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Title:Control System-Second Order System: p,i,d OPEN

```
%Author:ShivaKumar Naga Vankadhara
%PS No:99003727
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%Version:1.7
```

This Document has equation for DC Motor

```
%Equation:Ldi/dt+Ri+Kw=V
%         Jdw/dt+bw=Ki
%T(s)=(K/LJ)/(s^2+((b/J)+(R/L)s+(R*b)/(L*J)+(K*K)/(L*J)
```

Math analysis

```
%dependent variables:w
%independent variables:t
%constant:K,R,L,J,b
%Roots:0.5*(-(b/J)-(R/L))+sqrt((((b*b)/(J*J))+((R*R)/(L*L))-((2*R*b)/
(L*J))-((4*K*K)/(L*J)))
%      0.5*(-(b/J)-(R/L))-sqrt((((b*b)/(J*J))+((R*R)/(L*L))-((2*R*b)/
(L*J))-((4*K*K)/(L*J)))

J = 0.01;
b = 0.1;
K = 1;
R = 1;
L = 0.5;
TF=tf([K/(J*L)],[1,((b/J)+(R/L)),(((K*K)+(R*b))/(L*J))]);
CF=1;
sys1 = CF*TF;
subplot(4,2,1)
step(sys1)
title("Step ")
subplot(4,2,2)
impulse(sys1)
title("Impulse")
S = stepinfo(sys1);
[wn,zeta]=damp(sys1)
p1=pole(sys1)
z1=zero(sys1)
```

```
J = 0.01;
b = 0.1;
K = 1;
R = 1;
L = 0.5;
TF=tf([K/(J*L)],[1,((b/J)+(R/L)),(((K*K)+(R*b))/(L*J))]);
CF=10;
sys2 = CF*TF;
subplot(4,2,3)
step(sys2)
title("Step with gain")
subplot(4,2,4)
impulse(sys2)
title("impulse with gain")
S = stepinfo(sys2)
[wn,zeta]=damp(sys2)
p2=pole(sys2)
z2=zero(sys2)
```

```
J = 0.01;
b = 0.1;
K = 1;
R = 1;
L = 0.5;
TF=tf([K/(J*L)],[1,((b/J)+(R/L)),(((K*K)+(R*b))/(L*J))]);
CF=tf([1,0],[1]);
sys3 = CF*TF;
subplot(4,2,5)
step(sys3)
title("Step with zero ")
subplot(4,2,6)
impulse(sys3)
title("impulse with zero ")
S = stepinfo(sys3)
[wn,zeta]=damp(sys3)
p3=pole(sys3)
z3=zero(sys3)
```

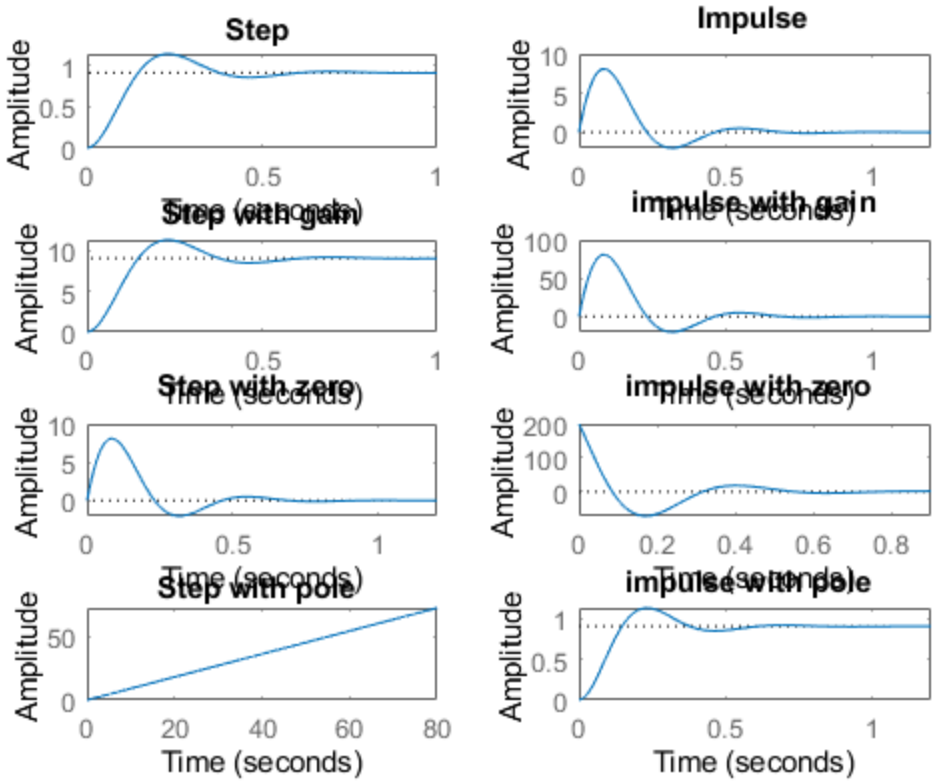
```
J = 0.01;
b = 0.1;
K = 1;
R = 1;
L = 0.5;
TF=tf([K/(J*L)],[1,((b/J)+(R/L)),(((K*K)+(R*b))/(L*J))]);
CF=tf([1],[1,0]);
sys4 = CF*TF;
subplot(4,2,7)
```

```
step(sys4)
title("Step with pole ")
subplot(4,2,8)
impulse(sys4)
title("impulse with pole ")
S = stepinfo(sys4)
[wn,zeta]=damp(sys4)
p4=pole(sys4)
z4=zero(sys4)
```

