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Title:Control System-Second Order System

```
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%Date:10/04/2021
%Version:1.4
```

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)))
```

Negtaive Feedback

```
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
sys = CF*TF
NCTF1=feedback(sys,1)
subplot(3,2,1)
step(NCTF1)
title("Step with negative")
subplot(3,2,2)
impulse(NCTF1)
title("impulse with negative")
S = stepinfo(NCTF1)
```

```
[wn,zeta]=damp(NCTF1)
```

```
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])
sys = CF*TF
NCTF2=feedback(sys,1)
subplot(3,2,3)
step(NCTF2)
title("Step with diff")
subplot(3,2,4)
impulse(NCTF2)
title("impulse with diff")
S = stepinfo(NCTF2)
[wn,zeta]=damp(NCTF2)
```

```
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])
sys = CF*TF
NCTF3=feedback(sys,1)
subplot(3,2,5)
step(NCTF3)
title("Step with integrator")
subplot(3,2,6)
impulse(NCTF3)
title("impulse with integrator")
S = stepinfo(NCTF3)
[wn,zeta]=damp(NCTF3)
```

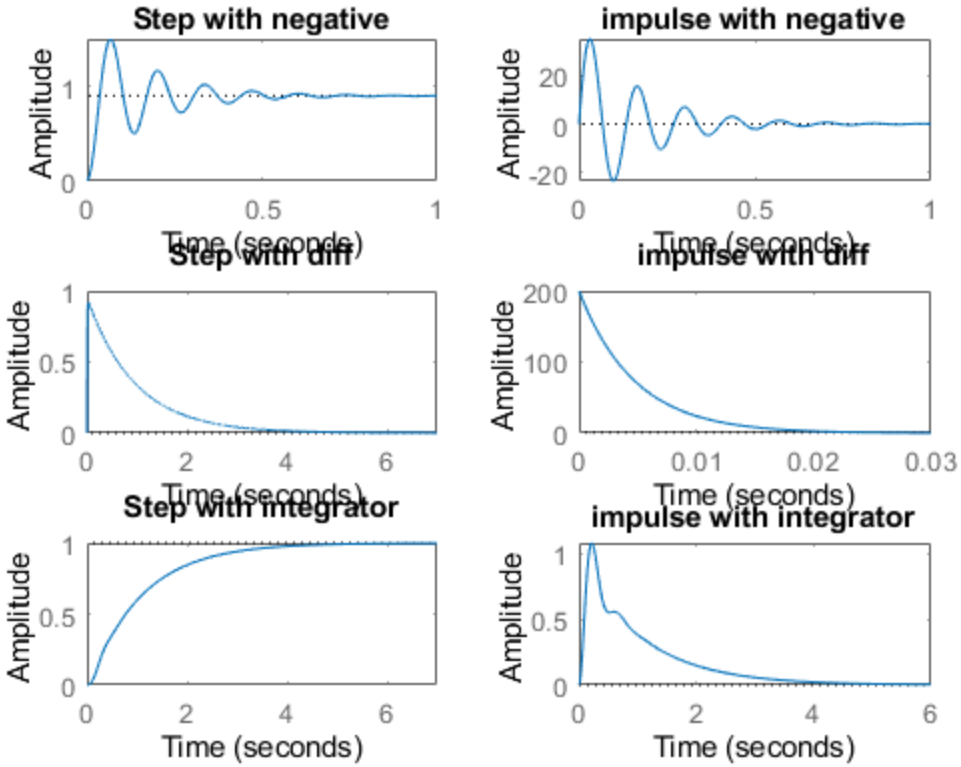
```
CF =

    10
```

```
sys =

        2000
  ----------------
  s^2 + 12 s + 220
```

```
Continuous-time transfer function.


NCTF1 =

        2000
  -----------------
  s^2 + 12 s + 2220

Continuous-time transfer function.


S =

  struct with fields:

        RiseTime: 0.0245
    SettlingTime: 0.6206
     SettlingMin: 0.4993
     SettlingMax: 1.5026
       Overshoot: 66.7860
      Undershoot: 0
            Peak: 1.5026
        PeakTime: 0.0667


wn =

   47.1169
   47.1169


zeta =

    0.1273
    0.1273


CF =

  s

Continuous-time transfer function.


sys =

       200 s
  ----------------
  s^2 + 12 s + 220

Continuous-time transfer function.
```

```
NCTF2 =

        200 s
  -----------------
  s^2 + 212 s + 220

Continuous-time transfer function.


