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Title:Control System-Second Order System:varying zeta value open system

```
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%Date:10/04/2021
%Version:1.0
```

This Document has equation for Second Order System

```
%w=1

jeta=1;
TF=tf([1],[1,(2*jeta),1])
sys = tf([1],[1,(2*jeta),1])
figure
subplot(2,3,1)
S = stepinfo(sys)
[z,p,k]= tf2zp([1],[1,(2*jeta),1])
zplane(z,p)

jeta=0.7;
TF=tf([1],[1,(2*jeta),1])
sys = tf([1],[1,(2*jeta),1])
%hold on
subplot(2,3,2)
S = stepinfo(sys)
[z,p,k]= tf2zp([1],[1,(2*jeta),1])
zplane(z,p)

jeta=1.5;
TF=tf([1],[1,(2*jeta),1])
sys = tf([1],[1,(2*jeta),1])
subplot(2,3,3)
S = stepinfo(sys)
[z,p,k]= tf2zp([1],[1,(2*jeta),1])
zplane(z,p)

jeta=-1;
TF=tf([1],[1,(2*jeta),1])
sys = tf([1],[1,(2*jeta),1])
subplot(2,3,4)
```

```
S = stepinfo(sys)
[z,p,k]= tf2zp([1],[1,(2*jeta),1])
zplane(z,p)


jeta=-0.5;
TF=tf([1],[1,(2*jeta),1])
sys = tf([1],[1,(2*jeta),1])
subplot(2,3,5)
S = stepinfo(sys)
[z,p,k]= tf2zp([1],[1,(2*jeta),1])
zplane(z,p)

jeta=-1.5;
TF=tf([1],[1,(2*jeta),1])
sys = tf([1],[1,(2*jeta),1])
subplot(2,3,6)
S = stepinfo(sys)
[z,p,k]= tf2zp([1],[1,(2*jeta),1])
zplane(z,p)

figure
jeta=0;
TF=tf([1],[1,(2*jeta),1])
sys = tf([1],[1,(2*jeta),1])
S = stepinfo(sys)
[z,p,k]= tf2zp([1],[1,(2*jeta),1])
zplane(z,p)
```

```
TF =

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

Continuous-time transfer function.


sys =

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

Continuous-time transfer function.


S =

  struct with fields:

        RiseTime: 3.3579
    SettlingTime: 5.8339
```

```
      SettlingMin: 0.9000
      SettlingMax: 0.9994
        Overshoot: 0
       Undershoot: 0
             Peak: 0.9994
         PeakTime: 9.7900


z =

  0×1 empty double column vector


p =

    -1
    -1


k =

     1


TF =

 
         1
  ---------------
  s^2 + 1.4 s + 1
 
Continuous-time transfer function.


sys =

 
         1
  ---------------
  s^2 + 1.4 s + 1
 
Continuous-time transfer function.


S = 

  struct with fields:

         RiseTime: 2.1268
     SettlingTime: 5.9789
      SettlingMin: 0.9001
      SettlingMax: 1.0460
        Overshoot: 4.5986
       Undershoot: 0
             Peak: 1.0460
         PeakTime: 4.4078
```

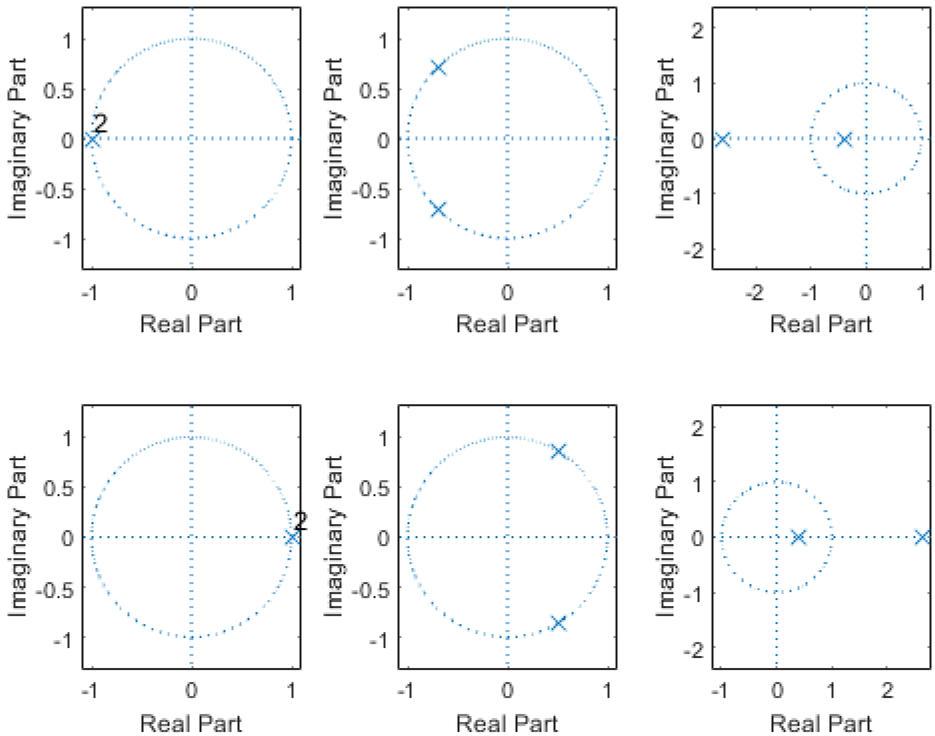
```
z =

  0×1 empty double column vector


p =

  -0.7000 + 0.7141i
  -0.7000 - 0.7141i


k =

     1


TF =

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

Continuous-time transfer function.


sys =

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

Continuous-time transfer function.


S =

  struct with fields:

        RiseTime: 5.8584
    SettlingTime: 10.6547
     SettlingMin: 0.9012
     SettlingMax: 0.9999
       Overshoot: 0
      Undershoot: 0
            Peak: 0.9999
        PeakTime: 25.9983


z =

  0×1 empty double column vector
```

