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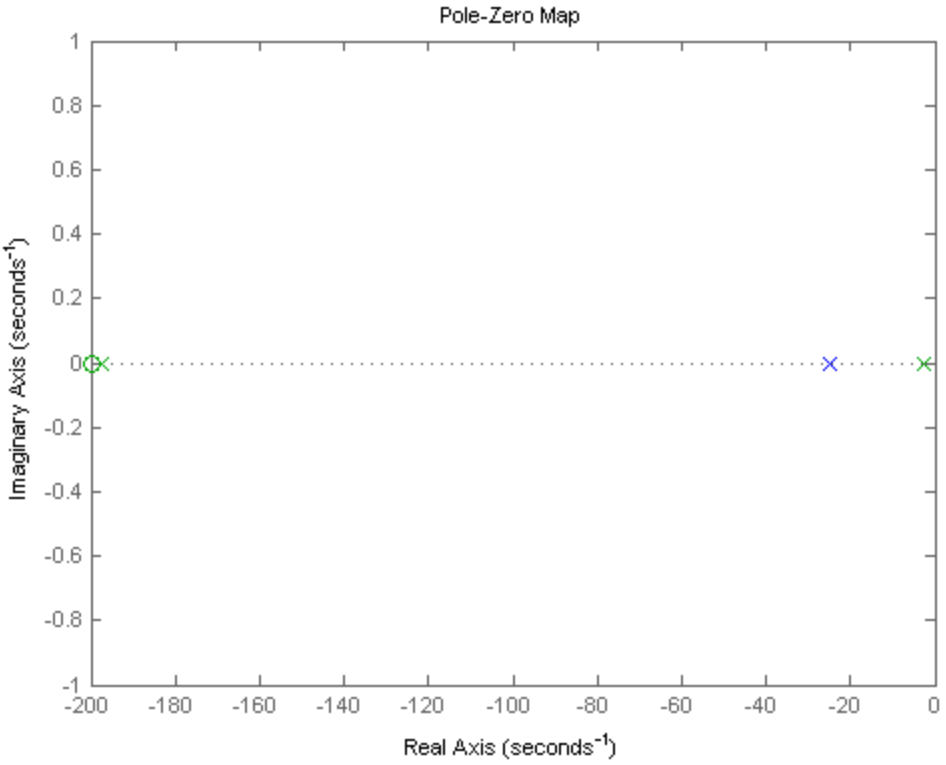
```
syms A1 Lf Rf kg Lg Rg Lm Rm kc Jt Bt kw s real

P = A1*kg/(Rf + Lf*s)
G = kc/((Lg+Lm)*s+Rg+Rm)
F = 1/(Jt*s+Bt)
H = kw

G1 = simplify(F*G*P/(1+F*G*H))
G2 = simplify(-F/(1+F*G*H))
```

```
P =

(A1*kg)/(Rf + Lf*s)


G =

kc/(Rg + Rm + s*(Lg + Lm))


F =

1/(Bt + Jt*s)


H =

kw


G1 =

(A1*kc*kg)/((Bt + Jt*s)*(Rf + Lf*s)*((kc*kw)/((Bt + Jt*s)*(Rg + Rm + s*(Lg


G2 =

-1/((Bt + Jt*s)*((kc*kw)/((Bt + Jt*s)*(Rg + Rm + s*(Lg + Lm))) + 1))
```

```
clear all
s = tf('s');

A1 = 4;
Lf = 2;
Rf = 50;
kg = 5;
Lg = 0.005;
Rg = 1;
Lm = 0.005;
Rm = 1;
kc = 0.5;
Jt = 0.05;
Bt = 0.005;
kw = 0.5;

P = A1*kg/(Rf + Lf*s)
G = kc/((Lg+Lm)*s+Rg+Rm)
F = 1/(Jt*s+Bt)
H = kw

G1 = minreal(F*G*P/(1+F*G*H))
G2 = minreal(-F/(1+F*G*H))

pole(G1)
zero(G1)
pole(G2)
zero(G2)

pzmap(G1,G2)
```

```
P =

     20
  --------
  2 s + 50

Continuous-time transfer function.


G =

     0.5
  ----------
  0.01 s + 2

Continuous-time transfer function.


F =

        1
  --------------
```

```
  0.05 s + 0.005

Continuous-time transfer function.


H =

     5.000000000000000e-01


G1 =

                10000
  ---------------------------------
  s^3 + 225.1 s^2 + 5522 s + 1.3e04

Continuous-time transfer function.


G2 =

     -20 s - 4000
  -------------------
  s^2 + 200.1 s + 520

Continuous-time transfer function.


ans =

    -1.974666438551345e+02
    -2.500000000000006e+01
    -2.633356144855816e+00


ans =

   Empty matrix: 0-by-1


ans =

    -1.974666438551441e+02
    -2.633356144855823e+00


ans =

  -200
```




```
A = [-Bt/Jt 0 kc/Jt ; 0 -Rf/Lf 0 ; -kw/(Lg+Lm) kg/(Lg+Lm) -(Rg+Rm)/(Lg+Lm)]
B = [0 -1/Jt ; A1/Lf 0 ; 0 0]
C = eye(3)
D = zeros(3,2)
eig(A)

sys1 = ss(A,B,C,D)
zpk(sys1)
```

```
A =

   -9.999999999999999e-02                         0     1.000000000000000
                        0    -2.500000000000000e+01
   -5.000000000000000e+01     5.000000000000000e+02    -2.000000000000000

B =

     0   -20
     2     0
     0     0

C =
```

```
     1     0     0
     0     1     0
     0     0     1


D =

     0     0
     0     0
     0     0


ans =

    -2.633356144855839e+00
    -1.974666438551442e+02
    -2.500000000000000e+01


sys1 =

  a =
         x1    x2    x3
   x1  -0.1     0    10
   x2     0   -25     0
   x3   -50   500  -200

  b =
        u1   u2
   x1    0  -20
   x2    2    0
   x3    0    0

  c =
       x1  x2  x3
   y1   1   0   0
   y2   0   1   0
   y3   0   0   1

  d =
       u1  u2
   y1   0   0
   y2   0   0
   y3   0   0

Continuous-time state-space model.


ans =

  From input 1 to output...
                 10000
   1:  -------------------------
       (s+2.633) (s+25) (s+197.5)
```

```
          2
 2:  ------
     (s+25)

            1000 (s+0.1)
 3:  -------------------------
     (s+2.633) (s+25) (s+197.5)

From input 2 to output...
          -20 (s+200)
 1:  -------------------
     (s+2.633) (s+197.5)

 2:  0

            1000
 3:  -------------------
     (s+2.633) (s+197.5)

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

