Asst. Professor, Dept. of ETE

ROOT LOCUS

AIM:

To obtain Root locus of a given T. F. and hence finding breakaway point, intersection point on imaginary axis using MATLAB .

THEORY:

- Root locus technique is used to find the roots of the characteristic equation.
- This technique provides a graphical method of plotting the locus of the roots in the s plane as a given parameter usually gain is varied over the complete range of values.
- This method brings in to focus the complete dynamic response of the system.
- By using root locus method the designer can predict the effects location of closed loop poles by varying the gain value or adding open loop poles and/or open loop zeroes.
- The closed loop poles are the roots of the characteristic equation.

Terms related to root locus technique are :

1.Characteristic Equation :

$$1 + G(s)H(s) = 0$$

Differentiating the characteristic equation and equating dk/ds equals to zero, break away points are obtained.

2. Break away Points :

Suppose two root loci start from pole and move in opposite direction collide with each other such that after collision they start moving in different directions in the symmetrical way. Or the break away points at which multiple roots of the characteristic equation 1 + G(s)H(s)= 0 occur. The value of K is maximum at the points where the branches of root loci break away. Break away points may be real, imaginary or complex.

3. Break in Point:

Condition of break in to be there on the plot is written below : Root locus must be present between two adjacent zeros on the real axis.

4. Centre of Gravity:

It is also known centroid and is defined as the point on the plot from where all the asymptotes start. Mathematically, it is calculated by the difference of summation of poles and zeros in the transfer function when divided by the difference of total number of poles and total number of zeros. Centre of gravity is always real & it is denoted by σA. Where N is number of poles & M is number of zeros.

$$\sigma_A = \frac{(sum\ of\ real\ parts\ of\ poles) - (sum\ of\ real\ parts\ of\ zeros)}{N - M}$$

5. Asymptotes of Root Loci:

Asymptote originates from the centre of gravity or centroid and goes to infinity at definite some angle. Asymptotes provide direction to the root locus when they depart break away points.

6. Angle of Asymptotes:

Asymptotes makes some angle with the real axis and this angle can be calculated from the given formula,

$$\text{Angle of asymptotes} = \frac{(2p+1)*180}{N-M}$$

Where p = 0, 1, 2 .... (N-M-1)

7. Angle of Arrival or Departure:

We calculate angle of departure when there exists complex poles in the system. Angle of departure can be calculated as

180-{(sum of angles to a complex pole from the other poles)-(sum of angle to a complex pole from the zeros)}

8. Intersection of Root Locus with the Imaginary Axis :

In order to find out the point of intersection root locus with imaginary axis, we have to use Routh Hurwitz criterion. First, we find the auxiliary equation then the corresponding value of K will give the value of the point of intersection.

9. Symmetry of Root Locus:

Root locus is symmetric about the x axis or the real axis.

