

Scilab Manual for
Advanced Control Systems
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Contents

List of Scilab Solutions	4
1 To plot the phase portrait of systems having stable and unstable nodes.	6
2 To plot the phase portrait of systems having stable and unstable focus.	11
3 To plot the phase portrait of systems having vortex point.	15
4 To plot the phase portrait of systems having saddle point.	19
5 To demonstrate limit cycles for vander pol's equation.	23
6 To demonstrate the effect of the static nonlinearities.	25
7 To demonstrate the stability of the system using Describing function.	27
8 To demonstrate the stability of the system using Lyapunov equation.	30
9 Stabilization of double integrator system using variable structure control.	32
10 Design the exact feedback linearizing controller for the non linear system.	34
11 To design sliding mode controller for a linear system.	36

12 To demonstrate model reference adaptive control system. 38

List of Experiments

Solution 1.01	Lab01	.....	6
Solution 2.1	Lab02	.....	11
Solution 3.01	Lab03	.....	15
Solution 4.01	Lab04	.....	19
Solution 7.01	Lab07	.....	27
Solution 8.01	Lab08	.....	30

List of Figures

1.1	Lab01	9
1.2	Lab01	10
2.1	Lab02	14
2.2	Lab02	14
3.1	Lab03	17
3.2	Lab03	18
4.1	Lab04	21
4.2	Lab04	22
5.1	Lab05	24
6.1	Lab06	26
6.2	Lab06	26
7.1	Lab07	29
9.1	Lab09	33
10.1	Lab10	35
11.1	Lab11	37
11.2	Lab11	37
12.1	Lab12	39

Experiment: 1

To plot the phase portrait of systems having stable and unstable nodes.

Scilab code Solution 1.01 Lab01

```
1 //Lab. 01: To plot the phase portrait of systems
   having stable and unstable nodes.
2
3 //scilab - 5.5.0
4 // Operating System : Windows 7, 32-bit
5
6 clc;
7 clear all;
8 clf;
9
10 //System transfer function
11 s=poly(0, 's');
12 g=1/(s^2+3*s+2);
13
14 //Draw pole zero map of the system
15 plzr(g);
16 title('Pole-zero map of the system with real stable
```

```

    eigen values ', 'fontsize',3)
17 //Convert the given transfer function into state
    space form
18 sys=tf2ss(g);
19
20 //Plot of system phase trajectory
21 sys.c=[1,0;0,1];
22 sys.d=[0 0]';
23
24 t=0:0.2:10;
25 a1=size(t);
26 u=zeros(a1(1),a1(2));
27 figure
28 for i=-2.0:0.5:2;
29     for j=-2:0.5:2;
30         y1=csim(u,t,sys,[i,j]');
31         plot(y1(1,:),y1(2,:));
32     end
33 end
34
35 set(gca(),"grid",[0.3 0.3])
36 title('Phase portrait of the system with stable node
    ', 'fontsize',3)
37 xlabel('x1(t)', 'fontsize',2)
38 ylabel('x2(t)', 'fontsize',2)
39 f=get("current_figure") //Current figure handle
40 f.background=8
41 //System transfer function
42 s=poly(0,'s');
43 g=1/(s^2-3*s+2);
44
45 // Draw pole zero map of the system
46 figure;
47 plzr(g);
48 title('Pole-zero map of the system with real
    unstable eigen values ', 'fontsize',3)
49 f=get("current_figure") //Current figure handle
50 f.background=8

```



```

51 //Convert the given transfer function into state
    space form
52 sys=tf2ss(g);
53
54 //Plot of system phase trajectory
55 sys.c=[1,0;0,1];
56 sys.d=[0 0]';
57
58 a1=size(t);
59 u=zeros(a1(1),a1(2));
60 figure
61 for i=-2.0:0.5:2;
62     for j=-2:0.5:2;
63         y1=csim(u,t,sys,[i,j]');
64         plot(y1(1,:),y1(2,:));
65     end
66 end
67 set(gca(),"grid",[0.3 0.3])
68 f=get("current_figure") //Current figure handle
69 f.background=8
70 zoom_rect([-5,-5,5,5])
71 title('Phase portrait of the system with unstable
        node','fontsize',3)
72 xlabel('x1(t)','fontsize',2)
73 ylabel('x2(t)','fontsize',2)