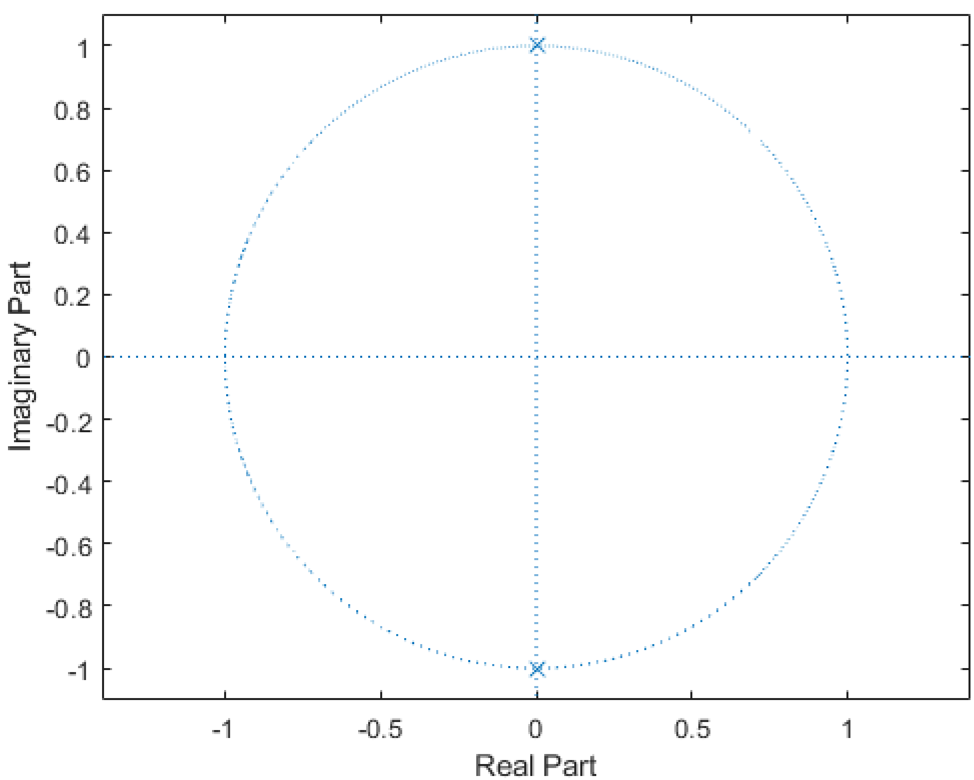
```
p =

   -2.6180
   -0.3820


k =

     1


TF =

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

Continuous-time transfer function.


sys =

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

Continuous-time transfer function.


S =

  struct with fields:

        RiseTime: NaN
    SettlingTime: NaN
     SettlingMin: NaN
     SettlingMax: NaN
       Overshoot: NaN
      Undershoot: NaN
            Peak: Inf
        PeakTime: Inf


z =

  0×1 empty double column vector


p =

     1
     1
```

```
k =

     1


TF =

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

Continuous-time transfer function.


sys =

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

Continuous-time transfer function.


S =

  struct with fields:

        RiseTime: NaN
    SettlingTime: NaN
     SettlingMin: NaN
     SettlingMax: NaN
       Overshoot: NaN
      Undershoot: NaN
            Peak: Inf
        PeakTime: Inf


z =

  0×1 empty double column vector


p =

   0.5000 + 0.8660i
   0.5000 - 0.8660i


k =

     1
```

```
TF =

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

Continuous-time transfer function.


sys =

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

Continuous-time transfer function.


S =

  struct with fields:

        RiseTime: NaN
    SettlingTime: NaN
     SettlingMin: NaN
     SettlingMax: NaN
       Overshoot: NaN
      Undershoot: NaN
            Peak: Inf
        PeakTime: Inf


z =

  0×1 empty double column vector


p =

    2.6180
    0.3820


k =

     1


TF =

     1
  -------
  s^2 + 1
```

```
Continuous-time transfer function.


sys =

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

Continuous-time transfer function.


S =

  struct with fields:

        RiseTime: NaN
    SettlingTime: NaN
     SettlingMin: NaN
     SettlingMax: NaN
       Overshoot: NaN
      Undershoot: NaN
            Peak: Inf
        PeakTime: Inf


z =

  0×1 empty double column vector


p =

   0.0000 + 1.0000i
   0.0000 - 1.0000i


k =

     1
```


Imaginary Part
Real Part
2


Imaginary Part
Real Part

Analysis based on zeta

1. If zeta>0 we may get the roots on the left side of the imaginary axis. 2. If zeta<0 we may get the roots on the right side of the imaginary axis. 3. If zeta lies in the range of [0-1] we get complex conjugate roots. 4. If zeta ranges greater than 1 we get real roots and distinct. 5. If zeta is equal to 1 we get real roots. 6. If zeta is zero poles lies on the imaginary axis like complex conjugate roots system is undamped.

Published with MATLAB® R2021a