PROGRAM FOR ROOT LOCUS

The given transfer function is

$$G(s)H(s) = 10/(S^4 + 8S^3 + 36\ S^2 + 80\ S)$$

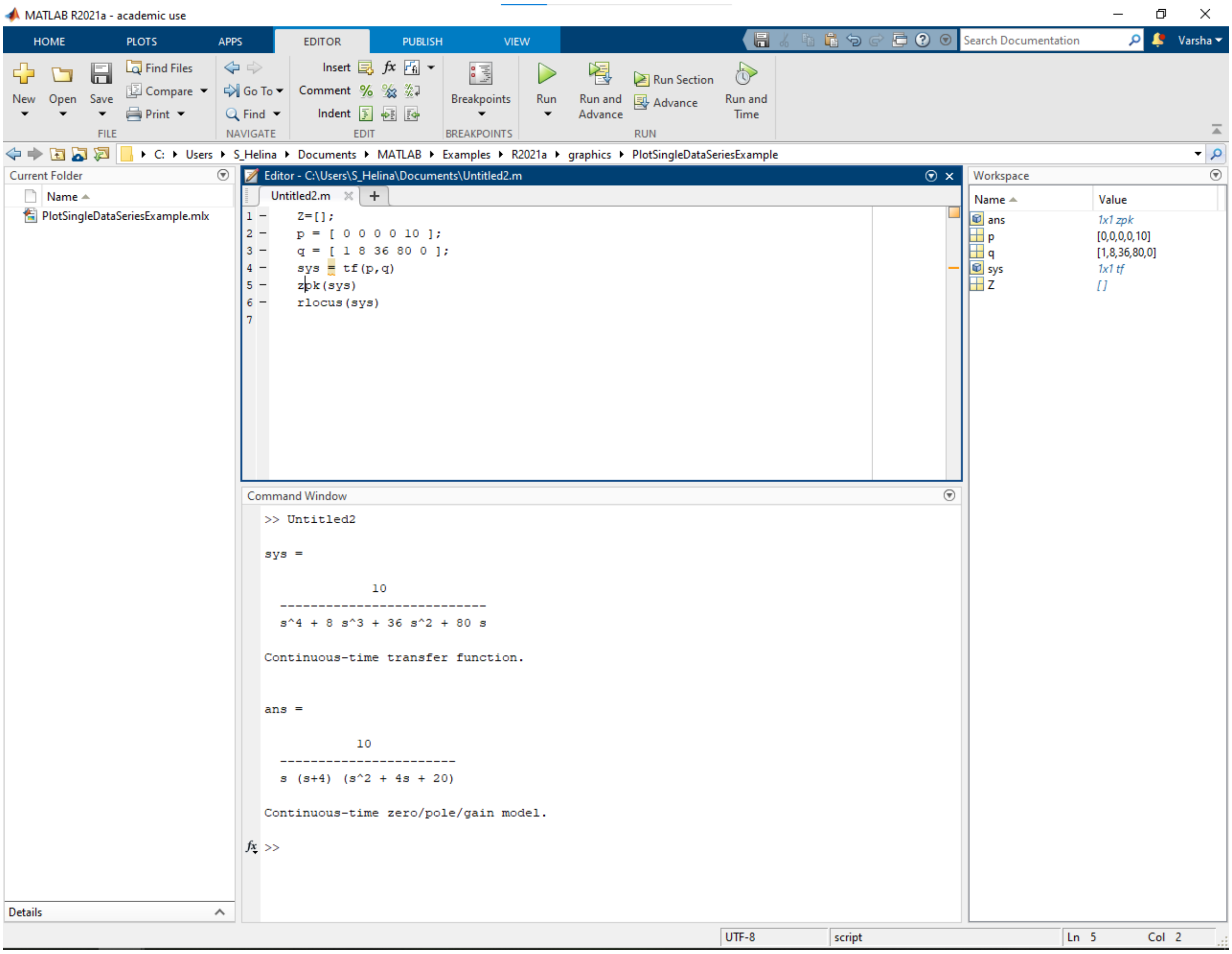
PROGRAM

```
Z=[];
p = [ 0 0 0 0 10 ];
q = [ 1 8 36 80 0 ];
sys = tf(p,q)
zpk(sys)
rlocus(sys)
```