```

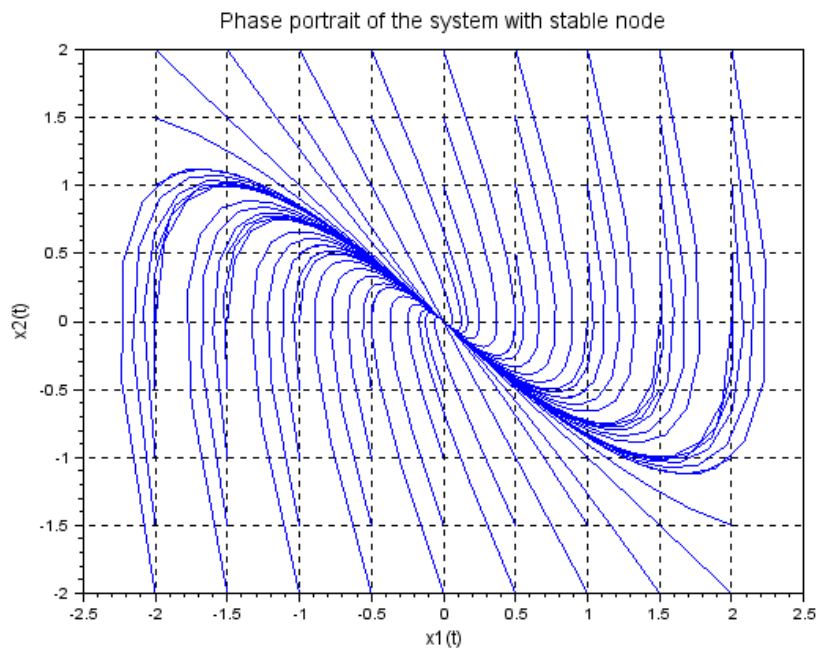


Figure 1.1: Lab01

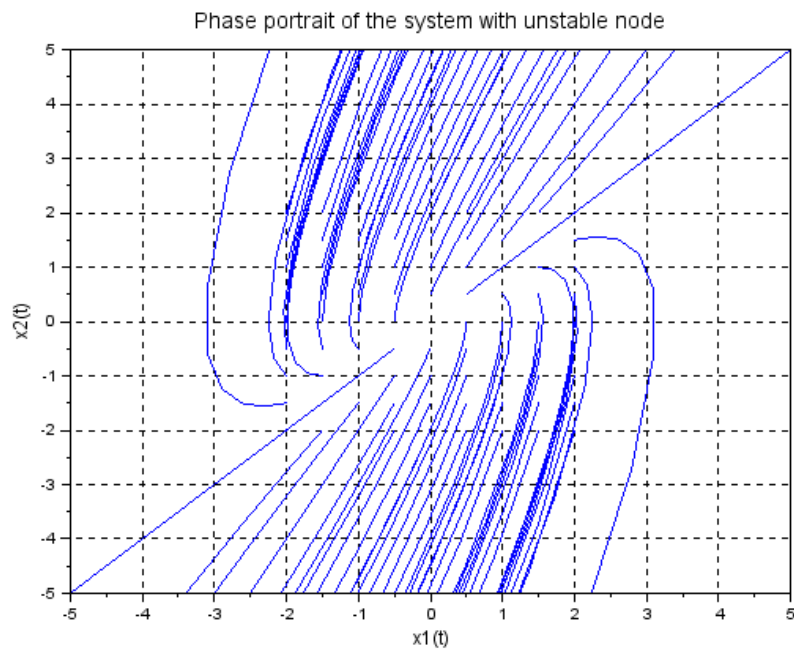


Figure 1.2: Lab01

Experiment: 2

To plot the phase portrait of systems having stable and unstable focus.

