Oscillateur conservatif lineaire a un degre de liberte

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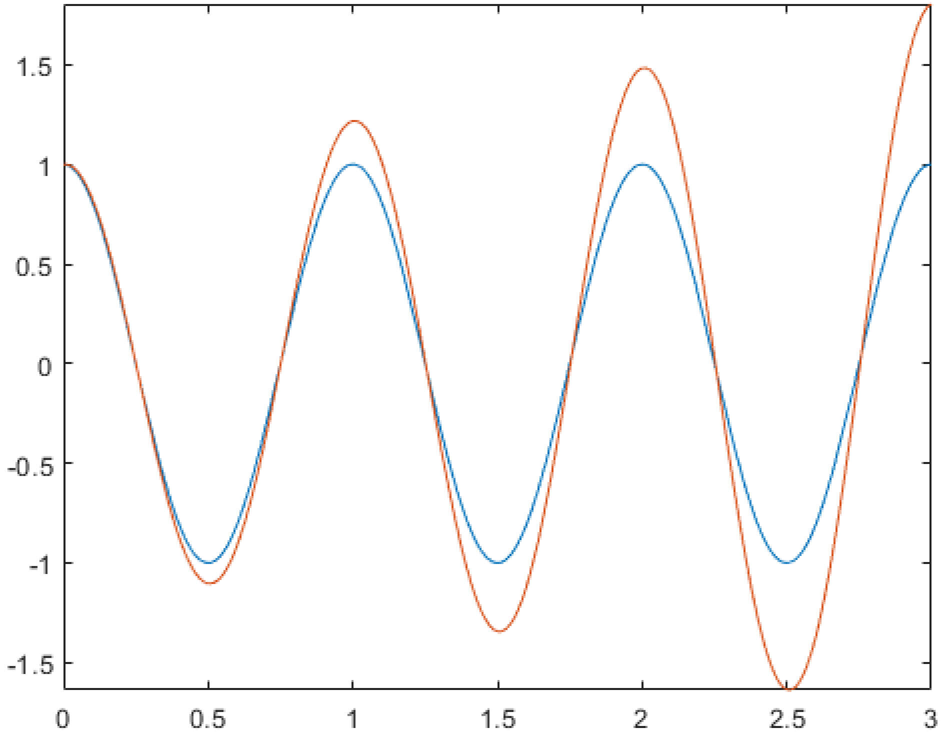
Question1

```
%1.1
w0 = 2*pi;
q = dsolve('D2q+(2*pi)^2*q=0','q(0)=1','Dq(0)=0');

%1.2
E = 0.5*((diff(q))^2+(2*pi*q)^2);
E = simplify(E)

##: Support of character vectors and strings will be removed in a
 future
release. Use sym objects to define differential equations instead.

E =

2*pi^2
```

Question2 EULER explicite

```
% 2.1 on peut trouver que D2q=-w0^2*q. Donc, si l'on simplifier
 l'equation
%5, on obtient les equations 6

%2.2
%methode 1
q2 = [1];
dq2 = [0];
deltat=0.01;
for i=1:300
    q2=[q2,q2(i)+deltat*dq2(i)];
    dq2=[dq2,dq2(i)+deltat*(-w0^2*q2(i))];
end
```

```
%2.3
figure(1)
fplot(q,[0,3])
hold on;
plot([0:0.01:3],q2)
hold off;

%2.4
E2 = 0.5.*((dq2).^2+(2*pi.*q2).^2);
figure(2)
fplot(E)
