Mathematical Modeling (Home Work # 2)

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$$\ddot{u} + \omega^2 u - \mu \dot{u} + \alpha \dot{u}^3 = 0$$

$$x_1 = u$$

$$x_2 = \dot{u}$$

$$\dot{x}_1 = x_2 \quad (1)$$

$$\dot{x}_2 + \omega^2 x_1 - \mu x_2 + \alpha x_2^3 = 0$$

$$\dot{x}_2 = \mu x_2 - \alpha x_2^3 - \omega^2 x_1 \quad (2)$$

Graphs

Let $w = 0.4$,

$\alpha = 0.2$

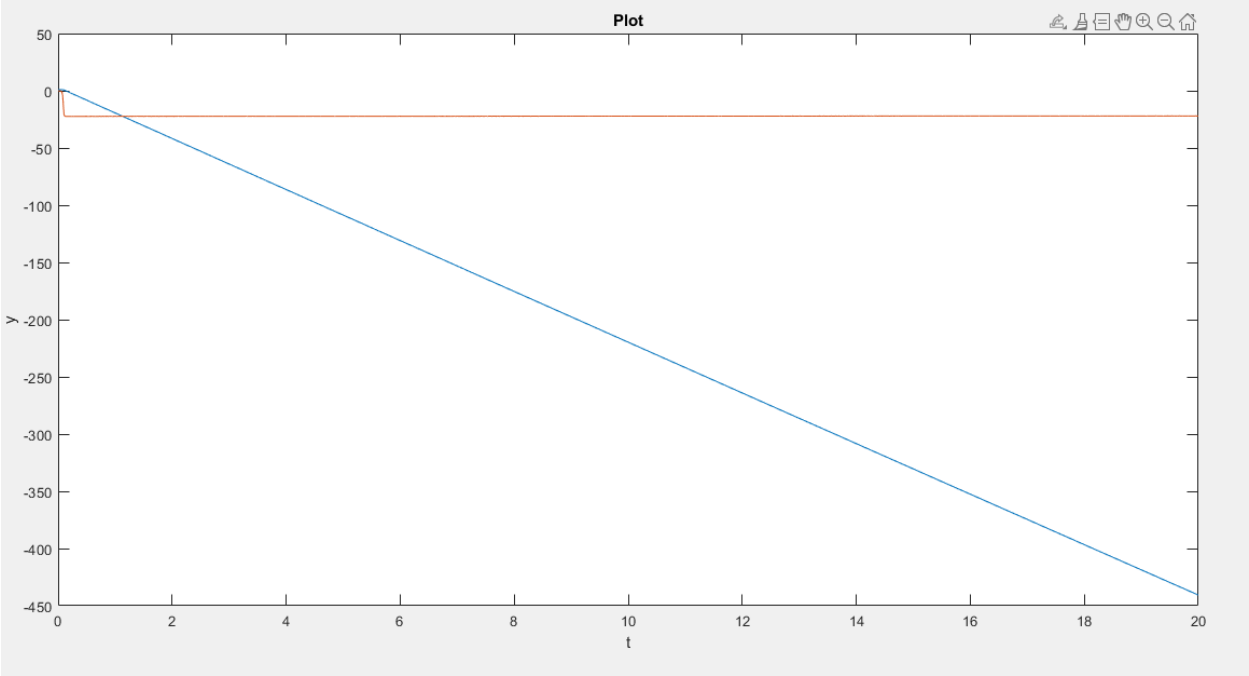
$\mu = 100$

Time Series Plot

Code:

```
[t,y] = ode45(@na,[0 20],[1; 0]);
plot(t,y(:,1),t,y(:,2))
title('Plot');
xlabel('t');
ylabel('y');
```