Scilab code Solution 2.1 Lab02

```
1 //Lab. 02: To plot the phase portrait of systems
   having stable and unstable focus point.
2
3 //scilab - 5.5.0
4 // Operating System : Windows 7, 32-bit
5
6 clc;
7 clear all;
8 clf;
9
10 //System transfer function
11 s=poly(0, 's');
12 g=1/(s^2+s+1);
13
14 // Draw pole zero map of the system
15 plzr(g);
16 title('Pole-zero map of the system with stable
```

```

    underdamped eigen values ', 'fontsize', 3)
17 //Convert the given transfer function into state
    space form
18 sys=tf2ss(g);
19
20 //Plot of system phase trajectory
21 sys.c=[1,0;0,1];
22 sys.d=[0 0]';
23
24 t=0:0.2:10;
25 a1=size(t);
26 u=zeros(a1(1),a1(2));
27 figure
28 for i=-2.0:0.5:2;
29     for j=-2:0.5:2;
30 y1=csim(u,t,sys,[i,j]');
31 plot(y1(1,:),y1(2,:));
32 end
33 end
34 set(gca(),"grid",[0.3 0.3])
35 f=get("current_figure") //Current figure handle
36 f.background=8
37 title('Phase portrait of the system with stable
    focus ', 'fontsize', 3)
38 xlabel('x1(t)', 'fontsize', 2)
39 ylabel('x2(t)', 'fontsize', 2)
40
41 //System transfer function
42 s=poly(0, 's');
43 g=1/(s^2-s+1);
44
45 //Convert the given transfer function into state
    space form
46 sys=tf2ss(g);
47
48 // Draw pole zero map of the system
49 figure;
50 plzr(g);

```

```

51 f=get("current_figure") //Current figure handle
52 f.background=8
53 title('Pole-zero map of the system with negatively
        damped eigen values','fontsize',3)
54 //Plot of system phase trajectory
55 sys.c=[1,0;0,1];
56 sys.d=[0 0]';
57
58 a1=size(t);
59 u=zeros(a1(1),a1(2));
60 figure
61 for i=-2.0:0.5:2;
62     for j=-2:0.5:2;
63 y1=csim(u,t,sys,[i,j]');
64 plot(y1(1,:),y1(2,:));
65 end
66 end
67 set(gca(),"grid",[0.3 0.3])
68 f=get("current_figure") //Current figure handle
69 f.background=8
70 zoom_rect([-5,-5,5,5])
71 title('Phase portrait of the system with unstable
        focus ','fontsize',3)
72 xlabel('x1(t)','fontsize',2)
73 ylabel('x2(t)','fontsize',2)

