Modelli dinamici (Problema 2)
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1 Esercizio 1

1.1 Gli script

Gli script che realizzano la sperimentazione sono i seguenti.

```
y0=[0,1,0,0.8,0,1.2];
slot=[0,10];
l=input('Scegliere fra Eulero h=0.0025 (1), Eulero h=0.00025 (2),
RK h=0.005 (3), RK h=0.0005 (4) ');
if l==1
h=0.0025;
[x,y]=eulero(@pend_sfer2,slot,y0,h);
residuo=max(abs(y(:,1).^2+y(:,2).^2+y(:,3).^2-1))
plot3(y(:,1),y(:,2),y(:,3))
end
if l==2
h=0.00025;
[x,y]=eulero(@pend_sfer2,slot,y0,h);
residuo=max(abs(y(:,1).^2+y(:,2).^2+y(:,3).^2-1))
plot3(y(:,1),y(:,2),y(:,3))
end
if l==3
h=0.005;
[x,y]=RK4(@pend_sfer2,slot,y0,h);
residuo=max(abs(y(1,:).^2+y(2,:).^2+y(3,:).^2-1))
plot3(y(1,:),y(2,:),y(3,:))
end
if l==4
h=0.0005;
[x,y]=RK4(@pend_sfer2,slot,y0,h);
residuo=max(abs(y(1,:).^2+y(2,:).^2+y(3,:).^2-1))
plot3(y(1,:),y(2,:),y(3,:))
end
```

La funzione è così definita:

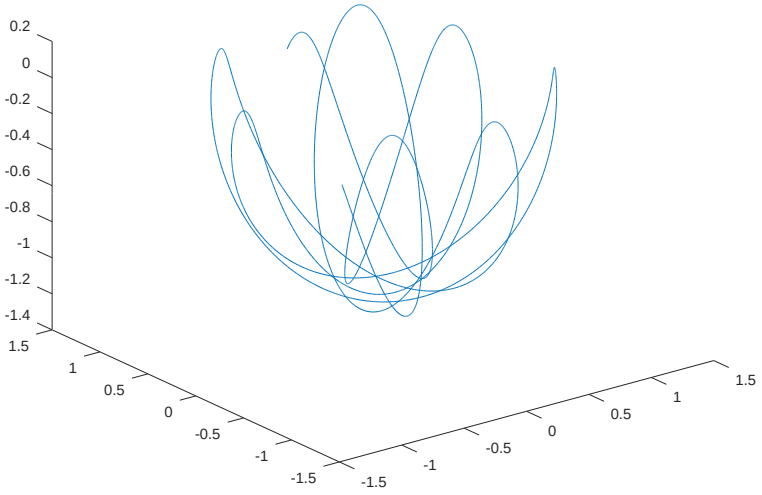
```
function yp=pend_sfer2(x,y)
yp=zeros(1,6);
yp(1)=y(4);
yp(2)=y(5);
yp(3)=y(6);
yp(4)=(-(2*(y(4)^2+y(5)^2+y(6)^2)-2*y(3)*9.8)/
(4*(y(1)^2+y(2)^2+y(3)^2))*2*y(1));
yp(5)=(-(2*(y(4)^2+y(5)^2 + y(6)^2)-2*y(3)*9.8)/
(4*(y(1)^2+y(2)^2+y(3)^2))*2*y(2));
yp(6)=(-9.8-(2*(y(4)^2+y(5)^2+y(6)^2)-2*y(3)*9.8)/
(4*(y(1)^2+y(2)^2+y(3)^2))*2*y(3));
end
```

L'ultimo script riguarda i metodi `ode23` e `ode45`.