hold on;
plot([0:0.01:3],E2)
hold off;
%plus le deltat est petit, plus le resultat est proche avec la
 solution
%exacte

%2.5
syms deltat1;
Ma_Amplifica=[1,deltat1;-w0^2*deltat1,1];
[x,y]=eig(Ma_Amplifica)


x =

[ (70368744177664*((2778046668940015^(1/2)*deltat1*1i)/8388608
 - 1))/(2778046668940015*deltat1) + 70368744177664/
(2778046668940015*deltat1), 70368744177664/(2778046668940015*deltat1)
 - (70368744177664*((2778046668940015^(1/2)*deltat1*1i)/8388608 + 1))/
(2778046668940015*deltat1)]
[
                                                                    1,
                                                                   1]


y =

[ 1 - (2778046668940015^(1/2)*deltat1*1i)/8388608,
                           0]
[                                                    0,
 (2778046668940015^(1/2)*deltat1*1i)/8388608 + 1]
```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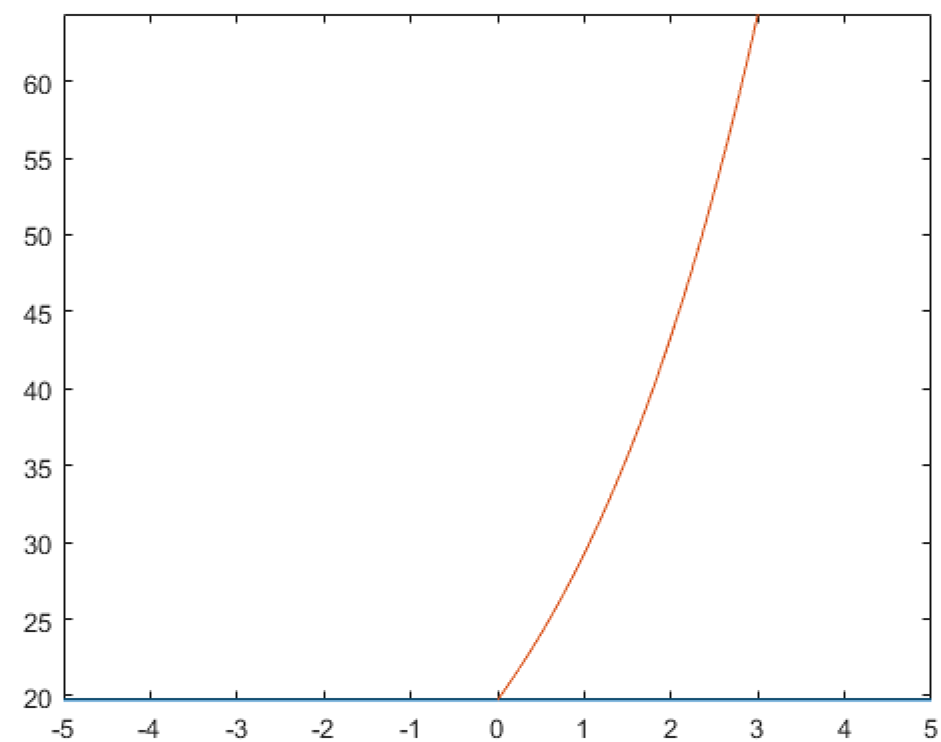
0.5
0
-0.5
-1
-1.5
0
0.5
1
1.5
2
2.5
3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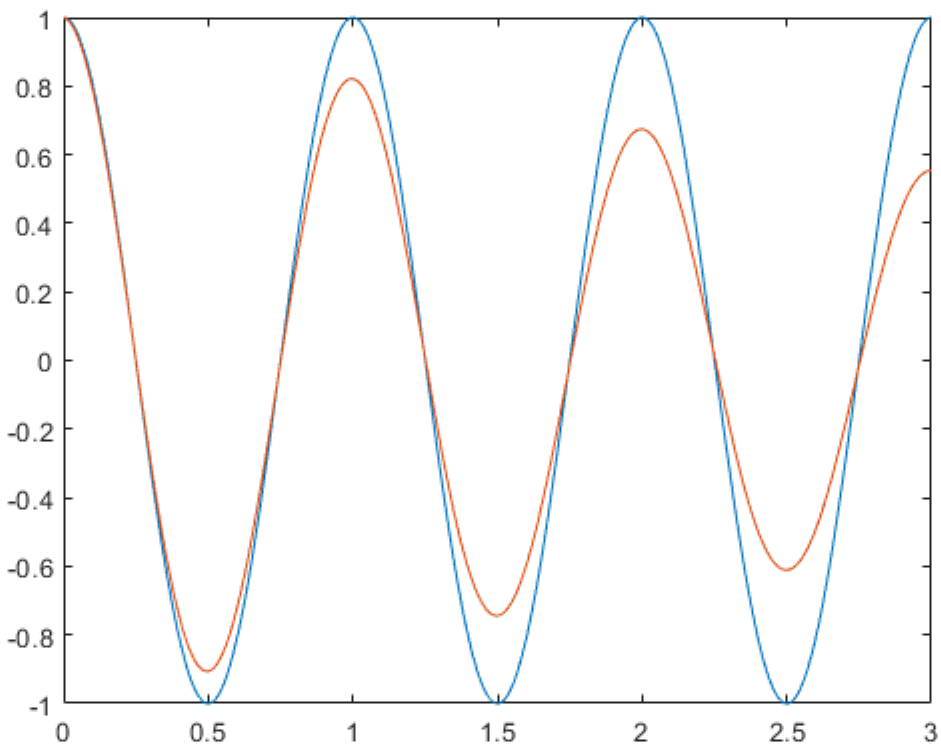
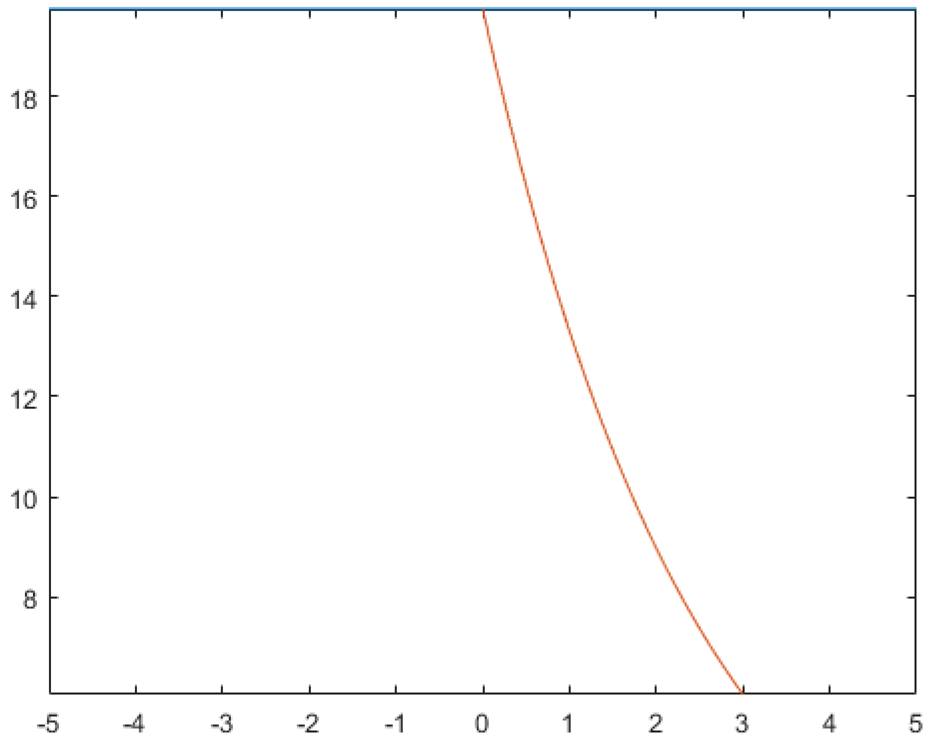
55
50
45
40
35
30
25
20
-5
-4
-3
-2
-1
0
1
2
3
4
5

question3 EULER implicite

```
%3.1
q3 = [1];
dq3 = [0];
deltat=0.01;
for i=1:300
    q3=[q3,(q3(i)+deltat*dq3(i))/(1+deltat^2*w0^2)];
    dq3=[dq3,dq3(i)+deltat*(-w0^2*q3(i+1))];
end

%3.2
figure(3)
fplot(q,[0,3])
hold on;
plot([0:0.01:3],q3)
hold off;

%3.3 on change deltat

%3.4
E3 = 0.5.*((dq3).^2+(2*pi.*q3).^2);
figure(4)
fplot(E);
hold on;
plot([0:0.01:3],E3);
hold off;
%plus le deltat est petit, plus le resultat est loin avec la solution
%exacte

% 3.5
syms deltat2;
Ma_Amplifica2=inv([1,-deltat2;w0^2*deltat2,1]);
[x,y]=eig(Ma_Amplifica2)


x =

