Project I

Vivek Rai, 12BT30025

a)

Let us make the following substitution $z = \dot{y}/\mu$

After simplification, we obtain the following two ordinary differential equations:

$\dot{z} = \mu(1 - y^2)z - y\mu^{-1}$ and $\dot{y} = z\mu$

c)

Several profile runs reveal that ODE15s runs almost 10x-15x faster than ODE45.

d)

The Van Der Pol oscillator is a non-conservative oscillator. The phase-plane and the time-axis plots from the oscillation reveal the non-linear damping in the oscillator. After running the simulation for several values of μ, we can observe that the system quickly goes into an oscillatory behavior compared to the situation when the value of μ is high. It is the simplest and best understood limit cycle (self-sustaining) that exhibits relaxation behavior, that is, alternating fast and slow time scales. This can be observed from the phase plane plots of the equation, where the curve moves with a slow time constant along the null clines but with a very fast time scale otherwise. This effect is further pronounced by increasing the value of μ which is the non-linearity parameter here.

It has been found that study of ion-channels and generation of action potential, when studied, reveals a model characteristic of this Van Der Pol oscillator. That is, a quick rise in the potential across the membrane in form of a spike and then gradual decay. This pattern is typical yet important feature of a nerve impulse.