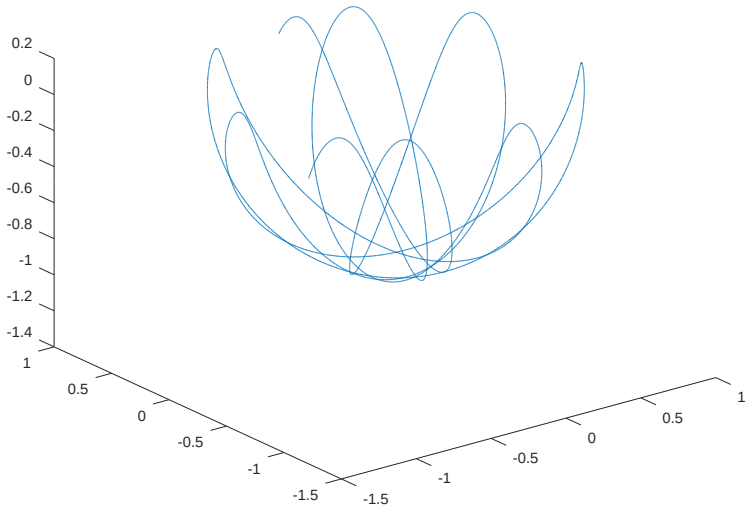
```
y0=[0,1,0,0.8,0,1.2];
slot=[0,10];
l=input('Scegliere fra ode23 (1), ode45 RelTol 10^-3 (2), ode45 RelTol 10^-6 (3)');
if l==1
[x,y]=ode23(@pend_sfer2,slot,y0);
residuo=max(abs(y(:,1).^2+y(:,2).^2+y(:,3).^2-1))
plot3(y(:,1),y(:,2),y(:,3))
end
if l==2
[x,y]=ode45(@pend_sfer2,slot,y0);
residuo=max(abs(y(:,1).^2+y(:,2).^2+y(:,3).^2-1))
plot3(y(:,1),y(:,2),y(:,3))
end
if l==3
[x,y]=ode45(@pend_sfer2,slot,y0, odeset('RelTol', 10^(-6)));
residuo=max(abs(y(:,1).^2+y(:,2).^2+y(:,3).^2-1))
plot3(y(:,1),y(:,2),y(:,3))
end
```

1.2 l grafici

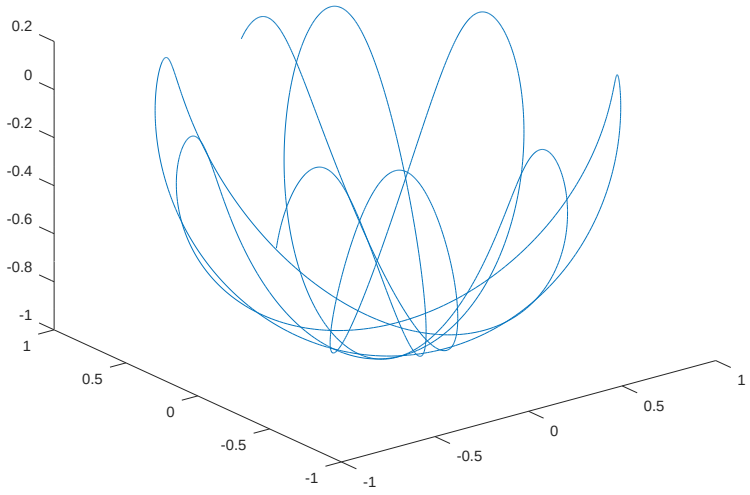
Si riporta il valore massimo del residuo, r_{max}.



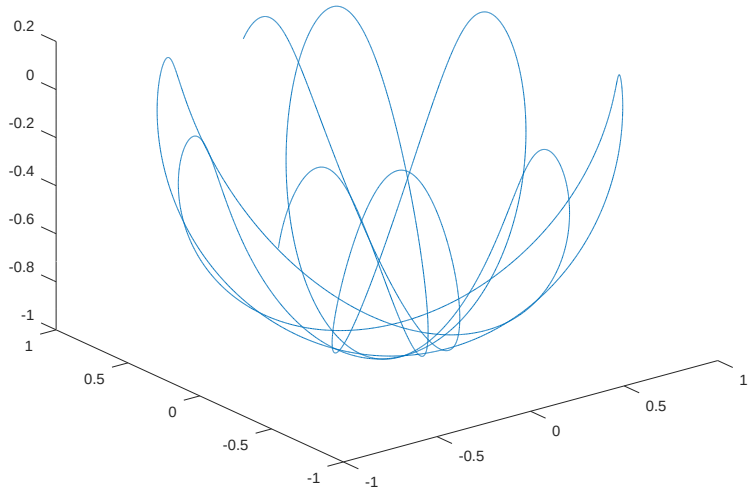
Eulero con $h = 0.0025$, vale che $r_{max} = 0.44791$