```

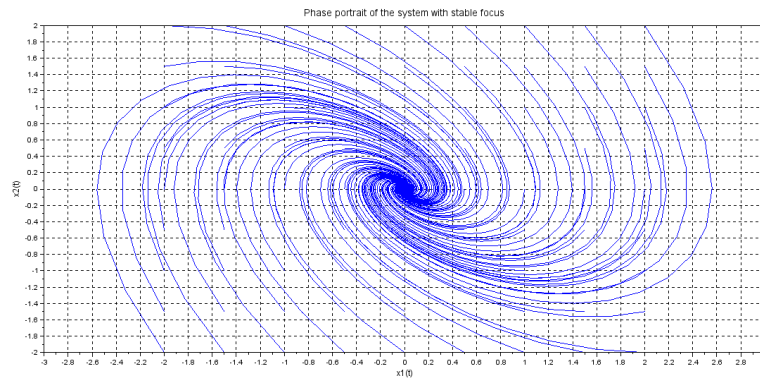


Figure 2.1: Lab02

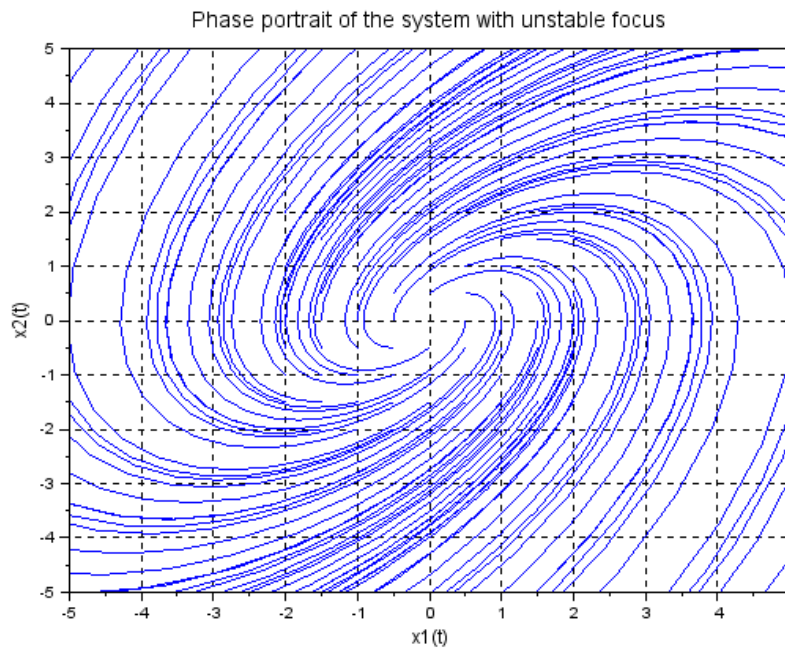


Figure 2.2: Lab02

Experiment: 3

To plot the phase portrait of systems having vortex point.

Scilab code Solution 3.01 Lab03

```
1 //Lab. 03: To plot the phase portrait of systems
   having vortex point.
2
3 //scilab - 5.5.0
4 // Operating System : Windows 7, 32-bit
5
6 clc;
7 clear all;
8 clf;
9
10 //System transfer function
11 s=poly(0, 's');
12 g=1/(s^2+4);
13
14 // Draw pole zero map of the system
15 plzr(g);
16 title('Pole-zero map of the system with critically
   damped eigen values ', 'fontsize',3)
17 //Convert the given transfer function into state
```



```

        space form
18 sys=tf2ss(g);
19
20 //Plot of system phase trajectory
21 sys.c=[1,0;0,1];
22 sys.d=[0 0]';
23
24 t=0:0.2:10;
25 a1=size(t);
26 u=zeros(a1(1),a1(2));
27 figure
28 for i=-2.0:0.5:2;
29     for j=-2:0.5:2;
30 y1=csim(u,t,sys,[i,j]');
31 plot(y1(1,:),y1(2,:));
32 end
33 end
34 set(gca(),"grid",[0.3 0.3])
35 f=get("current_figure") //Current figure handle
36 f.background=8
37 title('Phase portrait of the system with vortex
        point','fontsize',3)
38 xlabel('x1(t)','fontsize',2)
39 ylabel('x2(t)','fontsize',2)