```
[A,B,C,D]=linmod('lab02')
sys2 = ss(A,B,C,D)
zpk(sys2)
```

```
Warning: Using a default value of 0.2 for maximum step size.  The simulati
step size will be equal to or less than this value.  You can disable this
diagnostic by setting 'Automatic solver parameter selection' diagnostic to
'none' in the Diagnostics page of the configuration parameters dialog

A =

    -9.999999999999999e-02                         0     5.000000000000000
                         0    -2.500000000000000e+01
    -1.000000000000000e+01     2.500000000000000e+00    -2.000000000000000


B =

     0    -1
     4     0
     0     0


C =

     2.000000000000000e+01                         0
                         0     5.000000000000000e-01
                         0                         0     1.000000000000000


D =
```

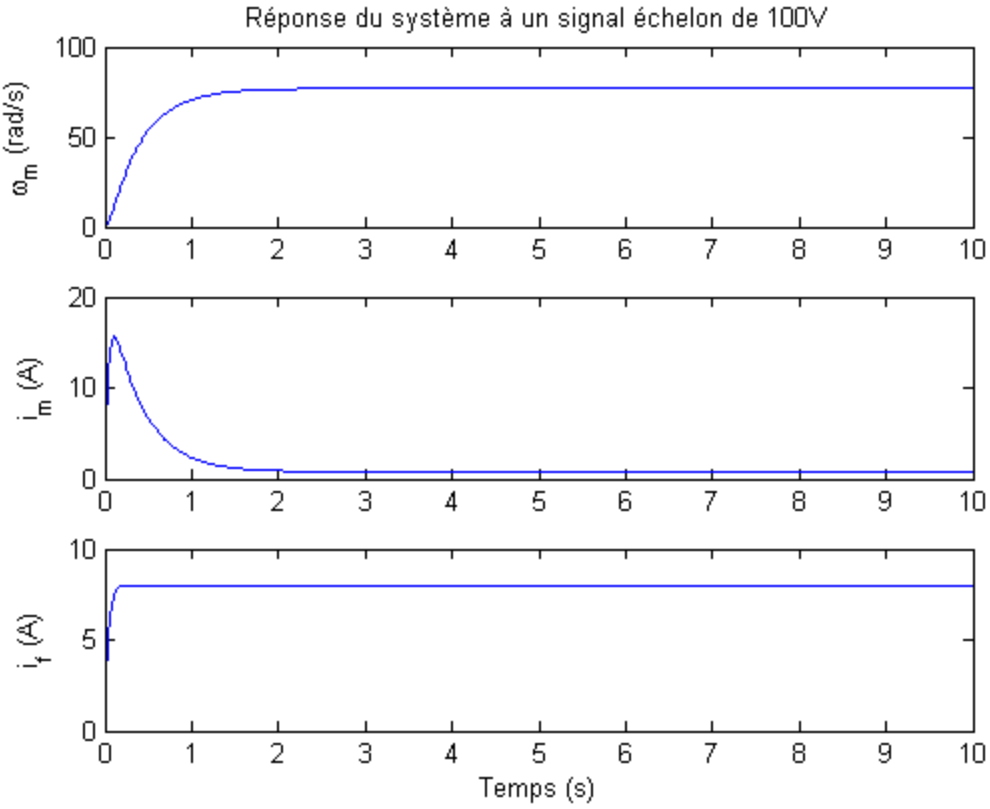
```
     0     0
     0     0
     0     0