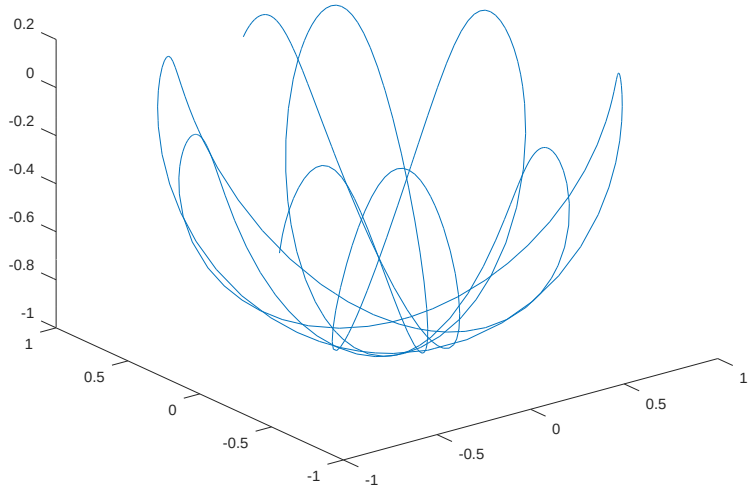
Eulero con $h = 0.00025$, vale che $r_{max} = 0.043485$



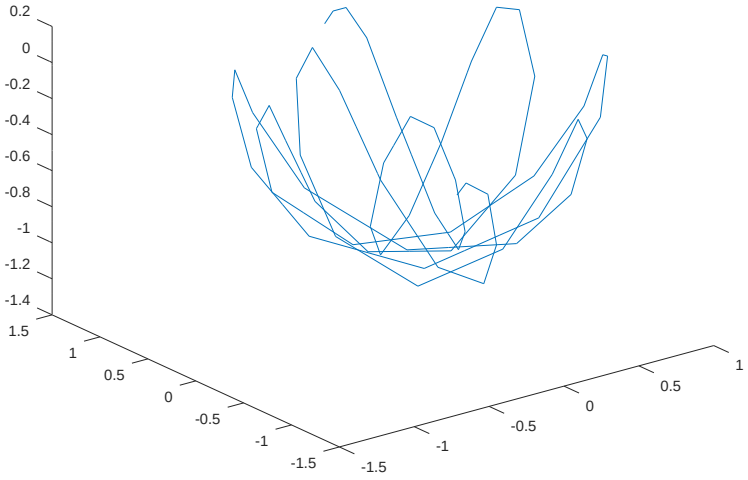
Runge-Kutta con $h = 0.005$, vale che $r_{max} = 4.7988e - 006$



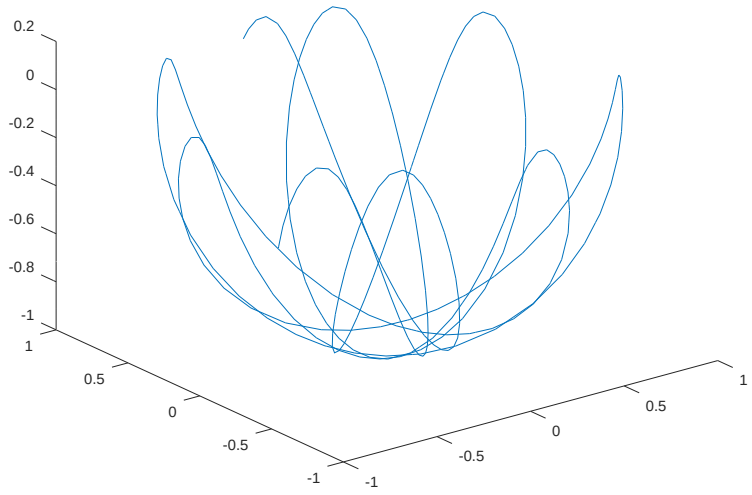
Runge-Kutta con $h = 0.0005$, vale che $r_{max} = 4.7984e - 010$