OUTPUT IN THE COMMAND WINDOW:

```
sys =

              10

  ---------------------------

  s^4 + 8 s^3 + 36 s^2 + 80 s

Continuous-time transfer function.


ans =

            10

  ----------------------

  s (s+4) (s^2 + 4s + 20)

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

OUTPUT



MATLAB R2021a - academic use
Editor - C:\Users\S_Helina\Documents\Untitled2.m
Z=[];
p = [0 0 0 0 10];
q = [1 8 36 80 0];
sys = tf(p,q)
zpk(sys)
rlocus(sys)
Command Window
>> Untitled2
sys =
10
----
s^4 + 8 s^3 + 36 s^2 + 80 s
Continuous-time transfer function.
ans =
10
----
s (s+4) (s^2 + 4s + 20)
Continuous-time zero/pole/gain model.

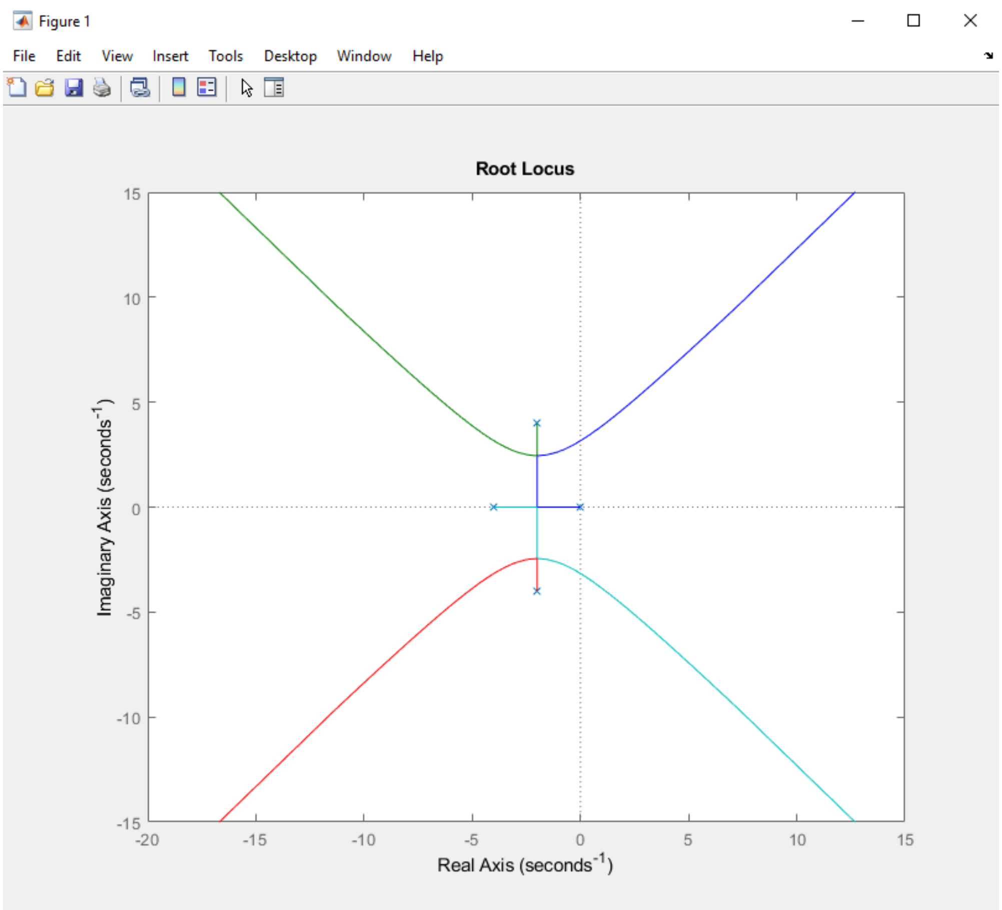


Figure 1
Root Locus
Imaginary Axis (seconds^-1)
Real Axis (seconds^-1)

NQUIST PLOT

AIM:

To draw the Nyquist plot for the given transfer function using MATLAB.

THEORY:

- Nyquist plot is a frequency response plot used to assess the stability of a system with feedback. In Cartesian coordinates, the real part of the transfer function is plotted on the X