sys2 =

  a =
         x1    x2    x3
   x1  -0.1     0    50
   x2     0   -25     0
   x3   -10   2.5  -200

  b =
       u1  u2
   x1   0  -1
   x2   4   0
   x3   0   0

  c =
        x1   x2   x3
   y1   20    0    0
   y2    0  0.5    0
   y3    0    0  100

  d =
       u1  u2
   y1   0   0
   y2   0   0
   y3   0   0

Continuous-time state-space model.


ans =

  From input 1 to output...
                 10000
   1:  --------------------------
       (s+2.633) (s+25) (s+197.5)

         2
   2:  ------
       (s+25)

              1000 (s+0.1)
   3:  --------------------------
       (s+2.633) (s+25) (s+197.5)

  From input 2 to output...
           -20 (s+200)
   1:  -------------------
       (s+2.633) (s+197.5)
```

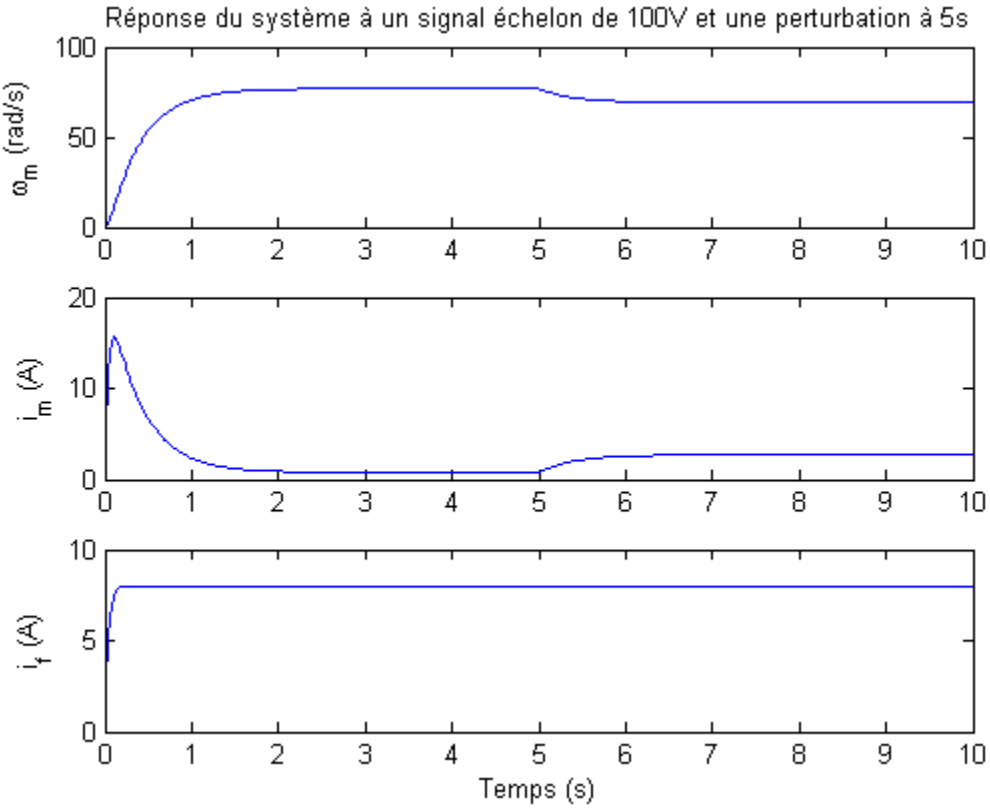
```
2:  0

            1000
3:  -------------------
    (s+2.633) (s+197.5)

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

2.2

```
figure(1)
sim('lab02_2')
sim('lab02_2b')

subplot(3,1,1)
plot(ScopeData(:,1), ScopeData(:,2))
ylabel('\omega_m (rad/s)')
title('Réponse du système à un signal échelon de 100V')

subplot(3,1,2)
plot(ScopeData(:,1), ScopeData(:,3))
ylabel('i_m (A)')

subplot(3,1,3)
plot(ScopeData(:,1), ScopeData(:,4))
ylabel('i_f (A)')
xlabel('Temps (s)')

figure(2)
subplot(3,1,1)
plot(ScopeDataCp(:,1), ScopeDataCp(:,2))
ylabel('\omega_m (rad/s)')
title('Réponse du système à un signal échelon de 100V et une perturbation à 5s')

subplot(3,1,2)
plot(ScopeDataCp(:,1), ScopeDataCp(:,3))
ylabel('i_m (A)')

subplot(3,1,3)
plot(ScopeDataCp(:,1), ScopeDataCp(:,4))
ylabel('i_f (A)')
xlabel('Temps (s)')
```

```
Warning: Using a default value of 0.2 for maximum step size.  The simulati
step size will be equal to or less than this value.  You can disable this
diagnostic by setting 'Automatic solver parameter selection' diagnostic to
'none' in the Diagnostics page of the configuration parameters dialog
Warning: Using a default value of 0.2 for maximum step size.  The simulati
step size will be equal to or less than this value.  You can disable this
diagnostic by setting 'Automatic solver parameter selection' diagnostic to
'none' in the Diagnostics page of the configuration parameters dialog
```