ode23, vale che $r_{max} = 0.0092088$



ode45 con `RelTol` pari a 10^{-3}, vale che $r_{max} = 0.55712$



ode45 con `RelTol` pari a 10^{-6}, vale che $r_{max} = 1.0655e-004$

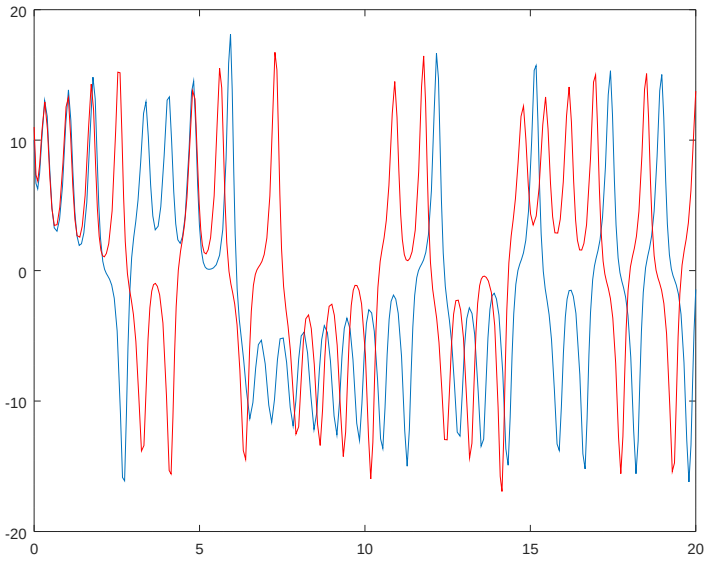
2 Esercizio 2

2.1 Lo script

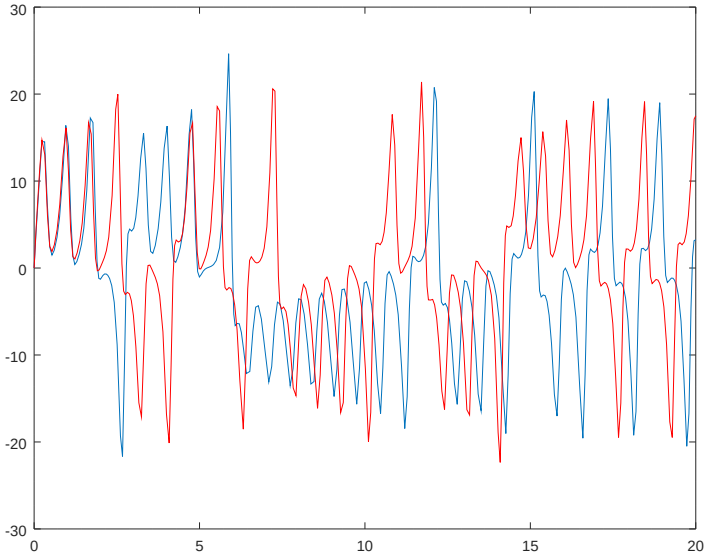
Lo script che realizza la sperimentazione è il seguente

```
sigma=10;
r=28;
b=8/3;
lorentz=@(x,y) [sigma*(y(2)-y(1));r*y(1)-y(2)-y(1)*y(3); y(1)*y(2)-b*y(3)];
y0=[10,0,20];
z0=[11,0,20];
[x,y]=ode45(lorentz,[0, 20],y0);
[w,z]=ode45(lorentz,[0, 20],z0);
l=input('Scegliere il grafico: (x,y1) [1], (x,y2) [2], (x,y3) [3], (y1,y2,y3) [4]');
if l==1
plot(x,y(:,1))
hold on
plot(w,z(:,1),'r')
end
if l==2
plot(x,y(:,2))
hold on
plot(w,z(:,2),'r')
end
if l==3
plot(x,y(:,3))
hold on
plot(w,z(:,3),'r')
end
if l==4
plot3(y(:,1),y(:,2),y(:,3))
hold on
plot3(z(:,1),z(:,2),z(:,3),'r')
end
```