[ 70368744177664/(2778046668940015*deltat2)
 + (8388608*(2778046668940015*deltat2^2 +
 70368744177664)*(2778046668940015^(1/2)*deltat2 - 8388608i))/
(2778046668940015*deltat2*(deltat2^2*2778046668940015i +
 70368744177664i)), 70368744177664/(2778046668940015*deltat2)
 - (8388608*(2778046668940015*deltat2^2 +
 70368744177664)*(2778046668940015^(1/2)*deltat2 + 8388608i))/
(2778046668940015*deltat2*(deltat2^2*2778046668940015i +
 70368744177664i))]
[


         1,
```

```
                    1]


y =

[ -(8388608*(2778046668940015^(1/2)*deltat2 - 8388608i))/
(deltat2^2*2778046668940015i + 70368744177664i),

         0]
[
                                                    0,
 (8388608*(2778046668940015^(1/2)*deltat2 + 8388608i))/
(deltat2^2*2778046668940015i + 70368744177664i)]
```

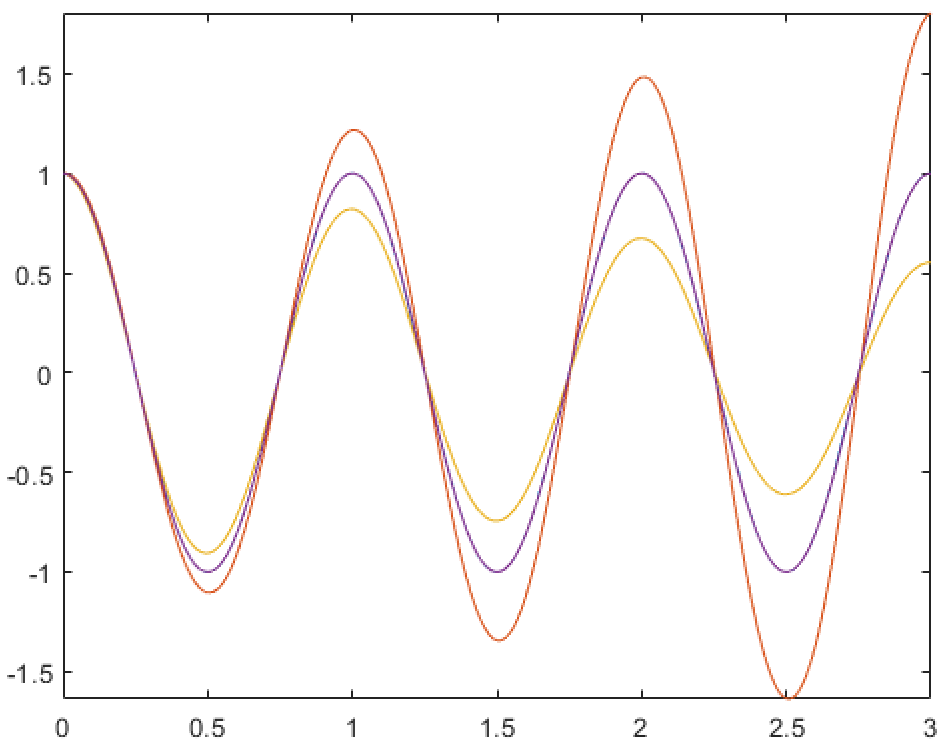


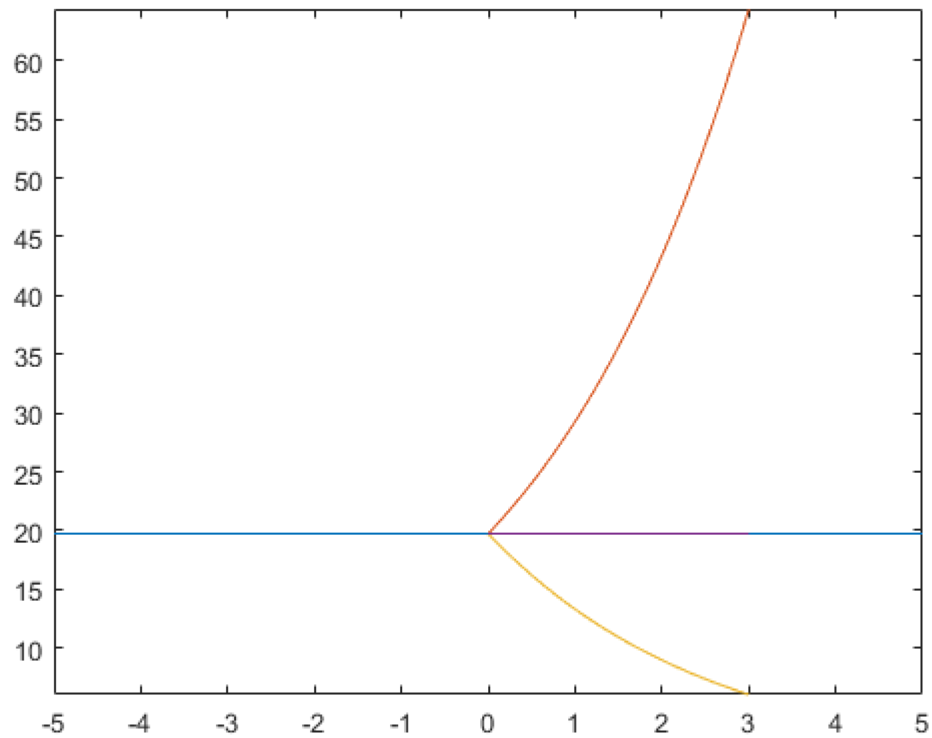


