Computational Neuroscience Project 1

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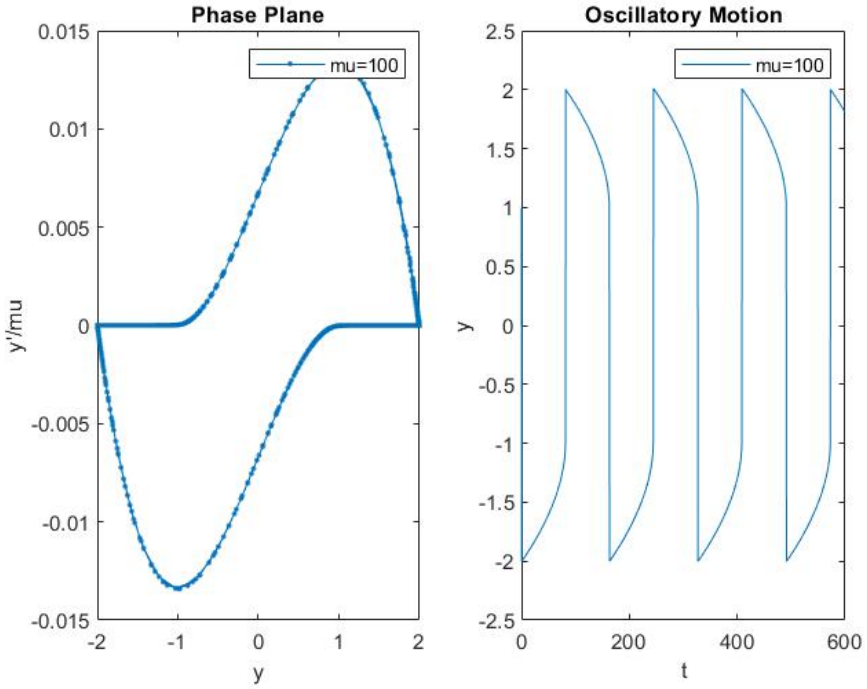
1

Let $\mu^{-1}y' = x_1$ and $y = x_2$. Substitute this in the main equation to get $\mu x_1' - \mu^2(1 - x_2^2)x_1 + x_2 = 0$
Taking 1st differential of x_1 and x_2 gives $\boxed{x_2' = \mu x_1}$ and $\boxed{x_1' = \mu^{-1}y'' = \mu(1 - x_2^2)x_1 - \frac{x_2}{\mu}}$

2

$\mu = 100$ and ode45 is the solver used. Phase plane and oscillatory motion plot



3

$\mu = 100$ - ode15s is about 9 to 10 times faster than ode45
$\mu = 1$ and 0.1 - ode45 is 10 to 11 times faster as the equations with these μ are not stiff

4

μ	steady state after
100	instantly
1	about $\frac{1}{2}$ cycle
0.1	many cycles

5 MATLAB Code for all plots

```
clear;
clc;

%% B and C Testing and Specific Mu

mu = 1; %change to 1 or 0.1 or any other value as needed
y0 = [1; 0]; %initial point
F = @(t,y) [mu*y(2);mu*(1-y(1)^2)*y(2)-y(1)/mu]; %system of ODE equations of x2 and

%% uncomment this code for ode15s solver (and comment out the ode45 code)
%tic
%[t,y]=ode15s(F, [0 500], y0);
%toc

tic
[t,y]=ode45(F, [0 500], y0); %0 to 500 is time range. lower it for 1 and 0.1
toc

%% D Routine to plot solutions

%change mu in legend accordingly

subplot(1,2,1)
plot(y(:,1),y(:,2)/mu,'-'),title('Phase Plane'),legend('mu=100') %state variables a
xlabel("y or x2");
ylabel("y'/mu or x1");
subplot(1,2,2)
plot(t,y(:,1)),title('Oscillatory Motion'),legend('mu=100')
xlabel("t");
ylabel("y");
```