axis, and the imaginary part is plotted on the Y axis. In polar coordinates, gain of the transfer function is the radial coordinate, and the phase of the transfer function is the corresponding angular coordinate.
- The stability analysis of a feedback control system is based on identifying the location of the roots of the characteristic equation on s-plane. The system is stable if the roots lie on the left-hand side of s-plane.
- Terms related to Nyquist plot are :

1. **Nyquist Path or Nyquist Contour**

   The Nyquist contour is a closed contour in the s-plane which completely encloses the entire right-hand half of s-plane

2. **Nyquist Encirclement**

   A point is said to be encircled by a contour if it is found inside the contour.

3. **Nyquist Mapping**

   The process by which a point in s-plane is transformed into a point in F(s) plane is called mapping and F(s) is called mapping function.

PROGRAM 1 FOR NQUIST PLOT

The given transfer function is

60/(s+1)(s+2)(s+5)

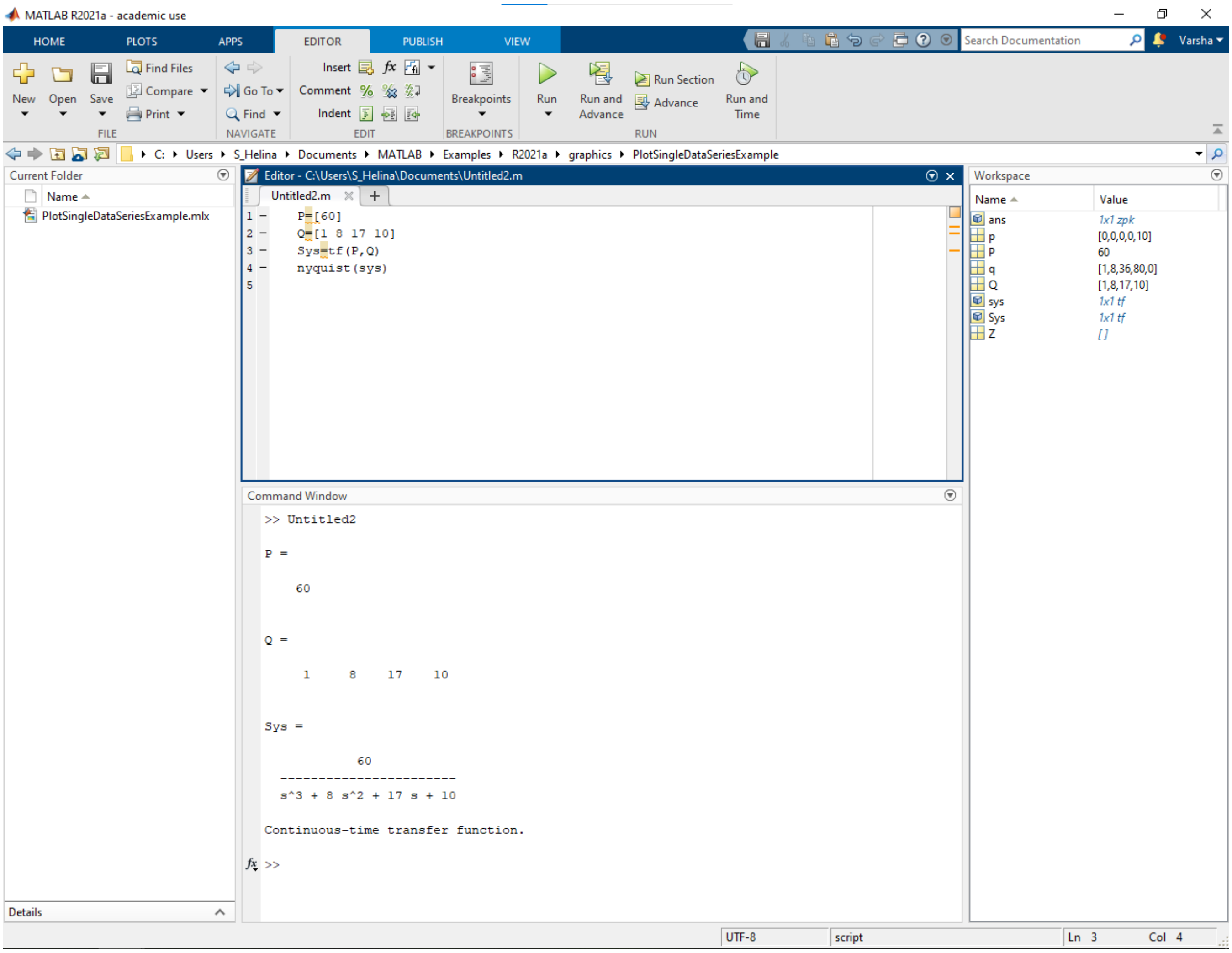
PROGRAM