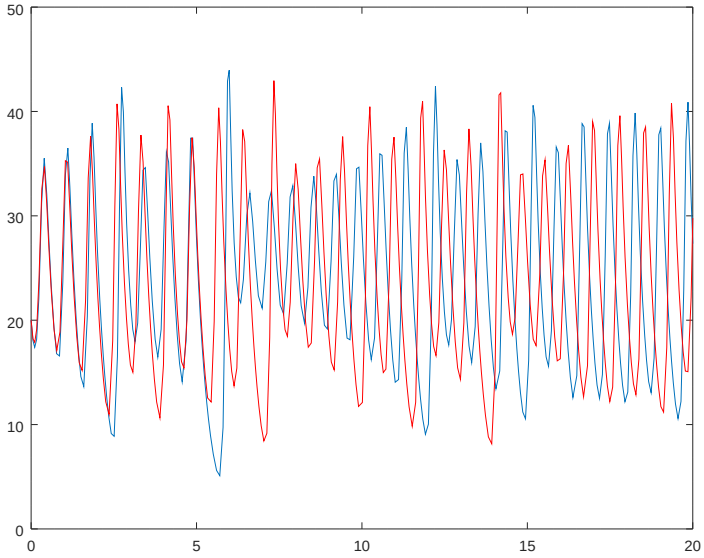
2.2 I grafici



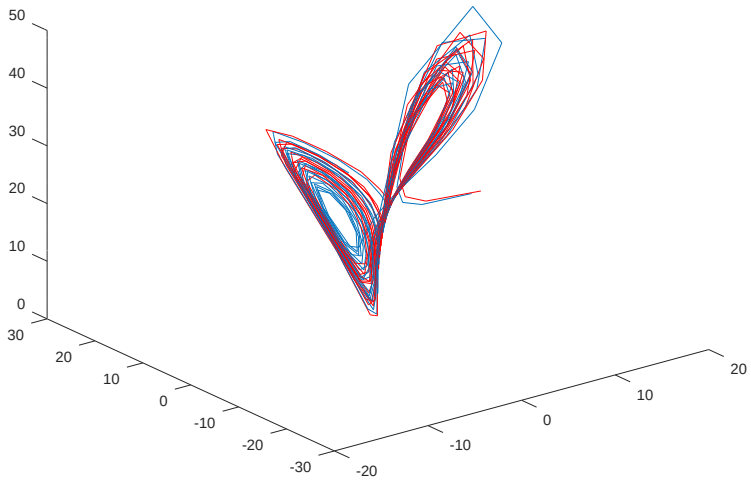
(x, y_1)



(x, y_2)



(x, y_3)



(y_1, y_2, y_3)

3 Esercizio 3

Ho utilizzato due script distinti per realizzare l'esercizio, in quanto Octave non supporta il comando `ode15s`.

3.1 Lo script

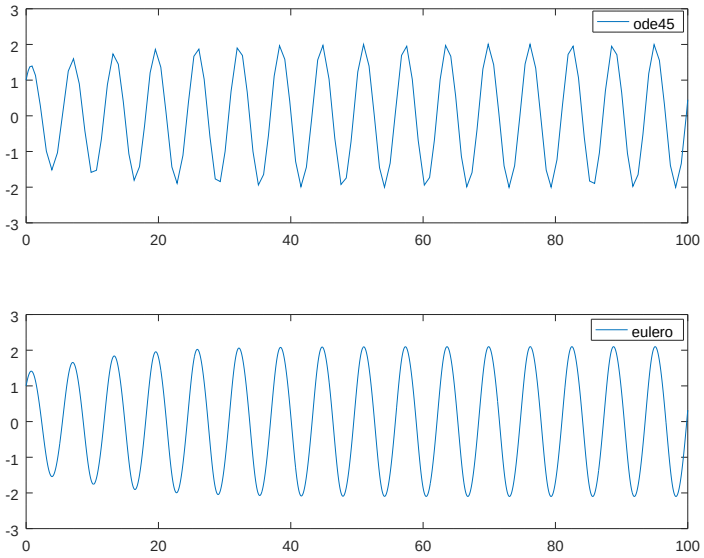
```
mu=input('Scegliere il valore di mu');
slot=[0,100];
y0=[1,1];
f=@(x,y) [y(2), mu*(1-y(1).^2)*y(2)-y(1)];
[x1,y1]=ode45(f,slot,y0);
[x2,y2]=eulero(f,slot,y0, 0.01);
subplot(2, 1, 1)
plot(x1,y1(:, 1));
legend('ode45');
subplot(2, 1, 2)
plot(x2,y2(:, 1));
legend('eulero');
```

