Table of Contents

Etude d’un double pendule avec l’hypotheese des petits mouvements

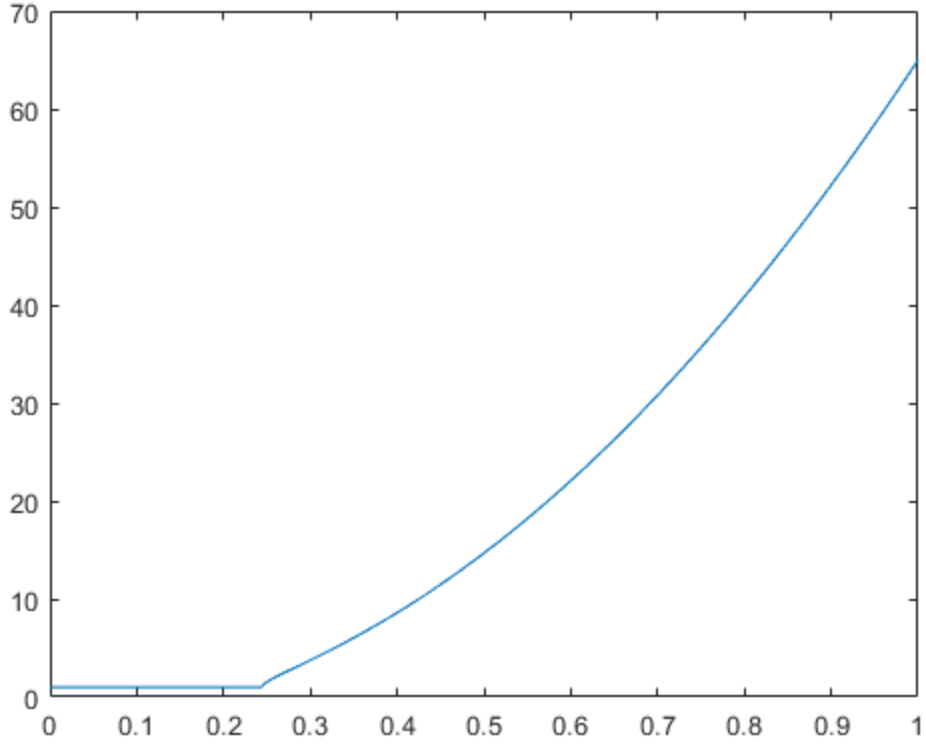
```
m = 2;
a = 0.5;
g = 9.81;
F0 = 20;
w = 2*pi;
```