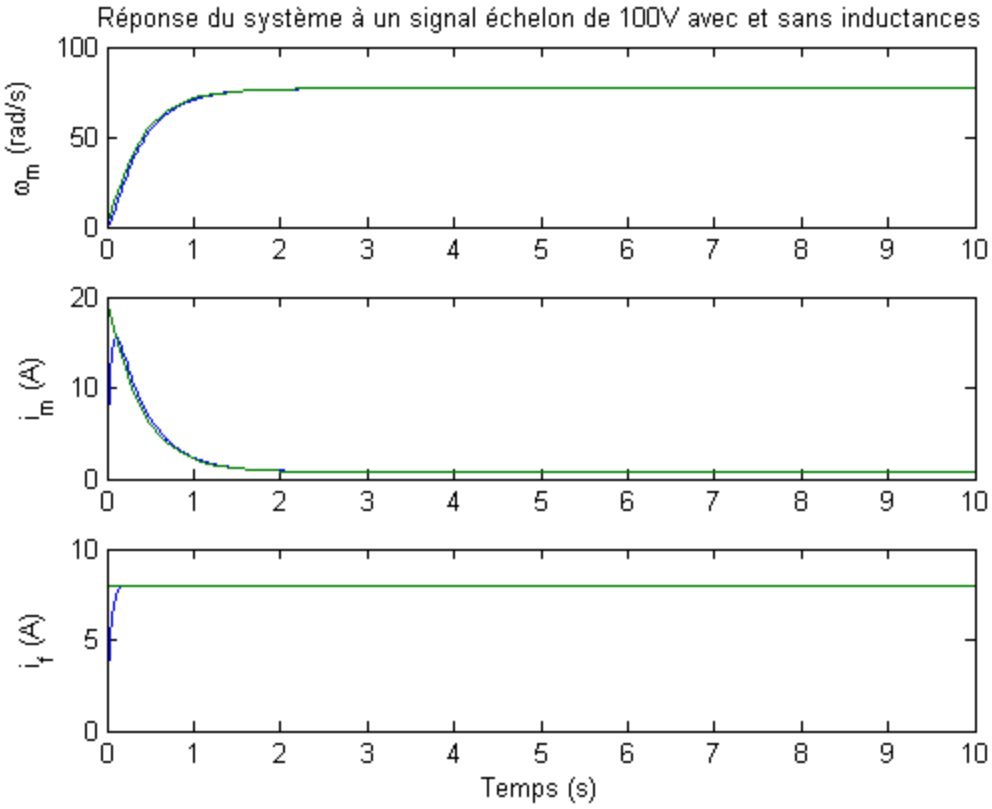

Réponse du système à un signal échelon de 100V
ωm (rad/s)
im (A)
if (A)
Temps (s)


Réponse du système à un signal échelon de 100V et une perturbation à 5s
ωm (rad/s)
im (A)
if (A)
Temps (s)

2.3

```
A1 = 4;
Lf = 0;
Rf = 50;
kg = 5;
Lg = 0;
Rg = 1;
Lm = 0;
Rm = 1;
kc = 0.5;
Jt = 0.05;
Bt = 0.005;
kw = 0.5;

sim('lab02_3')

figure(3)
subplot(3,1,1)
plot(ScopeData(:,1), ScopeData(:,2), ScopeDataL(:,1), ScopeDataL(:,2))
ylabel('\omega_m (rad/s)')
title('Réponse du système à un signal échelon de 100V avec et sans inductances')

subplot(3,1,2)
plot(ScopeData(:,1), ScopeData(:,3), ScopeDataL(:,1), ScopeDataL(:,3))
ylabel('i_m (A)')

subplot(3,1,3)
plot(ScopeData(:,1), ScopeData(:,4), ScopeDataL(:,1), ScopeDataL(:,4))
ylabel('i_f (A)')
xlabel('Temps (s)')
```

```
Warning: Using a default value of 0.2 for maximum step size.  The simulati
step size will be equal to or less than this value.  You can disable this
diagnostic by setting 'Automatic solver parameter selection' diagnostic to
'none' in the Diagnostics page of the configuration parameters dialog
```