Lo script da usare esclusivamente su Matlab è il seguente.

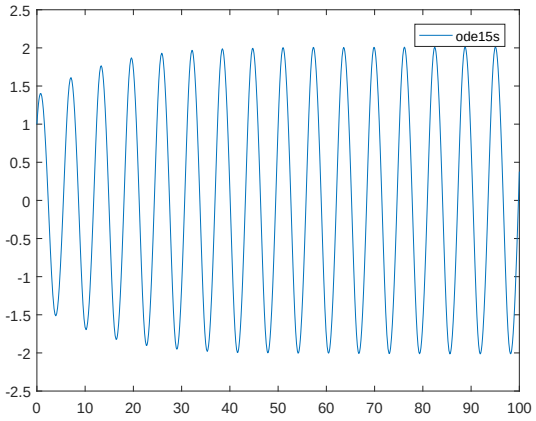
```
%% Provare solo su Matlab
mu=input('Scegliere il valore di mu');
slot=[0,100];
y0=[1,1];
f=@(x,y) [y(2), mu*(1-y(1).^2)*y(2)-y(1)]';
[x,y]=ode15s(f,slot,y0);
figure
plot(x2,y2(:, 1));
legend('ode15s');
```

3.2 I grafici e i commenti

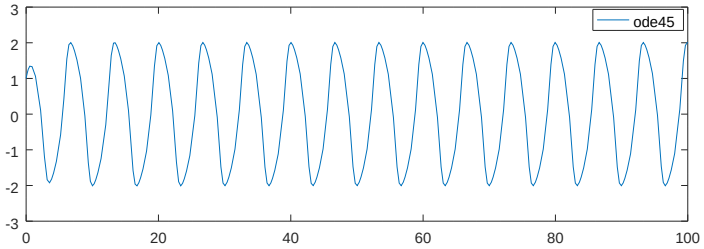
Si nota che il metodo di Eulero fallisce per $\mu = 100$.

