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M-TECH., MEDICAL IMAGING AND INFORMATICS

ROLL – 20MM62R02

PROJECT -1

The Van der Pol equation is a second order nonlinear differential equation and an ordinary differential equation with nonlinear damping. It is defined as:

$$\frac{d^2y}{dt^2} - \mu(1-y^2)\frac{dy}{dt} + y = 0 \ \ for \ \ \mu > 0$$

a) The equation is written as a system of two first-order ordinary differential equations (ODEs). These equations are evaluated for different values of the parameter μ.

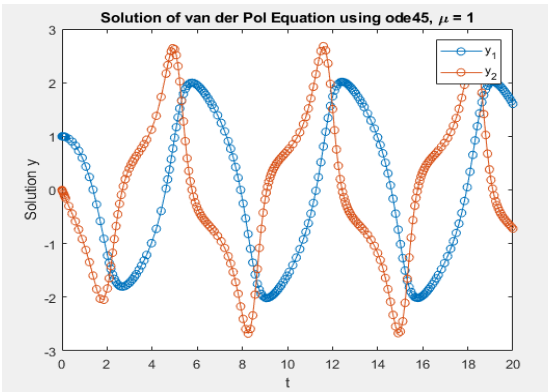
   where μ>0 is a scalar parameter, by making the substitution $y_1' = y_2$ The resulting system of first-order ODEs is

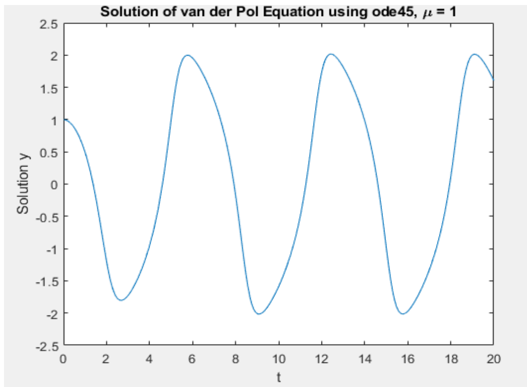
$$y_1' = y_2$$

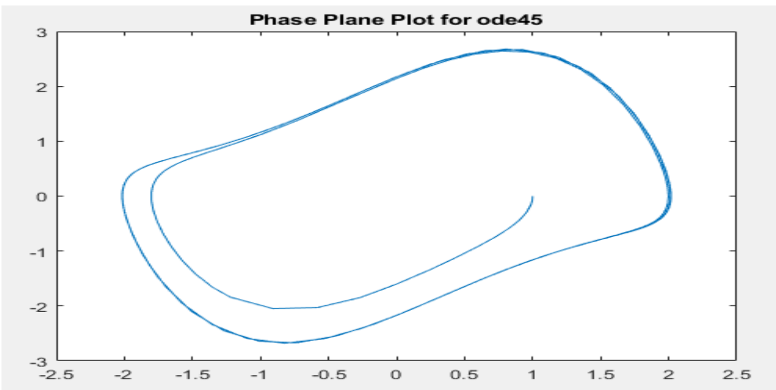
   $y_2' = \mu(1 - y_1^2)y_2 - y_1$

b) Solutions of Van Der Pol equation are shown :

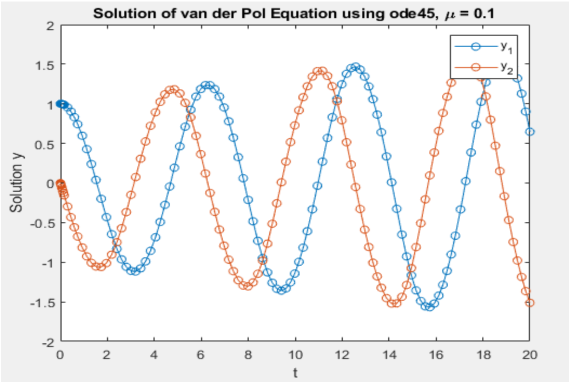
Using **<u>ode45</u>** function and **μ = 1**

