Solving ODEs on Matlab

MATLAB has several built in functions for solving ODEs. Among the various choices, ode23 and ode45 are the mainstay of MATLAB's ODE solving capabilities and should serve well for solving most equations. The most straightforward way of using these functions is given below, in the form of a step-by-step procedure:

- Write the differential equation(s) as a set of first-order ODEs: For ODEs of order>=2, this step involves introducing new variables and equations. Basically you need the equations in vector form:

  - $d\mathbf{X}/dt = \mathbf{F}(\mathbf{X},t)$, where $\mathbf{X} = [\ x_1\ \ x_2\ \ \ldots\ \ x_n\ ]^T$ and,
  - $\mathbf{F} = [\ f1(x_1, x_2, \ldots, x_n, t)\ \ f2(x_1, x_2, \ldots, x_n, t)\ \ \ldots\ fn(x_1, x_2, \ldots, x_n, t)\ ]^T$

- Write a function (say, 'your_function') to compute the state derivative $d\mathbf{X}/dt$. Essentially, you have to write a function whose input is $(t,\mathbf{X})$ (where $\mathbf{X}$ is a column vector) and the output is the column vector $d\mathbf{X}/dt$ (essentially, $[\ f1(x_1, x_2, \ldots, x_n, t)\ \ f2(x_1, x_2, \ldots, x_n, t)\ \ \ldots\ fn(x_1, x_2, \ldots, x_n, t)\ ]^T$)

- Use the built-in solvers (ode23, ode45, etc.) to solve the problem. The most basic syntax for calling these functions is:

  - **[time, solution] = ode23('your_function', tspan, x_o)**
    - Where, tspan is the time span, x_o are the initial conditions.

- Extract the desired variables from the output and interpret the results.