```

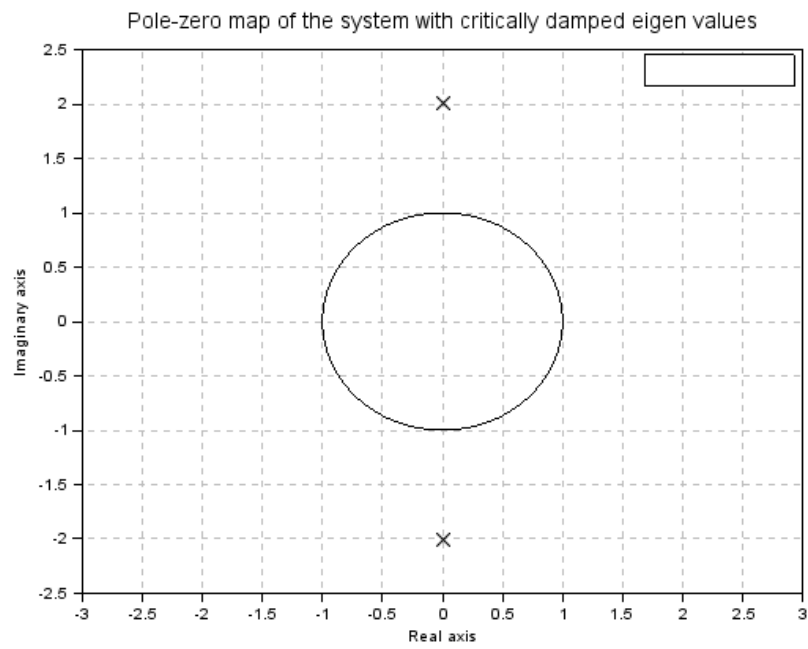


Figure 3.1: Lab03

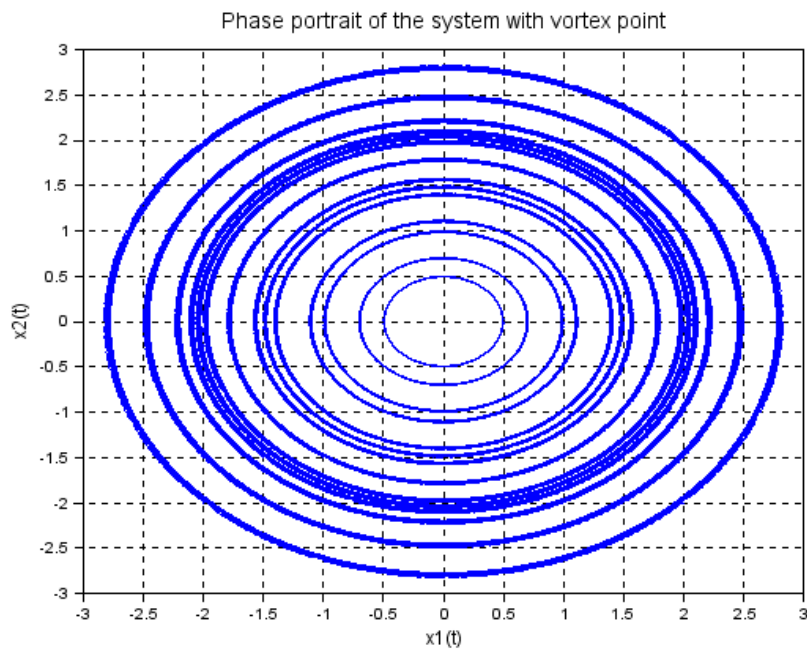


Figure 3.2: Lab03

Experiment: 4

To plot the phase portrait of systems having saddle point.

Scilab code Solution 4.01 Lab04

```
1 //Lab. 04: To plot the Phase portrait of systems
   having saddle point.
2
3 //scilab - 5.5.0
4 // Operating System : Windows 7, 32-bit
5
6 clc;
7 clear all;
8 clf;
9
10 //System transfer function
11 s=poly(0, 's');
12 g=1/(s^2+1*s-2);
13
14 //Convert the given transfer function into state
   space form
15 sys=tf2ss(g);
16
17 // Draw pole zero map of the system
```

```

18 plzr(sys);
19 title('Pole-zero map of the system with real stable
      and unstable eigen values','fontsize',3)
20 //Plot of system phase trajectory
21 sys.c=[1,0;0,1];
22 sys.d=[0 0]';
23
24 t=0:0.2:5;
25 a1=size(t);
26 u=zeros(a1(1),a1(2));
27 figure;
28 for i=-2.0:0.5:2;
29     for j=-2:0.5:2;
30 y1=csim(u,t,sys,[i,j]');
31 plot(y1(1,:),y1(2,:));
32 end
33 end
34 set(gca(),"grid",[0.3 0.3])
35 f=get("current_figure") //Current figure handle
36 f.background=8
37 zoom_rect([-3,-3,3,3])
38 title('Phase portrait of the system with saddle
      point','fontsize',3)
39 xlabel('x1(t)','fontsize',2)
40 ylabel('x2(t)','fontsize',2)