question4 RUNGE KUTTA

```
%4.1 selon l"equation 1, [Dq;D2q]=[0,1;-w0^2,0][q;Dq]

%4.2

q4 = [1];
dq4 = [0];
deltat = 0.01;
A = [0,1;-w0^2,0];
for i=1:300
    k1 = A*[q4(i);dq4(i)];
    k2 = A*([q4(i);dq4(i)]+deltat/2.*k1);
    k3 = A*([q4(i);dq4(i)]+deltat/2.*k2);
    k4 = A*([q4(i);dq4(i)]+deltat.*k3);
    K = (k1+2*k2+2*k3+k4)./6;
    q4 = [q4,q4(i)+deltat*K(1)];
    dq4 = [dq4,dq4(i)+deltat*K(2)];
end

%4.3
figure(5)
fplot(q,[0,3])
hold on;
plot([0:0.01:3],q2)
```

```
plot([0:0.01:3],q3)
plot([0:0.01:3],q4)
hold off;

%on peut trouver que le result de RUNGE KUTTA est meme avec la
 solution
%exacte. C"est-a-dire, le result de RUNGE KUTTA est precis.

%4.4
E4 = 0.5.*((dq4).^2+(2*pi.*q4).^2);
figure(6)
fplot(E)
hold on;
plot([0:0.01:3],E2);
plot([0:0.01:3],E3);
plot([0:0.01:3],E4);
hold off;
% Pour calculer E, le schema de RUNGE KUTTA est plus precis.