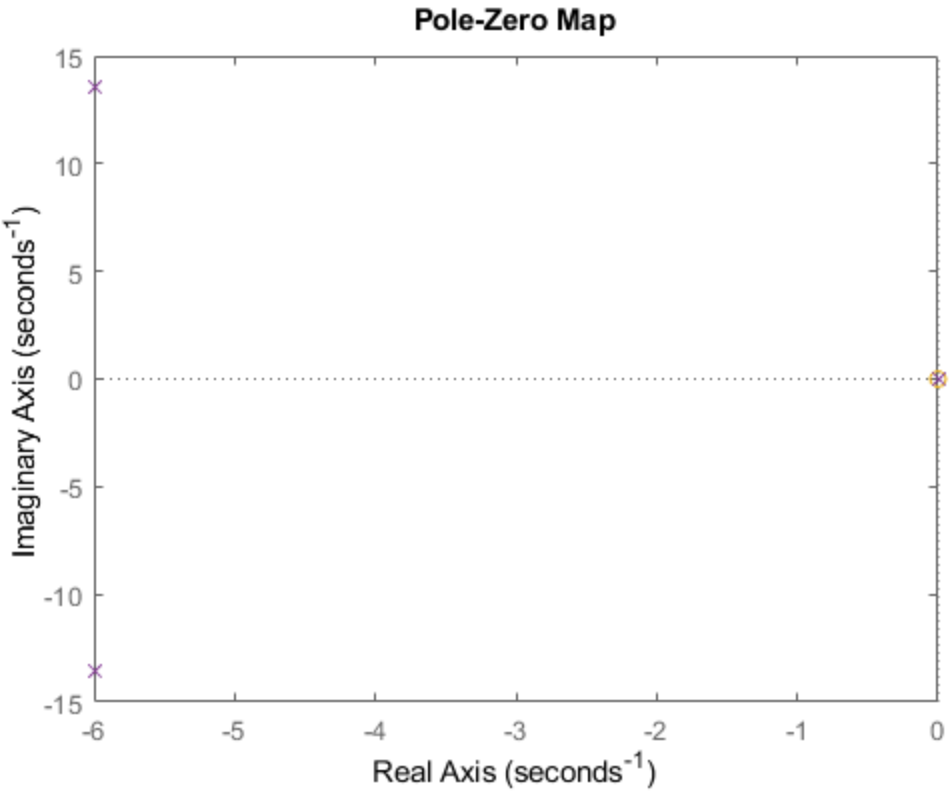
```
wn =

   14.8324
   14.8324


zeta =

    0.4045
    0.4045


p1 =

  -6.0000 +13.5647i
  -6.0000 -13.5647i


z1 =

  0×1 empty double column vector


S =

  struct with fields:

        RiseTime: 0.0993
    SettlingTime: 0.5669
     SettlingMin: 8.5269
     SettlingMax: 11.3557
       Overshoot: 24.9123
      Undershoot: 0
            Peak: 11.3557
        PeakTime: 0.2303


wn =

   14.8324
   14.8324
```

```
zeta =

    0.4045
    0.4045


p2 =

  -6.0000 +13.5647i
  -6.0000 -13.5647i


z2 =

  0×1 empty double column vector


S =

  struct with fields:

        RiseTime: 0
    SettlingTime: 0.6520
     SettlingMin: -2.0155
     SettlingMax: 8.0919
       Overshoot: Inf
      Undershoot: Inf
            Peak: 8.0919
        PeakTime: 0.0844


wn =

   14.8324
   14.8324


zeta =

    0.4045
    0.4045


p3 =

  -6.0000 +13.5647i
  -6.0000 -13.5647i


z3 =

     0
```

```
S =

  struct with fields:

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


wn =

         0
   14.8324
   14.8324


zeta =

   -1.0000
    0.4045
    0.4045


p4 =

   0.0000 + 0.0000i
  -6.0000 +13.5647i
  -6.0000 -13.5647i


z4 =

  0×1 empty double column vector
```




```
figure
hold on
pzmap(sys1)
pzmap(sys2)
pzmap(sys3)
pzmap(sys4)
```



Analysis

```
%1.There is no change in the poles when we add differentiator,
 integrator
% and differentiator.
%2. When we add a differentiator the system becomes more stable
 because a
%zero is getting added to it.
%3. Adding a differentiator IVT got shifted from zero, Fvt will remain
 same
% for impulse response.
%4. FVT of integrator of impulse got shifted to zero.
%5. By adding integrator step response doesn't settle.
```

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