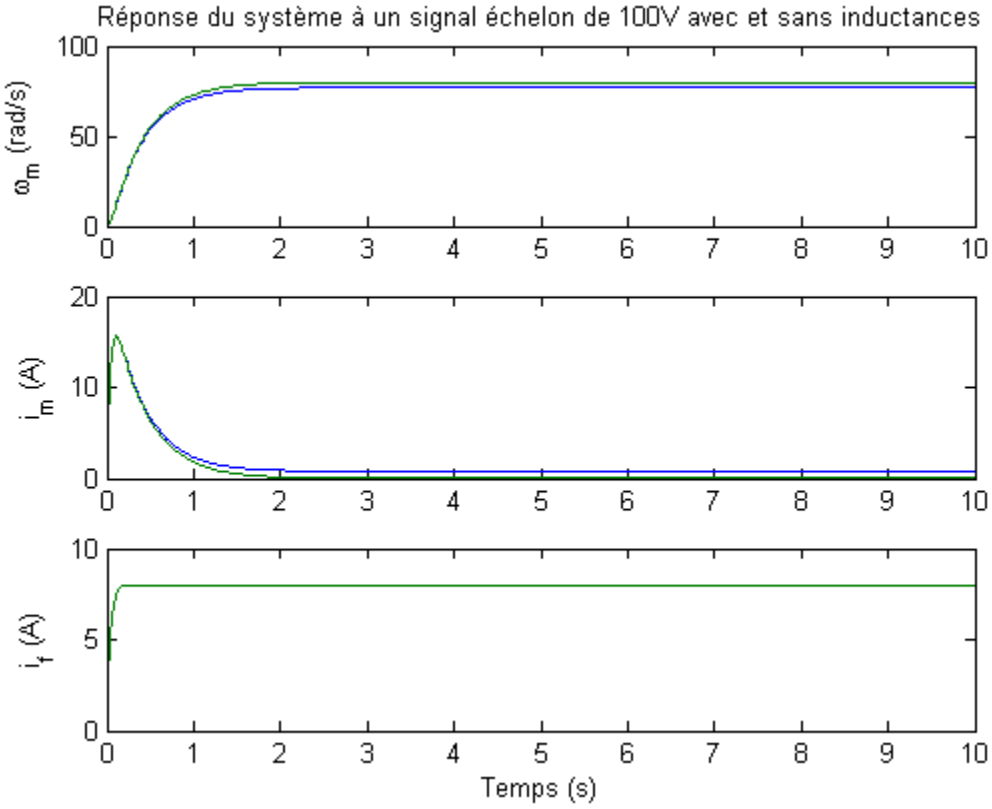


2.4

```
A1 = 4;
Lf = 2;
Rf = 50;
kg = 5;
Lg = 0.005;
Rg = 1;
Lm = 0.005;
Rm = 1;
kc = 0.5;
Jt = 0.05;
Bt = 0;
kw = 0.5;

sim('lab02_4')

figure(4)
subplot(3,1,1)
plot(ScopeData(:,1), ScopeData(:,2), ScopeDataB(:,1), ScopeDataB(:,2))
ylabel('\omega_m (rad/s)')
title('Réponse du système à un signal échelon de 100V avec et sans inductances')

subplot(3,1,2)
plot(ScopeData(:,1), ScopeData(:,3), ScopeDataB(:,1), ScopeDataB(:,3))
```

```
ylabel('i_m (A)')

subplot(3,1,3)
plot(ScopeData(:,1), ScopeData(:,4), ScopeDataB(:,1), ScopeDataB(:,4))
ylabel('i_f (A)')
xlabel('Temps (s)')
```

```
Warning: Using a default value of 0.2 for maximum step size.  The simulati

step size will be equal to or less than this value.  You can disable this
diagnostic by setting 'Automatic solver parameter selection' diagnostic to
'none' in the Diagnostics page of the configuration parameters dialog
```



3.1

```
A1 = 4;
Lf = 2;
Rf = 50;
kg = 5;
Lg = 0.005;
Rg = 1;
Lm = 0.005;
Rm = 1;
kc = 0.5;
Jt = 0.05;
Bt = 0.005;
kw = 0.5;
```

```
A2 = 20;
kt = 0.25;
kpre = 0.2423076923;

G3 = minreal(kpre*A2*G1/(1+A2*G1*kt));
%G4 = ???;
[A,B,C,D] = linmod('lab02_3_1');
sys = ss(A,B,C,D);
zpk(sys)
```