```





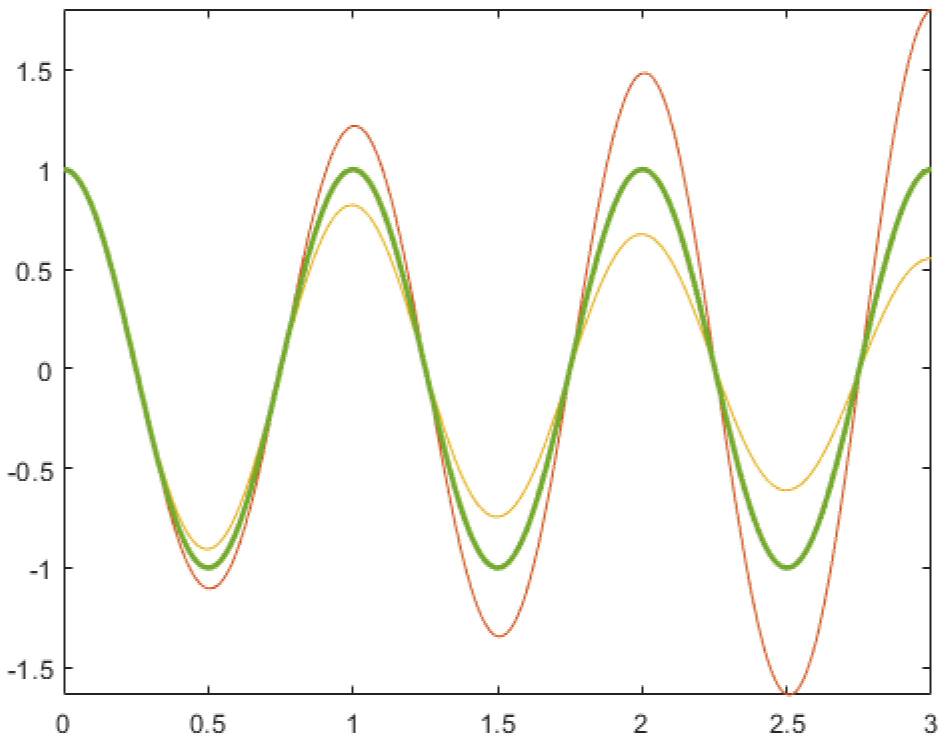
question 5

```
% q5(i+1)=q5(i)+deltat*dq5(i)+(0.5-
beta)*deltat^2*d2q5(i)+beta*deltat^2*d2q5(i+1)
% dq5(i+1)=dq5(i)+(1-gamma)*deltat*d2q5(i)+gamma*deltat*d2q5(i+1)
%5.1
deltat = 0.01;
B = [1+0.25*deltat^2*w0^2,0;0.5*deltat*w0^2,1];
C = [1-(0.5-0.25)*deltat^2*w0^2,deltat;-(1-0.5)*deltat*w0^2,1];
A = inv(B)*C;
q5 = [1];
dq5 = [0];
for i=1:300
    K = [q5(i);dq5(i)];
    K = A*K;
    q5(i+1) = K(1);
    dq5(i+1) = K(2);
end
figure(7)
fplot(q,[0,3])
hold on;
plot([0:0.01:3],q2)
plot([0:0.01:3],q3)
plot([0:0.01:3],q4)
plot([0:0.01:3],q5,'linewidth',2)
```

```
hold off;

E5 = 0.5.*((dq5).^2+(2*pi.*q5).^2);
figure(8)
fplot(E);
hold on;
plot([0:0.01:3],E2);
plot([0:0.01:3],E3);
plot([0:0.01:3],E4);
plot([0:0.01:3],E5);
hold off;
% on trouve que le schema de newmark est tres precis

syms deltat3;
B = [1+0.25*deltat3^2*w0^2,0;0.5*deltat3*w0^2,1];
C = [1-(0.5-0.25)*deltat3^2*w0^2,deltat3;-(1-0.5)*deltat3*w0^2,1];
Ma_Amplifica4=inv(B)*C;
[x,y]=eig(Ma_Amplifica4)


%5.2
deltat = 0.01;%0.2  0.5
B = [1+0*deltat^2*w0^2,0;0.5*deltat*w0^2,1];
C = [1-(0.5-0)*deltat^2*w0^2,deltat;-(1-0.5)*deltat*w0^2,1];
A = inv(B)*C;
q6 = [1];
dq6 = [0];
for i=1:300
    K = [q6(i);dq6(i)];
    K = A*K;
    q6(i+1) = K(1);
    dq6(i+1) = K(2);
end
figure(9)
fplot(q,[0,3])
hold on;
plot([0:0.01:3],q2)
plot([0:0.01:3],q3)
plot([0:0.01:3],q4)
plot([0:0.01:3],q5)
plot([0:0.01:3],q6,'linewidth',2)
hold off;
syms deltat4;
B = [1+0*deltat4^2*w0^2,0;0.5*deltat4*w0^2,1];