S =

  struct with fields:

        RiseTime: 0
    SettlingTime: 3.7813
     SettlingMin: 6.5963e-04
     SettlingMax: 0.9234
       Overshoot: Inf
      Undershoot: 0
            Peak: 0.9234
        PeakTime: 0.0253


wn =

    1.0429
  210.9571


zeta =

     1
     1


CF =

  1
  -
  s

Continuous-time transfer function.


sys =

          200
  --------------------
  s^3 + 12 s^2 + 220 s

Continuous-time transfer function.
```

```
NCTF3 =

             200
  --------------------------
  s^3 + 12 s^2 + 220 s + 200

Continuous-time transfer function.


S =

  struct with fields:

        RiseTime: 2.2719
    SettlingTime: 4.1463
     SettlingMin: 0.9044
     SettlingMax: 0.9993
       Overshoot: 0
      Undershoot: 0
            Peak: 0.9993
        PeakTime: 7.6683


wn =

    0.9549
   14.4725
   14.4725


zeta =

    1.0000
    0.3816
    0.3816
```



Positive Feedback

```
figure
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
sys = CF*TF
PCTF1=feedback(sys,-1)
subplot(3,2,1)
step(PCTF1)
title("Step with positive")
subplot(3,2,2)
impulse(PCTF1)
title("impulse with positive")
S = stepinfo(PCTF1)
[wn,zeta]=damp(PCTF1)



J = 0.01;
b = 0.1;
```

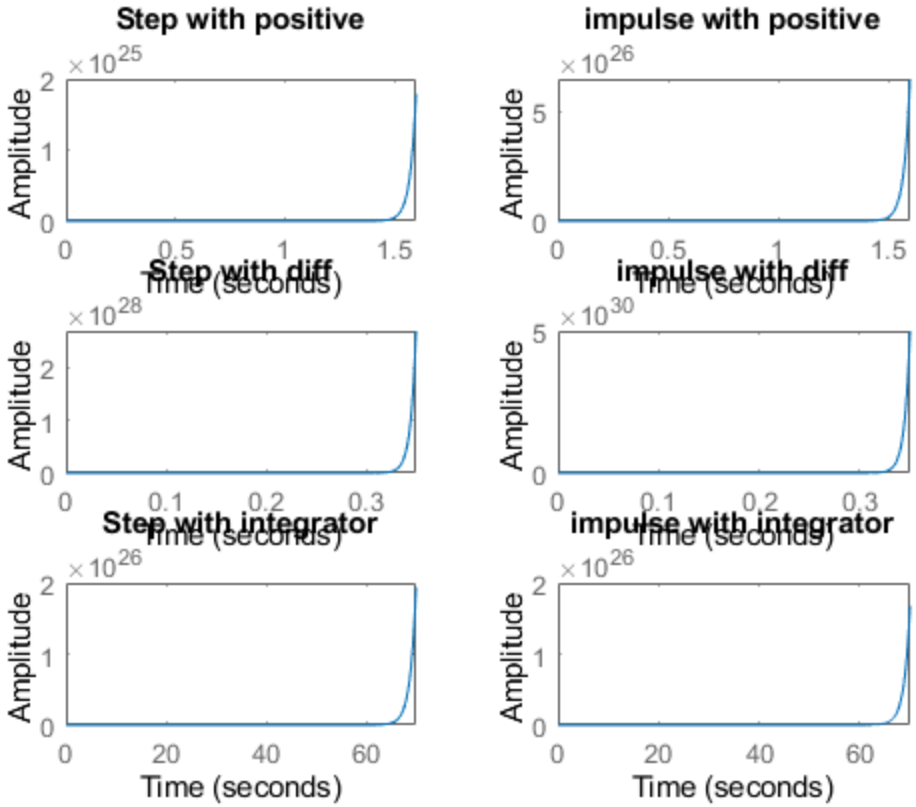
```
K = 1;
R = 1;
L = 0.5;
TF=tf([K/(J*L)],[1,((b/J)+(R/L)),(((K*K)+(R*b))/(L*J))]);
CF=tf([1,0],[1])
sys = CF*TF
PCTF2=feedback(sys,-1)
subplot(3,2,3)
step(PCTF2)
title("Step with diff")
subplot(3,2,4)
impulse(PCTF2)
title("impulse with diff")
S = stepinfo(PCTF2)
[wn,zeta]=damp(PCTF2)



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])
sys = CF*TF
PCTF3=feedback(sys,-1)
subplot(3,2,5)
step(PCTF3)
title("Step with integrator")
subplot(3,2,6)
impulse(PCTF3)
title("impulse with integrator")
S = stepinfo(PCTF3)
[wn,zeta]=damp(PCTF3)
```

```
CF =

    10


sys =

        2000
  ----------------
  s^2 + 12 s + 220

Continuous-time transfer function.