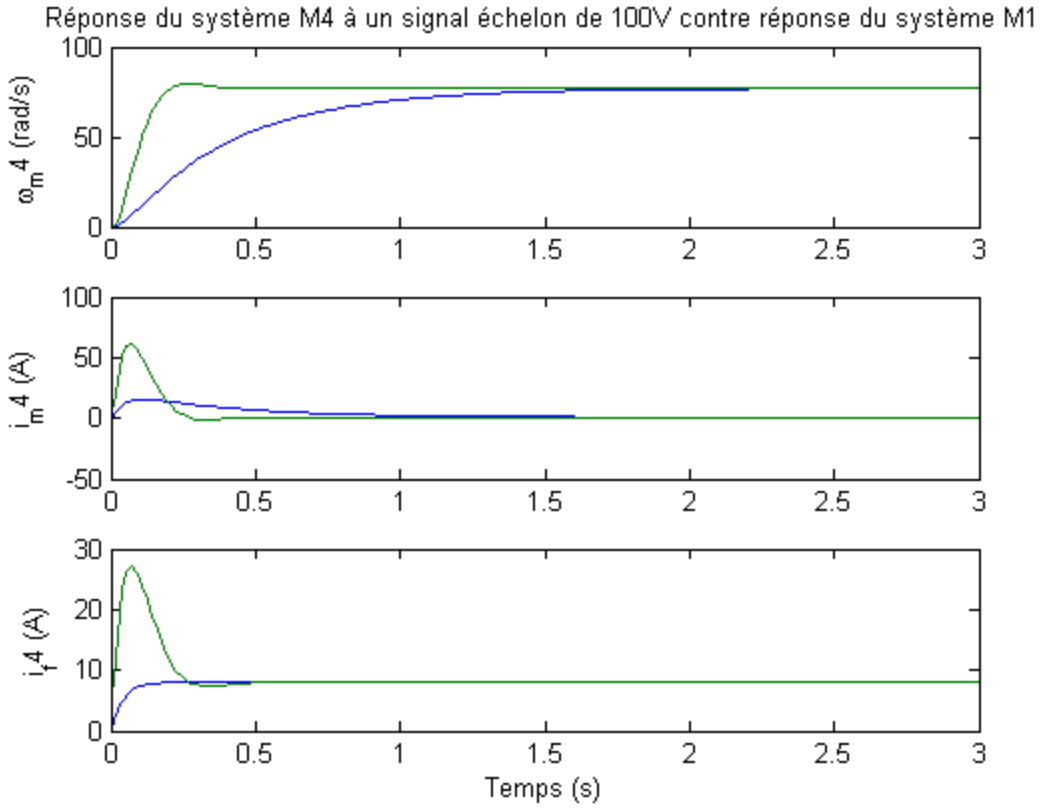
```
Warning: Using a default value of 0.2 for maximum step size.  The simulati
step size will be equal to or less than this value.  You can disable this
diagnostic by setting 'Automatic solver parameter selection' diagnostic to
'none' in the Diagnostics page of the configuration parameters dialog

ans =

  From input 1 to output...
                    48462
   1:  --------------------------------
       (s+198.9) (s^2 + 26.17s + 316.7)

                 4846.2 (s+0.1)
   2:  --------------------------------
       (s+198.9) (s^2 + 26.17s + 316.7)

              9.6923 (s+197.5) (s+2.633)
   3:  --------------------------------
       (s+198.9) (s^2 + 26.17s + 316.7)

  From input 2 to output...
              -20 (s+200) (s+25)
   1:  --------------------------------
       (s+198.9) (s^2 + 26.17s + 316.7)

                 1000 (s+125)
   2:  --------------------------------
       (s+198.9) (s^2 + 26.17s + 316.7)

                 200 (s+200)
   3:  --------------------------------
       (s+198.9) (s^2 + 26.17s + 316.7)

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

3.2 M5

```
A1 = 4;
Lf = 2;
Rf = 50;
kg = 5;
Lg = 0.005;
```

```
Rg = 1;
Lm = 0.005;
Rm = 1;
kc = 0.5;
Jt = 0.05;
Bt = 0.005;
kw = 0.5;
A2 = 20;
kt = 0.25;
kpre = 0.2423076923;

M1 = sim('lab02_2', 'StopTime', '3');
ScopeData = M1.get('ScopeData');
M4 = sim('lab02_3_2', 'StopTime', '3');
ScopeData3_2 = M4.get('ScopeData3_2');

figure(5)
subplot(3,1,1)
plot(ScopeData(:,1), ScopeData(:,2), ScopeData3_2(:,1), ScopeData3_2(:,2))
ylabel('\omega_m4 (rad/s)')
title('Réponse du système M4 à un signal échelon de 100V contre réponse du système

subplot(3,1,2)
plot(ScopeData(:,1), ScopeData(:,3), ScopeData3_2(:,1), ScopeData3_2(:,3))
ylabel('i_m4 (A)')

subplot(3,1,3)
plot(ScopeData(:,1), ScopeData(:,4), ScopeData3_2(:,1), ScopeData3_2(:,4))
ylabel('i_f4 (A)')
xlabel('Temps (s)')
```