```
P=[60]

Q=[1 8 17 10]

Sys=tf(P,Q)

nyquist(sys)
```

OUTPUT IN THE COMMAND WINDOW:

```
P =

    60

Q =

     1     8    17    10

Sys =

            60
  ----------------------
  s^3 + 8 s^2 + 17 s + 10

Continuous-time transfer function.
```

OUTPUT


MATLAB R2021a - academic use
HOME
PLOTS
APPS
EDITOR
PUBLISH
VIEW
Search Documentation
Varsha
New
Open
Save
Find Files
Compare
Print
FILE
Go To
Find
NAVIGATE
Insert
Comment
Indent
EDIT
Breakpoints
BREAKPOINTS
Run
Run and Advance
Run Section
Advance
Run and Time
RUN
C: ▸ Users ▸ S_Helina ▸ Documents ▸ MATLAB ▸ Examples ▸ R2021a ▸ graphics ▸ PlotSingleDataSeriesExample
Current Folder
Name
PlotSingleDataSeriesExample.mlx
Details
Editor - C:\Users\S_Helina\Documents\Untitled2.m
Untitled2.m
P=[60]
Q=[1 8 17 10]
Sys=tf(P,Q)
nyquist(sys)
Command Window
>> Untitled2
P =
60
Q =
1 8 17 10
Sys =
60
----
s^3 + 8 s^2 + 17 s + 10
Continuous-time transfer function.
>>
Workspace
Name
Value
ans
1x1 zpk
p
[0,0,0,0,10]
P
60
q
[1,8,36,80,0]
Q
[1,8,17,10]
sys
1x1 tf
Sys
1x1 tf
Z
[]
UTF-8
script
Ln 3
Col 4

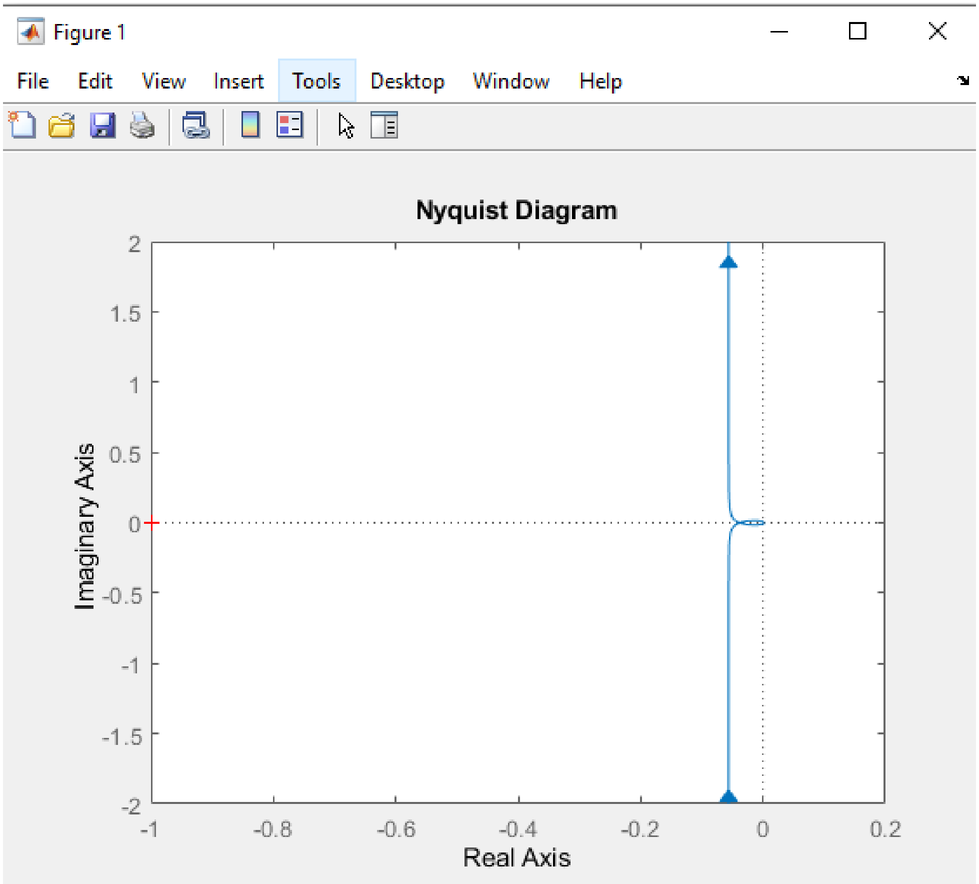


Figure 1
File Edit View Insert Tools Desktop Window Help
Nyquist Diagram
Imaginary Axis
Real Axis
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-1
-0.8
-0.6
-0.4
-0.2
0
0.2

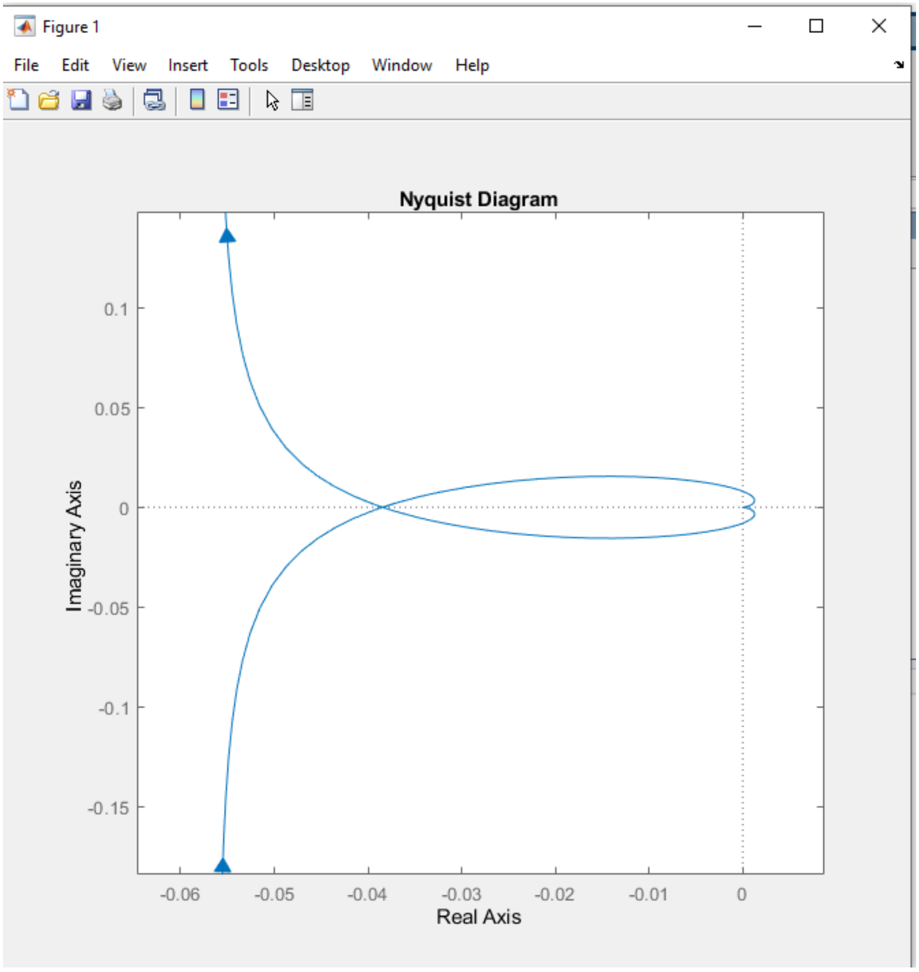


Figure 1
File Edit View Insert Tools Desktop Window Help
Nyquist Diagram
Imaginary Axis
Real Axis
0.1
0.05
0
-0.05
-0.1
-0.15
-0.06
-0.05
-0.04
-0.03
-0.02
-0.01
0

zoomed in