```

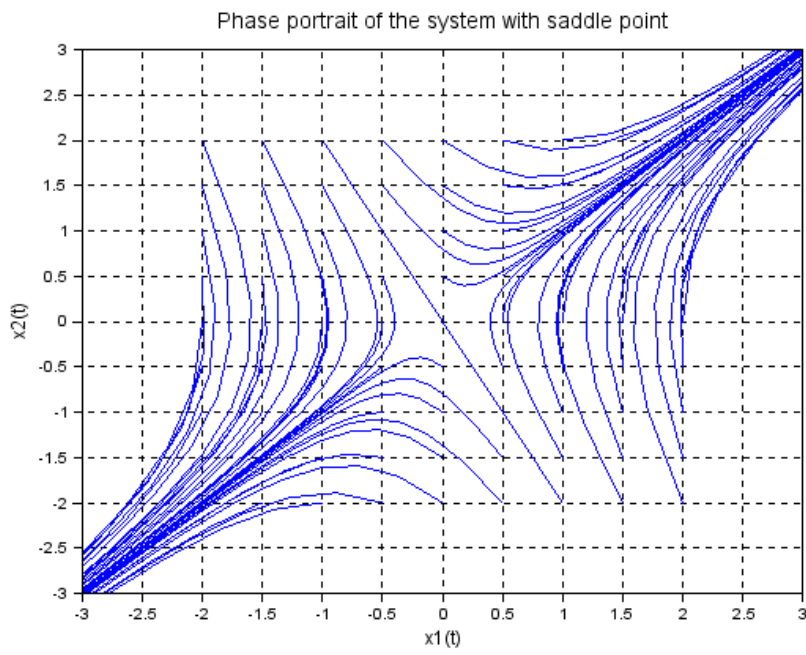


Figure 4.1: Lab04

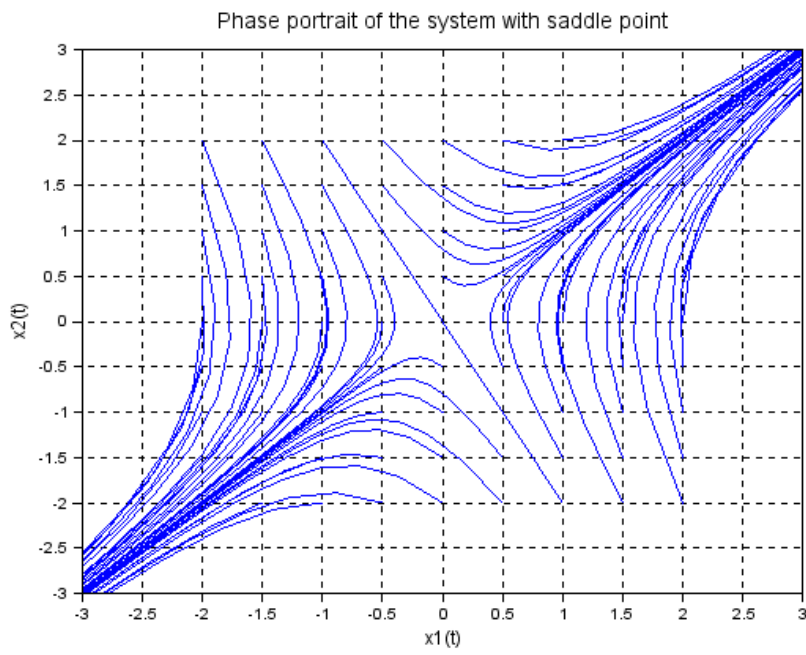


Figure 4.2: Lab04

Experiment: 5

To demonstrate limit cycles for vander pol's equation.

