# NATIONAL INSTITUTE OF TECHNOLOGY SIKKIM



**CONTROL SYSTEM LABORATORY II**

NAME :- VIKRAM KUMAR

ROLL NO:- B190095EE

SUBJECT:- CONTROL SYSTEM LAB- (II)

SUBJECT CODE:-EE16203

SUBMITTED TO :- DR. KUNTAL MONDAL

SUBMITTED BY:- VIKRAM KUMAR

**EXPERIMENT -1**

**AIM:-** To study the dynamic in the state space of the given system.

**MATLAB CODE:-**

clear all;

clc;

close all;

% Code for Equilibrium point(s),Jacobian Matrix, and Eigenvalues

syms x1 x2

% system is given below

dx1=x2;

dx2=-x1+x1^3/6-x2;

[X Y]=solve(dx1,dx2); % equilibrium point

P=[X Y];

J=jacobian([dx1,dx2],[x1,x2]);

disp('The equilibrium point followed by Jacobian\n')

for i=1:1:length(X)

disp('equilibrium point:')

disp(P(i,:))

Jacobian=double(subs(J,[x1,x2],P(i,:)))

disp('Eigenvalues are')

eigenvalues=eig(Jacobian)

end

**OUTPUT:-**

The equilibrium point followed by Jacobian\n

**equilibrium point**:

[ 0, 0]

**Jacobian** =

0 1

-1 -1

Eigenvalues are

**eigenvalues** =

-0.5000 + 0.8660i

-0.5000 - 0.8660i

**equilibrium point**:

[ 6^(1/2), 0]

**Jacobian** =

0 1

2 -1

Eigenvalues are

**eigenvalues** =

1

-2

**equilibrium point**:

[ -6^(1/2), 0]

**Jacobian** =

0 1

2 -1

Eigenvalues are

**eigenvalues** =

1

-2

**MATLAB CODE:-**

%Vector Field of Van der Pole equation (2D Nonlinear)

function [t,x]=VdP\_vector\_field(~)

clc;clear all;close all;

[x, y]= meshgrid(-4:0.2:4, -4:0.4:4);

global mu; mu=1;

px=y;

py=-x+mu\*(1-x.\*x).\*y;

%plot the results (phase space)

quiver(x,y,px,py,3);

grid on

xlabel('x');ylabel('y');

title('Vector Field of Van der Pol Equation');

tspan = [0 100]';%tspan=[t\_start t\_final];the interval of integration

x0 = [3 3]';%Intial Condition

[t,xx]=ode45(@vdp,tspan,x0);

%Van der Pole equation (in 2 1st order equations) in the form y' = f(t,y)

function dx=vdp(t,x)

dx=[x(2); -x(1)+mu\*(1-x(1)\*x(1))\*x(2)];

end

%plot the results (phase space)

figure(2),plot(xx(:,1),xx(:,2),'r\*');

grid on

xlabel('x');ylabel('y');

title('Phase space of Van der Pol Equation');

end

**OUTPUT:-**





**DISCUSSION:-**

* In non linear system dynamic depends on initial condition.
* Above given system having 3 equilibrium point which having type of equilibrium point is stable focus, saddle point 2 respectively.
* Limit cycle is isolated closed trajectory in the state space.
* When changing the initial condition shape of the limit cycle is also change.
* By changing the value of tspan we can control lighteness of colours.