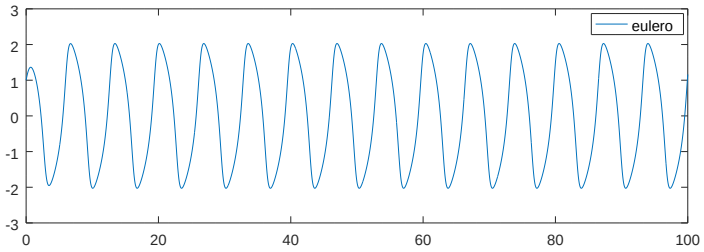


$\mu = 0.1$

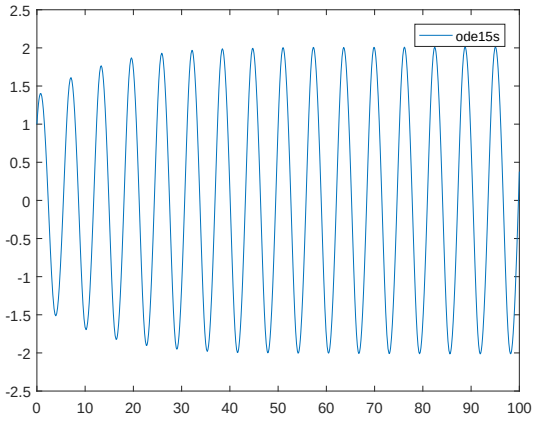


$\mu = 0.1$

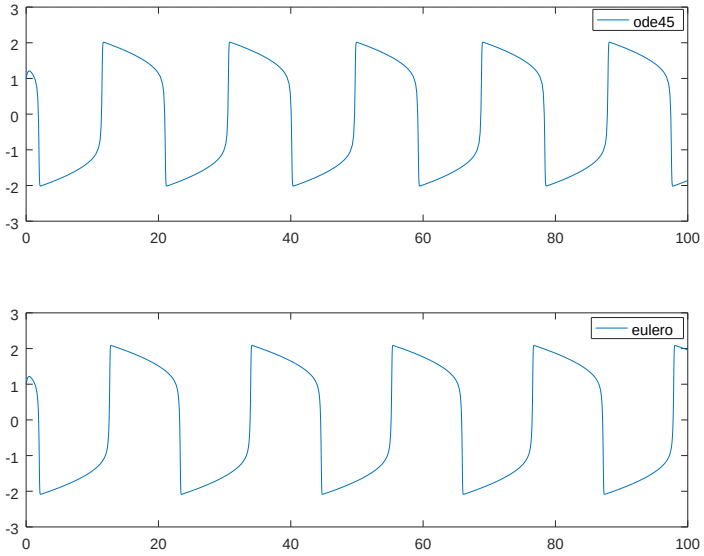




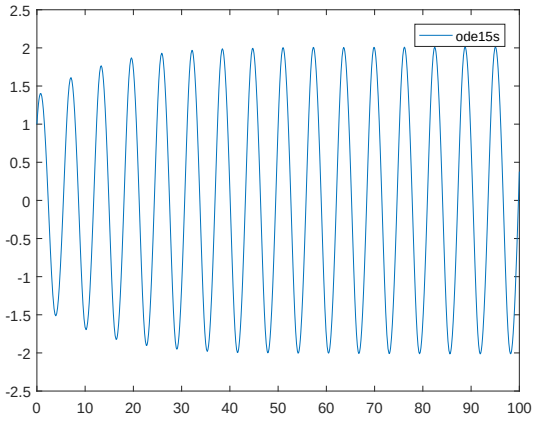
$\mu = 1$



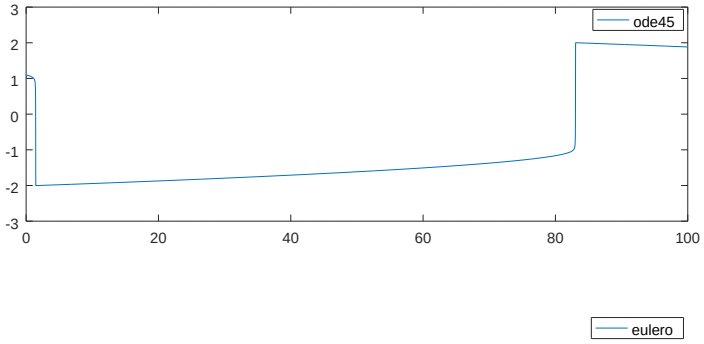
$\mu = 1$



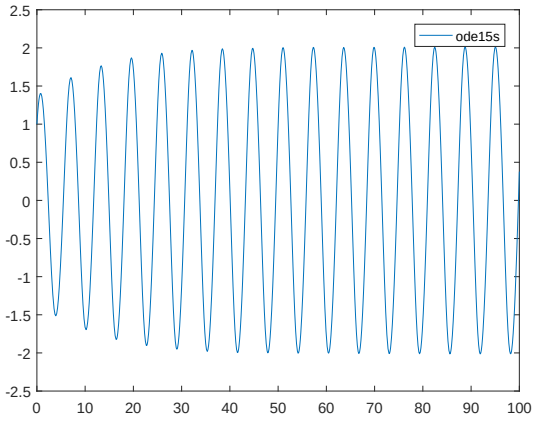
$\mu = 10$



$\mu = 10$



$\mu = 100$



$\mu = 100$