PCTF1 =
```

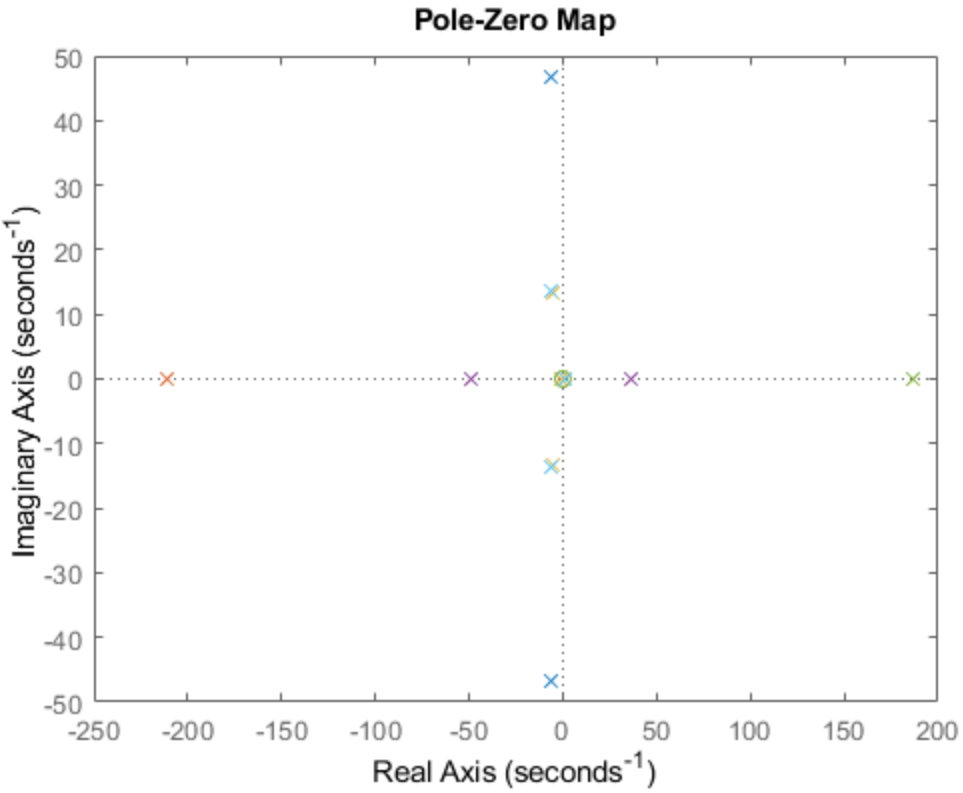
```
        2000
  -----------------
  s^2 + 12 s - 1780

Continuous-time transfer function.


S =

  struct with fields:

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


wn =

   36.6146
   48.6146


zeta =

    -1
     1


CF =

  s

Continuous-time transfer function.


sys =

       200 s
  ----------------
  s^2 + 12 s + 220

Continuous-time transfer function.


PCTF2 =

        200 s
  -----------------
  s^2 - 188 s + 220
```

```
Continuous-time transfer function.


S =

  struct with fields:

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


wn =

    1.1776
  186.8224


zeta =

    -1
    -1


CF =

  1
  -
  s

Continuous-time transfer function.


sys =

          200
  --------------------
  s^3 + 12 s^2 + 220 s

Continuous-time transfer function.


PCTF3 =

             200
  -------------------------
  s^3 + 12 s^2 + 220 s - 200
```

```
Continuous-time transfer function.


S =

  struct with fields:

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


wn =

    0.8653
   15.2030
   15.2030


zeta =

   -1.0000
    0.4231
    0.4231
```




```
figure
hold on
pzmap(NCTF1)
pzmap(NCTF2)
pzmap(NCTF3)
pzmap(PCTF1)
pzmap(PCTF2)
pzmap(PCTF3)
```



Analysis

```
%1. Positive feedback system when P,I,D are added system becomes
 unstable.
%2. Rise time will decrease when you add a differentiator because over
%shoot increases, Ts also increases.
%3. When we add an integrator to this system rise time bacame higher
 and
%overshoot became zero this says that system is getting towards
 stable.
%4. Adding the positive feed back makes the zeta value change.
```

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