C = [1-(0.5-0)*deltat4^2*w0^2,deltat4;-(1-0.5)*deltat4*w0^2,1];
Ma_Amplifica4=inv(B)*C;
[x,y]=eig(Ma_Amplifica4)
eq=abs(y(1,1))-1;
eq2=abs(y(2,2))-1;
vpasolve(eq,deltat4)
vpasolve(eq2,deltat4)
% on peut trouver le temps critique est 0
```

```
x =

[ - (2778046668940015*deltat3^2 - 281474976710656)/
(11112186675760060*deltat3) - ((2778046668940015*deltat3^2
 + 281474976710656)*(- deltat3^2*2778046668940015i +
 33554432*2778046668940015^(1/2)*deltat3 + 281474976710656i))/
(11112186675760060*deltat3*(deltat3^2*2778046668940015i +
 281474976710656i)), - (2778046668940015*deltat3^2 - 281474976710656)/
(11112186675760060*deltat3) + ((2778046668940015*deltat3^2
 + 281474976710656)*(deltat3^2*2778046668940015i +
 33554432*2778046668940015^(1/2)*deltat3 - 281474976710656i))/
(11112186675760060*deltat3*(deltat3^2*2778046668940015i +
 281474976710656i))]
[



                  1,



                                 1]


y =

[ (- deltat3^2*2778046668940015i +
 33554432*2778046668940015^(1/2)*deltat3 + 281474976710656i)/
(deltat3^2*2778046668940015i + 281474976710656i),

                                                0]
[

                         0, -(deltat3^2*2778046668940015i +
 33554432*2778046668940015^(1/2)*deltat3 - 281474976710656i)/
(deltat3^2*2778046668940015i + 281474976710656i)]


x =

[ (19807040628566084398385987584*((2778046668940015*deltat4^2)/140737488355328
 + (2778046668940015^(1/2)*deltat4*(2778046668940015*deltat4^2 -
 281474976710656)^(1/2))/140737488355328 - 1))/(2778046668940015*(-