Initial conditions 1 and 0



Phase Portrait Plots

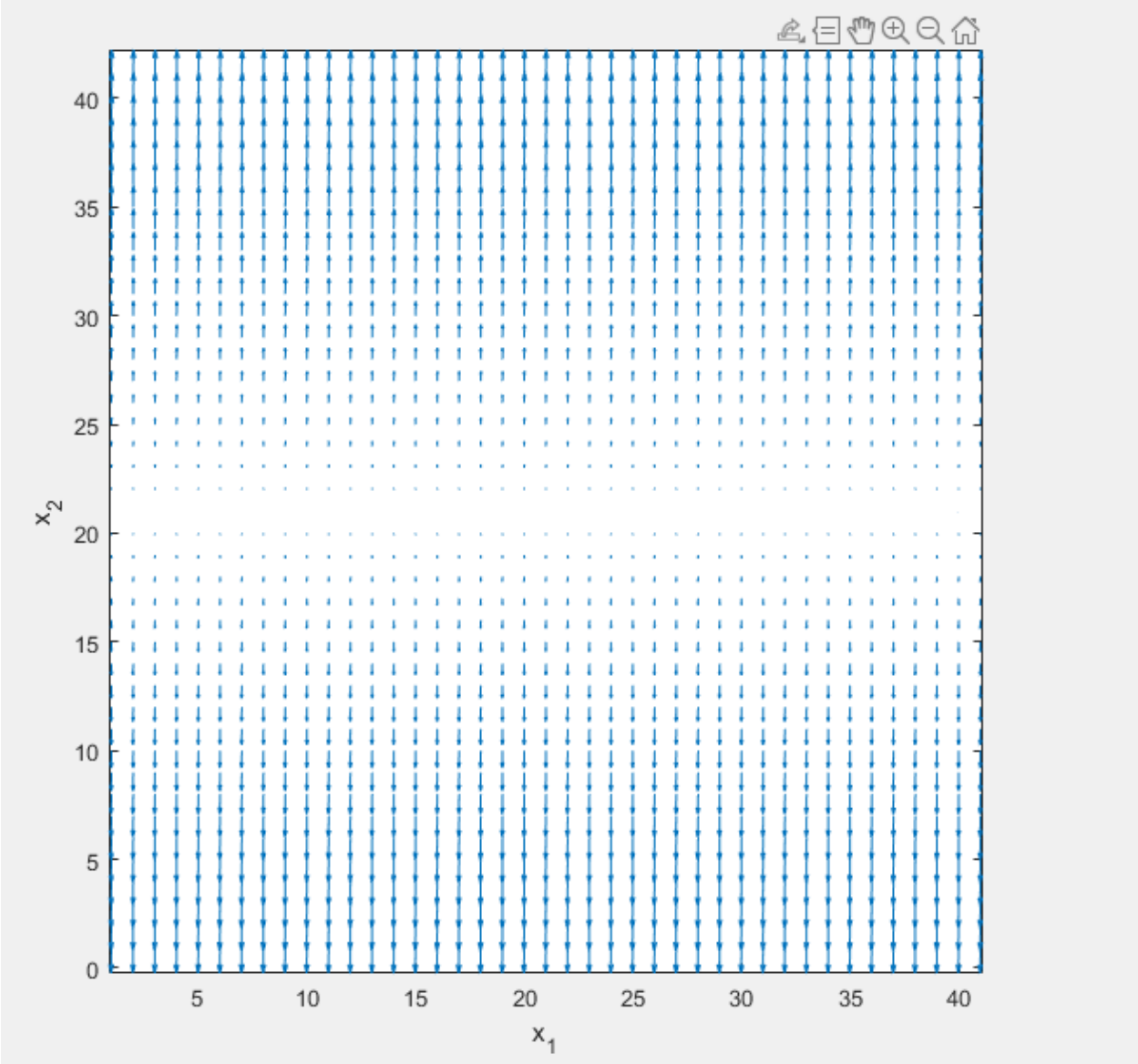
Code:

```
[X1,X2] = meshgrid(-10:0.5:10);

xs = arrayfun(@(x,y) {odeFun([],[x,y])}, X1, X2);
x1s = cellfun(@(x) x(1), xs);
x2s = cellfun(@(x) x(2), xs);

quiver(x1s, x2s)
xlabel('x_1')
ylabel('x_2')
axis tight equal;

function dxdt = odeFun(t,x)
w = 0.4;
mu = 100;
alpha = 0.2
    dxdt(1) = x(2);
    dxdt(2) = mu*x(2) - alpha*x(2)^3 - w^2*x(1);
end
```


40
35
30
25
20
15
10
5
0
x_2
5
10
15
20
25
30
35
40
x_1