A nonlinear pendulum

Contents

• The differential equation:
• The corresponding system of the first order differential equations:
• Input initial conditions:
• Define the interval on which solution is computed:
• Solve the system using ode45 procedure:
• Extract the positions and velocities:
• Plots of the positions and velocities as functions of time:
• Plot of the phase portrait (velocity as the function of position):

The differential equation:

\[ \ddot{\theta} + \omega^2 \sin \theta = 0, \quad \theta(0) = 0, \quad \dot{\theta}(0) = 1. \]

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:

\[ z_0 = [0,1]; \]

Define the interval on which solution is computed:

\[ t_{\text{span}} = [0,20]; \]

Solve the system using ode45 procedure:

\[ [t,z] = \text{ode45('ode3',t_{\text{span}},z_0);} \]

Extract the positions and velocities:

\[ x = z(:,1); \quad v = z(:,2); \]
Plots of the positions and velocities as functions of time:

Note: *The dashed curve indicates velocities*

\[ \text{plot}(t,x,t,v,'--') \]

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

\[ \text{figure(2)} \]
\[ \text{plot}(x,v) \]