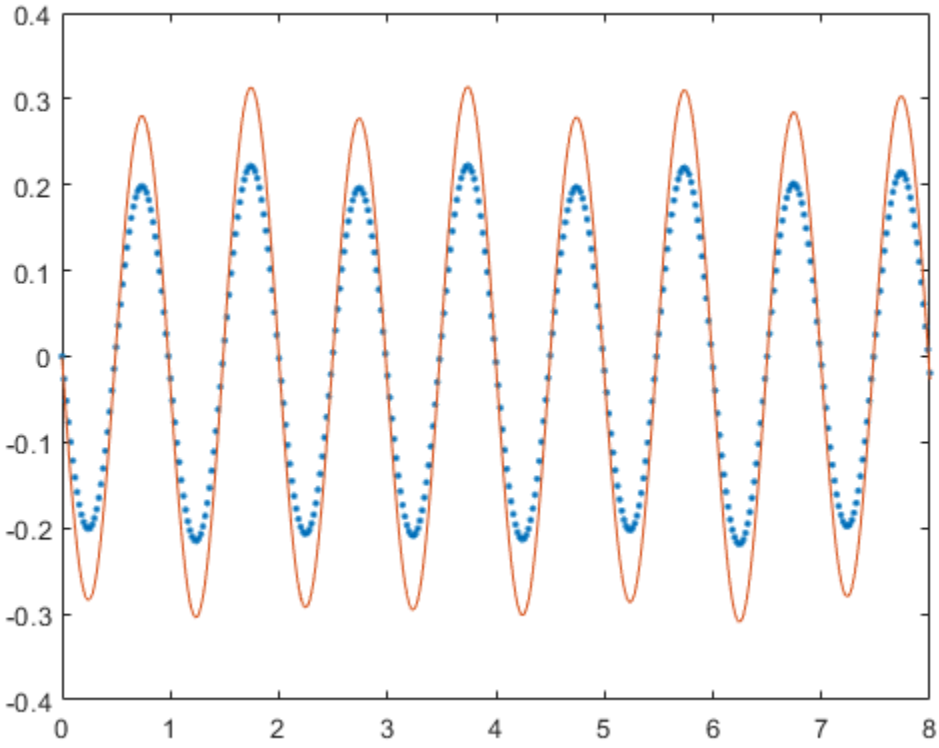
1 NEWMARK EXPLICITE

```
syms deltat;
X = [2,1;1,1];
Y = [2,0;0,1];

% soit q=[theta1,theta2]
% donc B*[q(i+1),dq(i+1)]=C*[q(i),dq(i)]+D
B = [eye(2),zeros(2);g/a*deltat*0.5.*inv(X)*Y,eye(2)];
C = [eye(2)-g/a*deltat^2*0.5.*inv(X)*Y,deltat.*eye(2);-0.5*deltat*g/
a.*inv(X)*Y,eye(2)];

A = inv(B)*C
eigmax=[];
for deltat=0:0.001:1
    eigmax=[eigmax,max(abs(eig(eval(A))))];
end
deltat=0:0.001:1;
figure(1);
plot(deltat,eigmax)

% 0.244

%1.3
%a*X*d2q0+g*Y*q0=0

%1.4
%relation(2)et(3)et
%X*d2qn+Y*qn=F0*sin(w*n*deltat).*[a;a/sqrt(2)]
%X*d2qn+1+Y*qn+1=F0*sin(w*(n+1)*deltat).*[a;a/sqrt(2)]

%1.5
q = [0;0];
```

```
dq = [-1.31519275;-1.85996342];
deltat = 0.02;
B = [eye(2),zeros(2);g/a*deltat*0.5.*inv(X)*Y,eye(2)];
C = [eye(2)-g/a*deltat^2*0.5.*inv(X)*Y,deltat.*eye(2);-0.5*deltat*g/
a.*inv(X)*Y,eye(2)];
A = inv(B)*C;
for n=1:400
    Z = F0*sin(w*n*deltat).*[a;a/sqrt(2)];
    D = [0.5*deltat^2/m/a/a*inv(X)*Z;deltat/m/a/a*inv(X)*Z];
    Q = A*[q(:,n);dq(:,n)]+inv(B)*D;
    q(:,n+1) = Q(1:2);
    dq(:,n+1) = Q(3:4);
end
figure(2)
plot(0:0.02:8,q(1,:),'.');
hold on;
plot(0:0.02:8,q(2,:));
hold off;
```

```
A =

[                                                                  1 -
 (981*deltat^2)/50,
                (981*deltat^2)/100,                deltat,
         0]
[
  (981*deltat^2)/50,
             1 - (981*deltat^2)/50,                     0,
     deltat]
[ (981*deltat*((981*deltat^2)/50 - 1))/50 - (981*deltat)/50
 + (962361*deltat^3)/5000, (981*deltat)/100 -
 (981*deltat*((981*deltat^2)/50 - 1))/100 - (962361*deltat^3)/5000, 1
 - (981*deltat^2)/50,    (981*deltat^2)/100]
[ (981*deltat)/50 - (981*deltat*((981*deltat^2)/50 - 1))/50 -
 (962361*deltat^3)/2500,   (981*deltat*((981*deltat^2)/50 - 1))/50 -
 (981*deltat)/50 + (962361*deltat^3)/5000,     (981*deltat^2)/50, 1 -
 (981*deltat^2)/50]
```