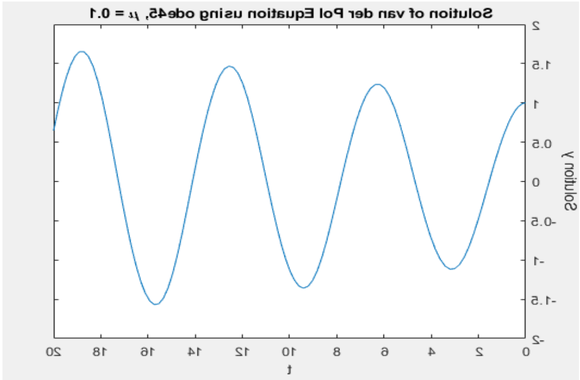


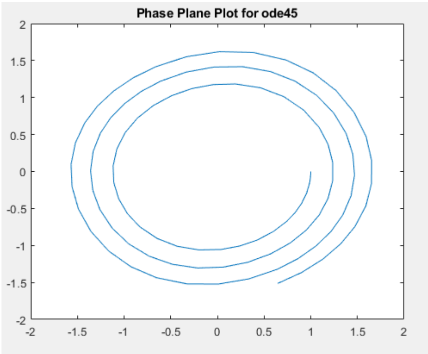




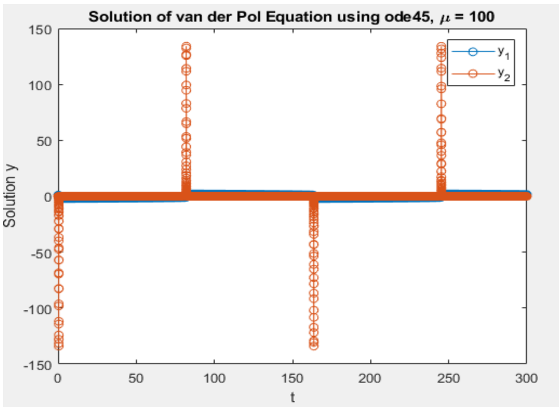
Using ode45 function and μ = 0.1

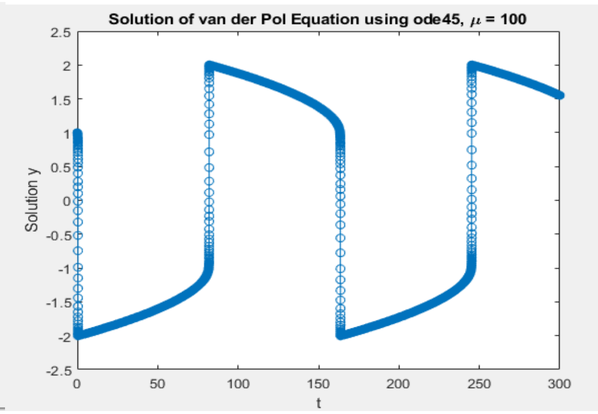


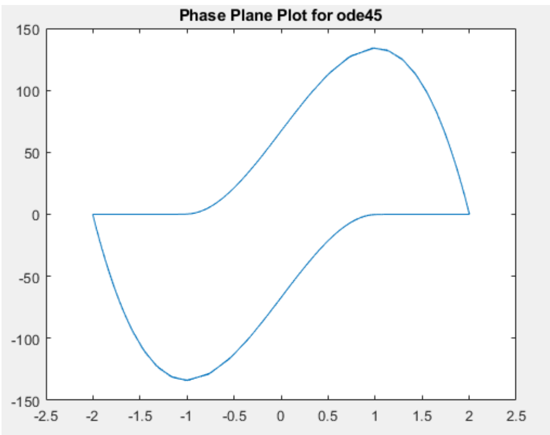




Using ode45 function and μ = 100







When μ>=100 i.e. μ is large, solving The Van der Pol equation using ode45 with the default relative and absolute error tolerances (1e-3 and 1e-6, respectively) is extremely slow, requiring several minutes to solve and plot the solution. The ode45 requires millions of time steps to complete the integration, due to the areas of stiffness where it struggles to meet the tolerances. The enormous number of time steps required to pass through areas of stiffness.

We can overcome this problem of stiffness using ode15s function. The ode15s solver passes through stiff areas with far fewer steps than ode45.

Using ode15s function and μ = 100 (Comparison with ode45)