```
Warning: Using a default value of 0.06 for maximum step size.  The simulat
step size will be equal to or less than this value.  You can disable this
diagnostic by setting 'Automatic solver parameter selection' diagnostic to
'none' in the Diagnostics page of the configuration parameters dialog
Warning: Using a default value of 0.06 for maximum step size.  The simulat
step size will be equal to or less than this value.  You can disable this
diagnostic by setting 'Automatic solver parameter selection' diagnostic to
'none' in the Diagnostics page of the configuration parameters dialog
```

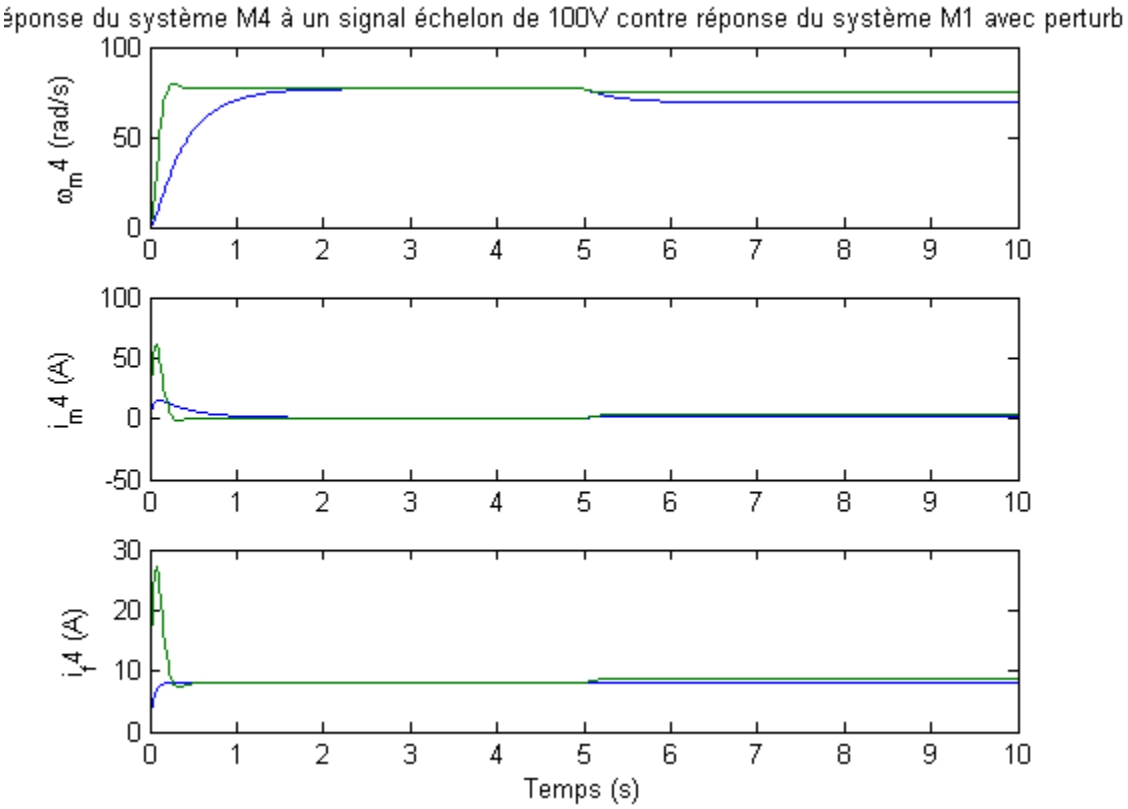


3.2 (suite)

```
A1 = 4;
Lf = 2;
Rf = 50;
kg = 5;
Lg = 0.005;
Rg = 1;
Lm = 0.005;
Rm = 1;
kc = 0.5;
Jt = 0.05;
Bt = 0.005;
kw = 0.5;
A2 = 20;
kt = 0.25;
kpre = 0.2423076923;

M1 = sim('lab02_2b', 'StopTime', '10');
ScopeData = M1.get('ScopeDataCp');
M4 = sim('lab02_3_2b', 'StopTime', '10');
ScopeData3_2 = M4.get('ScopeData3_2');

figure(5)
subplot(3,1,1)
```

```
plot(ScopeData(:,1), ScopeData(:,2), ScopeData3_2(:,1), ScopeData3_2(:,2))
ylabel('\omega_m4 (rad/s)')
title('Réponse du système M4 à un signal échelon de 100V contre réponse du système

subplot(3,1,2)
plot(ScopeData(:,1), ScopeData(:,3), ScopeData3_2(:,1), ScopeData3_2(:,3))
ylabel('i_m4 (A)')

subplot(3,1,3)
plot(ScopeData(:,1), ScopeData(:,4), ScopeData3_2(:,1), ScopeData3_2(:,4))
ylabel('i_f4 (A)')
xlabel('Temps (s)')
```