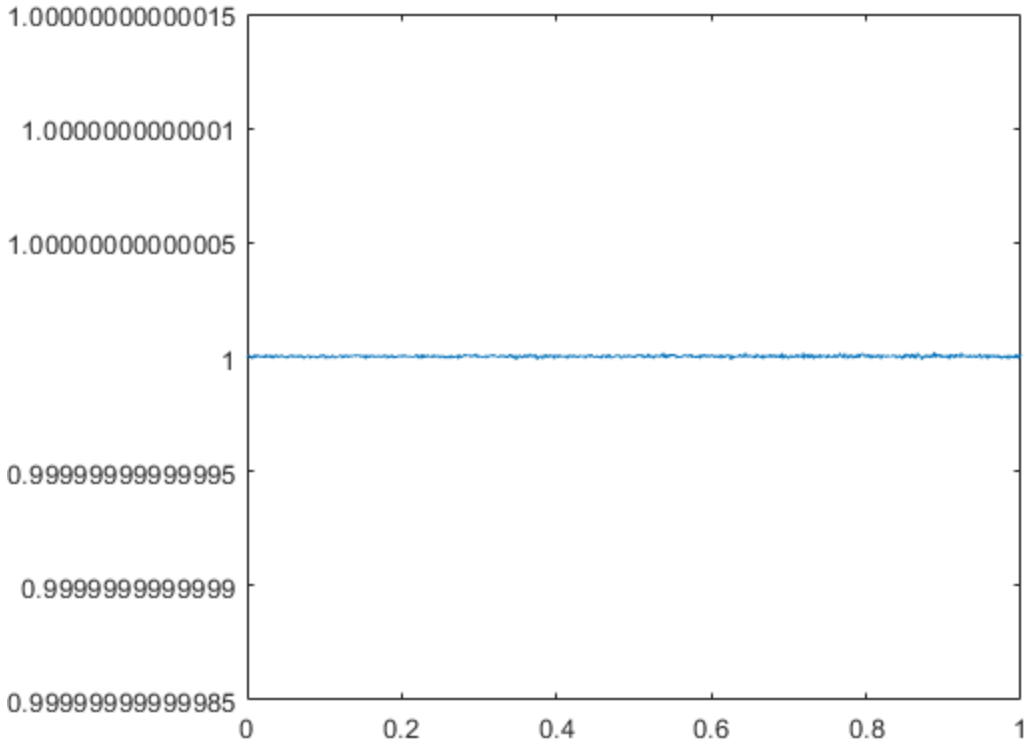

70
60
50
40
30
20
10
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

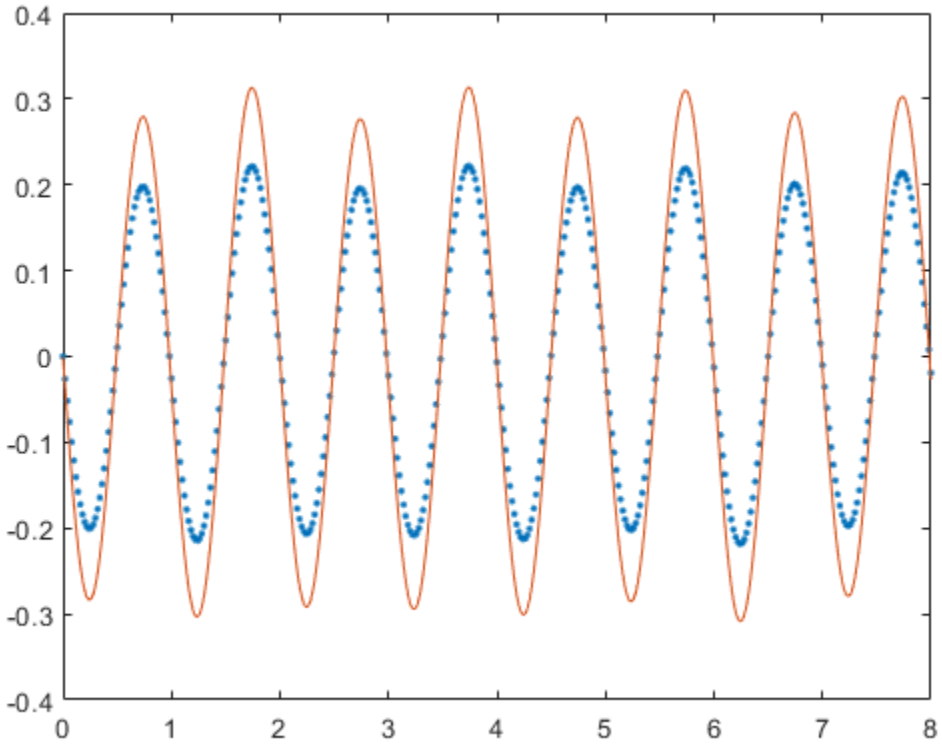

0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
0
1
2
3
4
5
6
7
8

2 Newmark implicite

```
syms deltat;
B = [eye(2)+g/a*0.25*deltat^2.*inv(X)*Y,zeros(2);g/
a*deltat*0.5.*inv(X)*Y,eye(2)];
C = [eye(2)-g/a*deltat^2*0.25.*inv(X)*Y,deltat.*eye(2);-0.5*deltat*g/
a.*inv(X)*Y,eye(2)];
A = inv(B)*C
eigmax2=[];
for deltat=0:0.001:1
    eigmax2=[eigmax2,max(abs(eig(eval(A))))];
end
deltat=0:0.001:1;
figure(3);
plot(deltat,eigmax2)
%c'est toujours 1

%2.3
%a*X*d2q0+g*Y*q0=0

%2.4
%[q(i+1),dq(i+1)]=A*[q(i),dq(i)]+D(ti)

%2.5
q2 = [0;0];
dq2 = [-1.31519275;-1.85996342];
deltat = 0.02;
B = [eye(2)+g/a*0.25*deltat^2.*inv(X)*Y,zeros(2);g/
a*deltat*0.5.*inv(X)*Y,eye(2)];
C = [eye(2)-g/a*deltat^2*0.25.*inv(X)*Y,deltat.*eye(2);-0.5*deltat*g/
a.*inv(X)*Y,eye(2)];
A = inv(B)*C;
for n=1:400
    Z = F0*sin(w*n*deltat).*[a;a/sqrt(2)];
    D = [0.5*deltat^2/m/a/a*inv(X)*Z;deltat/m/a/a*inv(X)*Z];
    Q = A*[q2(:,n);dq2(:,n)]+inv(B)*D;
    q2(:,n+1) = Q(1:2);
    dq2(:,n+1) = Q(3:4);
end
figure(4)
plot(0:0.02:8,q2(1,:),'.');
hold on;
plot(0:0.02:8,q2(2,:));
hold off;


A =

[                                                (962361*deltat^4)/
(962361*deltat^4 + 392400*deltat^2 + 20000) - (200*(981*deltat^2 +
 100)*((981*deltat^2)/100 - 1))/(962361*deltat^4 + 392400*deltat^2 +
 20000),                                          (981*deltat^2*(981*deltat^2
 + 100))/(962361*deltat^4 + 392400*deltat^2 + 20000) -
```

```
 (98100*deltat^2*((981*deltat^2)/100 - 1))/(962361*deltat^4 +
 392400*deltat^2 + 20000),             (200*deltat*(981*deltat^2 +
 100))/(962361*deltat^4 + 392400*deltat^2 + 20000),
              (98100*deltat^3)/(962361*deltat^4 + 392400*deltat^2 +
 20000)]
[                                (1962*deltat^2*(981*deltat^2
