A nonlinear pendulum

Contents

The differential equation:

$$\ddot{\theta} + \omega^2 \sin\theta = 0, \qquad \theta(0) = 0, \qquad \dot{\theta}(0) = 1.$$

The corresponding system of the first order differential equations:

$$\frac{dz_1}{dt} = z_2, \quad \frac{dz_2}{dt} = -\omega^2 \sin(z_1), \quad z_1(0) = 0, \quad z_2(0) = 1$$

Input initial conditions:

```
z0=[0,1];
```

Define the interval on which solution is computed:

```
tspan =[0,20];
```

Solve the system using `ode45` procedure:

```
[t,z] = ode45('ode3',tspan,z0);
```

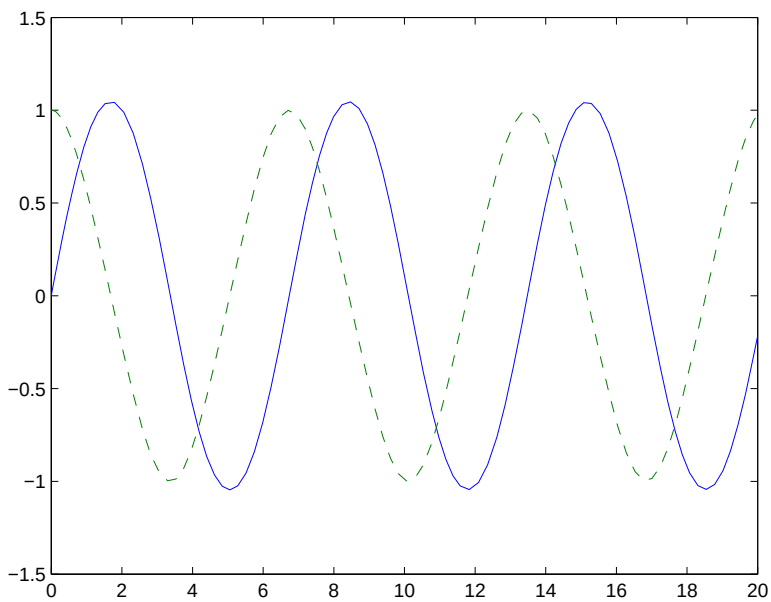
Extract the positions and velocities:

```
x=z(:,1); v=z(:,2);
```

Plots of the positions and velocities as functions of time:

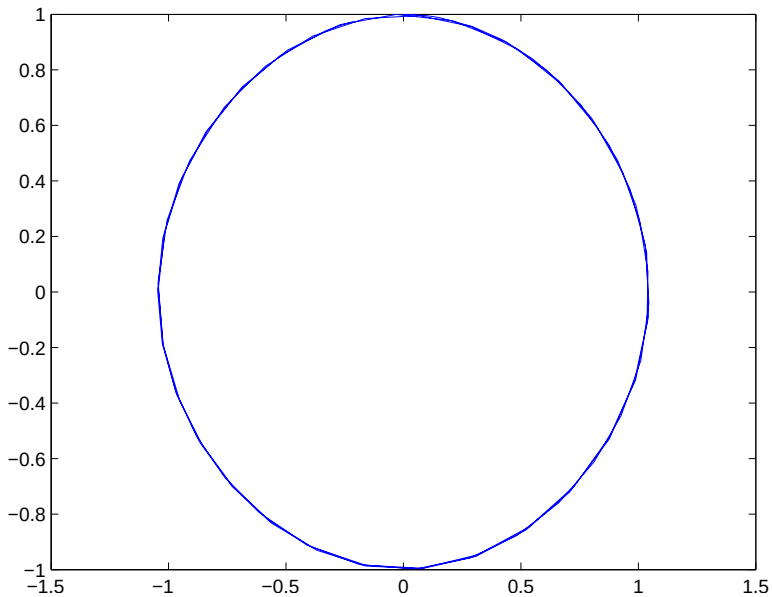
Note: *The dashed curve indicates velocities*

```
plot(t,x,t,v,'--')
```



Plot of the phase portrait (velocity as the function of position):

```
figure(2)
plot(x,v)
```


1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1
−1.5
−1
−0.5
0
0.5
1
1.5