```
Warning: Using a default value of 0.2 for maximum step size.  The simulati

step size will be equal to or less than this value.  You can disable this
diagnostic by setting 'Automatic solver parameter selection' diagnostic to
'none' in the Diagnostics page of the configuration parameters dialog
Warning: Using a default value of 0.2 for maximum step size.  The simulati
step size will be equal to or less than this value.  You can disable this
diagnostic by setting 'Automatic solver parameter selection' diagnostic to
'none' in the Diagnostics page of the configuration parameters dialog
```

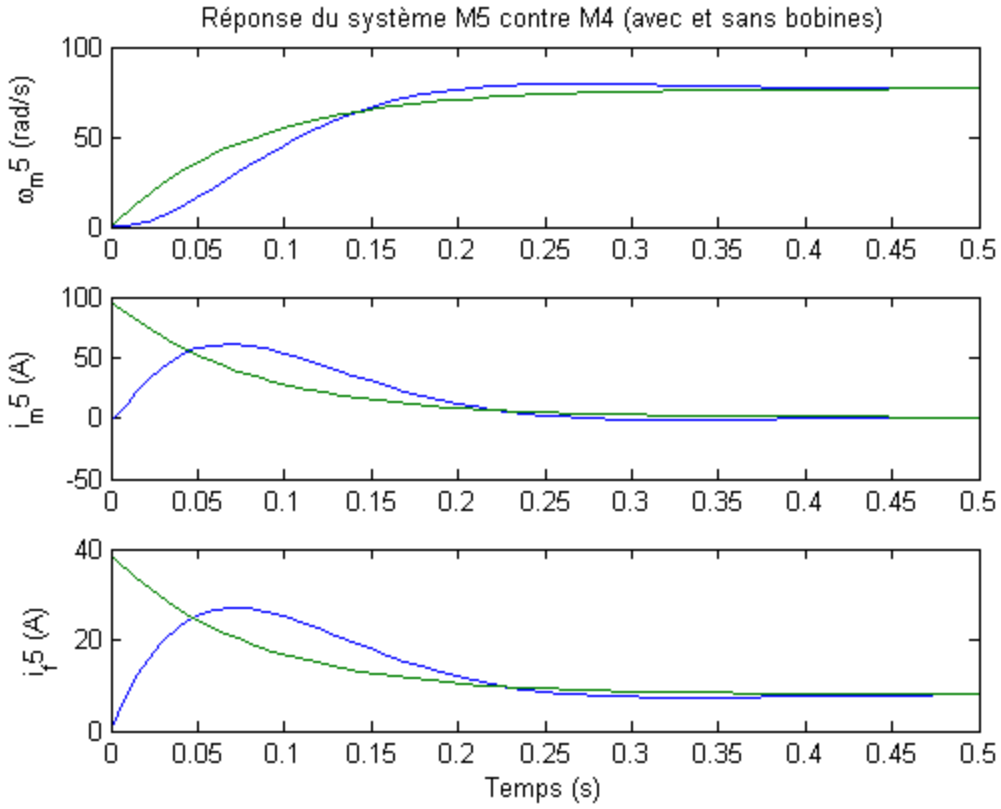


3.3

```
A1 = 4;
Lf = 2;
```

```
Rf = 50;
kg = 5;
Lg = 0.005;
Rg = 1;
Lm = 0.005;
Rm = 1;
kc = 0.5;
Jt = 0.05;
Bt = 0.005;
kw = 0.5;
A2 = 20;
kt = 0.25;
kpre = 0.2423076923;

M4 = sim('lab02_3_2', 'StopTime', '0.5');
ScopeData = M4.get('ScopeData3_2');

Lf = 0;
Lg = 0;
Lm = 0;

M5 = sim('lab02_3_2', 'StopTime', '0.5');
ScopeData3_2 = M5.get('ScopeData3_2');

figure(5)
subplot(3,1,1)
plot(ScopeData(:,1), ScopeData(:,2), ScopeData3_2(:,1), ScopeData3_2(:,2))
ylabel('\omega_m5 (rad/s)')
title('Réponse du système M5 contre M4 (avec et sans bobines)')

subplot(3,1,2)
plot(ScopeData(:,1), ScopeData(:,3), ScopeData3_2(:,1), ScopeData3_2(:,3))
ylabel('i_m5 (A)')

subplot(3,1,3)
plot(ScopeData(:,1), ScopeData(:,4), ScopeData3_2(:,1), ScopeData3_2(:,4))
ylabel('i_f5 (A)')
xlabel('Temps (s)')
```

```
Warning: Using a default value of 0.01 for maximum step size.  The simulat
step size will be equal to or less than this value.  You can disable this
diagnostic by setting 'Automatic solver parameter selection' diagnostic to
'none' in the Diagnostics page of the configuration parameters dialog
Warning: Using a default value of 0.01 for maximum step size.  The simulat
step size will be equal to or less than this value.  You can disable this
diagnostic by setting 'Automatic solver parameter selection' diagnostic to
'none' in the Diagnostics page of the configuration parameters dialog
```



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