 + 100))/(962361*deltat^4 + 392400*deltat^2 + 20000) -
 (196200*deltat^2*((981*deltat^2)/100 - 1))/(962361*deltat^4 +
 392400*deltat^2 + 20000),
        (962361*deltat^4)/(962361*deltat^4 + 392400*deltat^2 +
 20000) - (200*(981*deltat^2 + 100)*((981*deltat^2)/100 - 1))/
(962361*deltat^4 + 392400*deltat^2 + 20000),
      (196200*deltat^3)/(962361*deltat^4 + 392400*deltat^2 + 20000),
             (200*deltat*(981*deltat^2 + 100))/(962361*deltat^4 +
 392400*deltat^2 + 20000)]
[              (1924722*deltat^3)/(962361*deltat^4 +
 392400*deltat^2 + 20000) - (981*deltat)/50 + (1962*(981*deltat^3
 + 200*deltat)*((981*deltat^2)/100 - 1))/(962361*deltat^4
 + 392400*deltat^2 + 20000), (981*deltat)/100 -
 (196200*deltat*((981*deltat^2)/100 - 1))/(962361*deltat^4 +
 392400*deltat^2 + 20000) - (962361*deltat^2*(981*deltat^3 +
 200*deltat))/(100*(962361*deltat^4 + 392400*deltat^2 + 20000)),
 1 - (1962*deltat*(981*deltat^3 + 200*deltat))/(962361*deltat^4
 + 392400*deltat^2 + 20000),
 (196200*deltat^2)/(962361*deltat^4 + 392400*deltat^2 + 20000)]
[ (981*deltat)/50 - (392400*deltat*((981*deltat^2)/100
 - 1))/(962361*deltat^4 + 392400*deltat^2 + 20000) -
 (962361*deltat^2*(981*deltat^3 + 200*deltat))/(50*(962361*deltat^4
 + 392400*deltat^2 + 20000)),                (1924722*deltat^3)/
(962361*deltat^4 + 392400*deltat^2 + 20000) - (981*deltat)/50
 + (1962*(981*deltat^3 + 200*deltat)*((981*deltat^2)/100 - 1))/
(962361*deltat^4 + 392400*deltat^2 + 20000),
      (392400*deltat^2)/(962361*deltat^4 + 392400*deltat^2 + 20000),
 1 - (1962*deltat*(981*deltat^3 + 200*deltat))/(962361*deltat^4 +
 392400*deltat^2 + 20000)]
```


1.00000000000015
1.0000000000001
1.00000000000005
1
0.99999999999995
0.9999999999999
0.99999999999985
0
0.2
0.4
0.6
0.8
1


0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
0
1
2
3
4
5
6
7
8

Published with MATLAB® R2019b