 2778046668940015*deltat4^3 + 281474976710656*deltat4))
 - (140737488355328*(2778046668940015*deltat4^2
 - 140737488355328))/(2778046668940015*(-
 2778046668940015*deltat4^3 + 281474976710656*deltat4)), -
 (19807040628566084398385987584*((2778046668940015^(1/2)*deltat4*(2778046668940015
 - 281474976710656)^(1/2))/140737488355328 -
 (2778046668940015*deltat4^2)/140737488355328 + 1))/
(2778046668940015*(- 2778046668940015*deltat4^3 +
 281474976710656*deltat4)) -
 (140737488355328*(2778046668940015*deltat4^2 - 140737488355328))/
```

```
(2778046668940015*(- 2778046668940015*deltat4^3 +
 281474976710656*deltat4))]
[
                                                          1,

                                                 1]

y =

[ 1 - (2778046668940015^(1/2)*deltat4*(2778046668940015*deltat4^2
 - 281474976710656)^(1/2))/140737488355328 -
 (2778046668940015*deltat4^2)/140737488355328,
                                                            0]
[
                                                    0,
 (2778046668940015^(1/2)*deltat4*(2778046668940015*deltat4^2
 - 281474976710656)^(1/2))/140737488355328 -
 (2778046668940015*deltat4^2)/140737488355328 + 1]

ans =

0

ans =

0
```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-1.5
0
0.5
1
1.5
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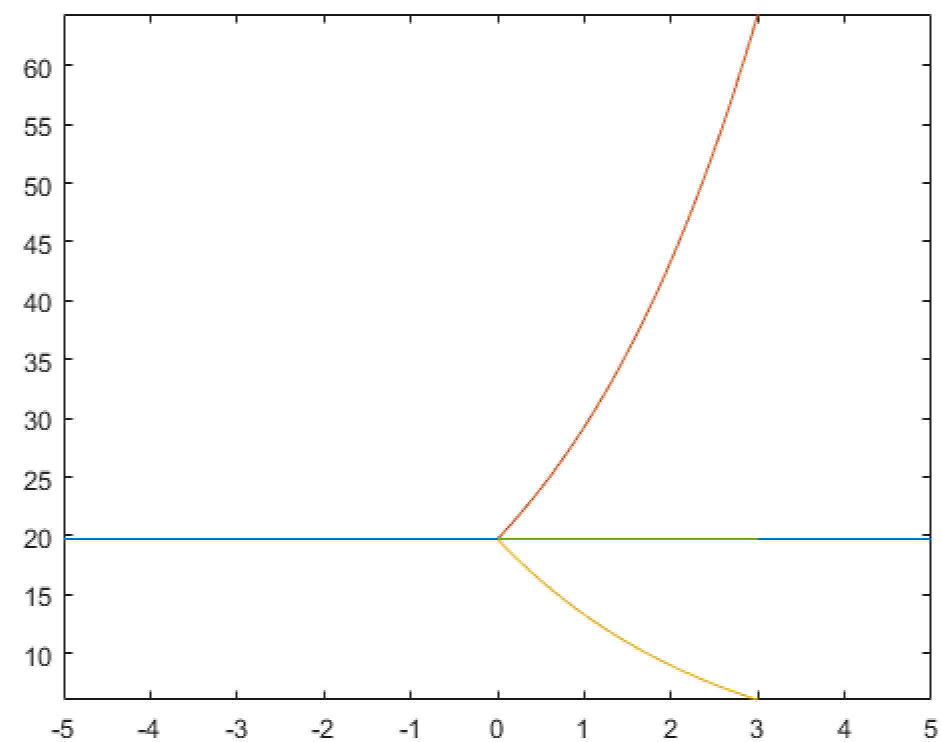
2.5
3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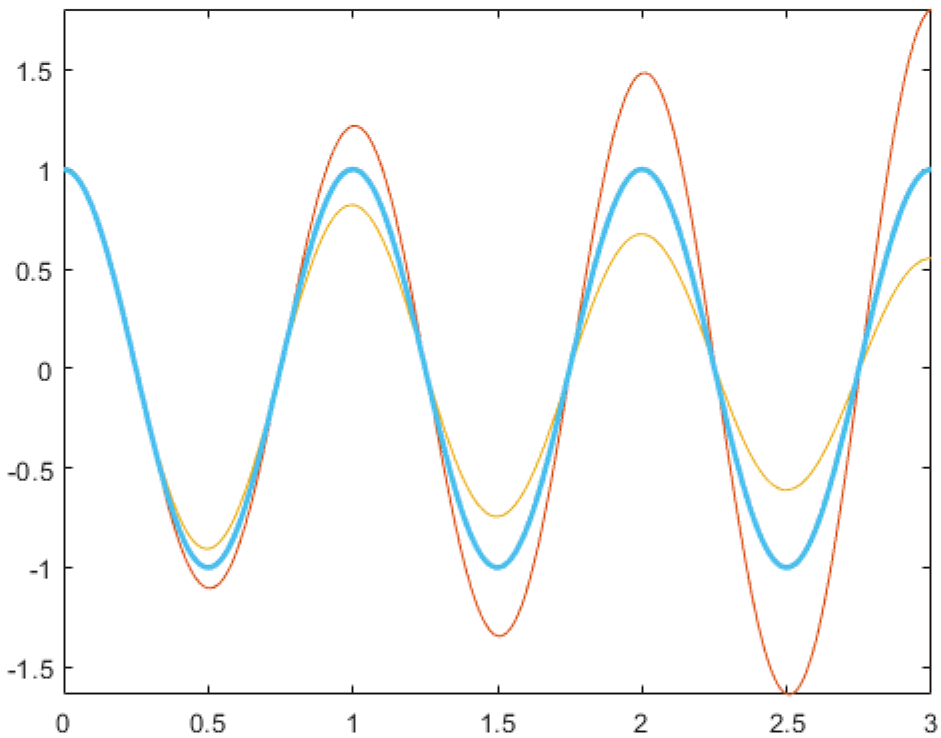
-5
-4
-3
-2
-1
0
1
2
3
4
5



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