This code can be downloaded from the website www.scilab.in

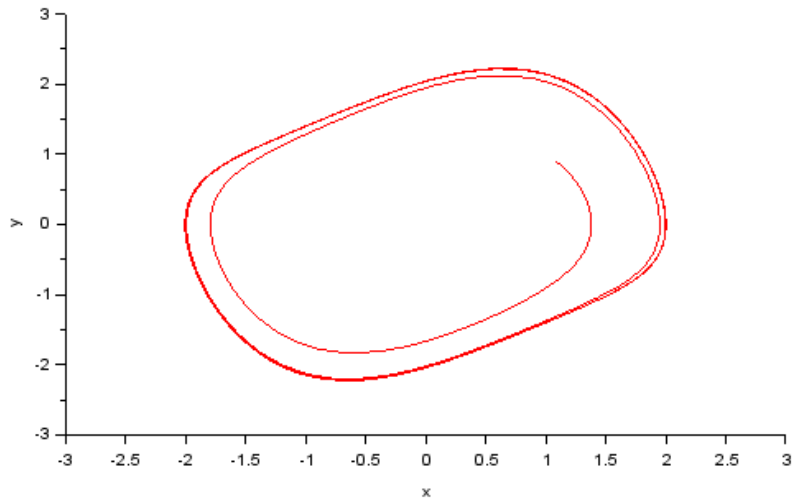


Figure 5.1: Lab05

Experiment: 6

**To demonstrate the effect of
the static nonlinearities.**

This code can be downloaded from the website www.scilab.in

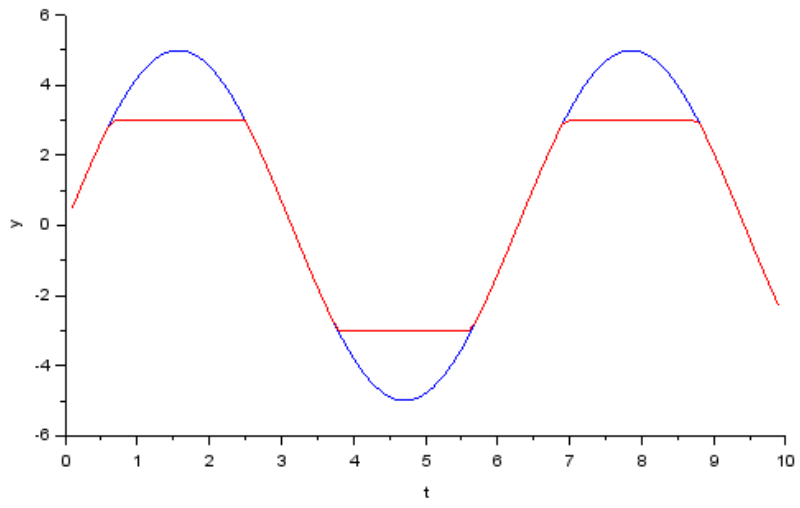


Figure 6.1: Lab06

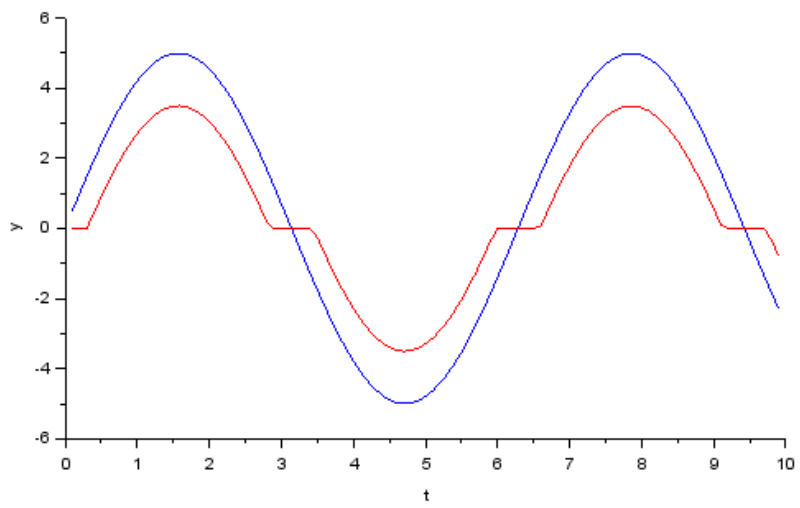


Figure 6.2: Lab06

Experiment: 7

To demonstrate the stability of the system using Describing function.

Scilab code Solution 7.01 Lab07

```
1 //Lab. 08: To check the stability of the system
   using Describing Functions.
2
3 //scilab - 5.5.0
4 // Operating System : Windows 7, 32-bit
5
6 clc;
7 clear all;
8
9 // Frequency Bounds
10
11 wmin=1;
12 wmax=100;
13 fmin=wmin/2/%pi;
14 fmax=wmax/2/%pi;
15
16 //System Model
```

```

17
18 s=poly(0,'s');
19 g1=syslin('c',10/(0.5*s^3+1.5*s^2+s))
20
21 //Nyquist Plot
22
23 nyquist(g1,fmin,fmax)
24
25
26 // Plot of Describing Function of Relay with
    Deadzone Nonlinearity
27 x=1:0.5:10;
28 n=(2/%pi)*(asin(1 ./x)+(1 ./x) .* sqrt(1-(1 ./x)
    .^2));
29 n1=-1 ./n;
30 z=size(n1);
31 plot2d(n1,zeros(1,z(2)),2)
32
33 h=legend(['DF Contour';'System Contour'])

```

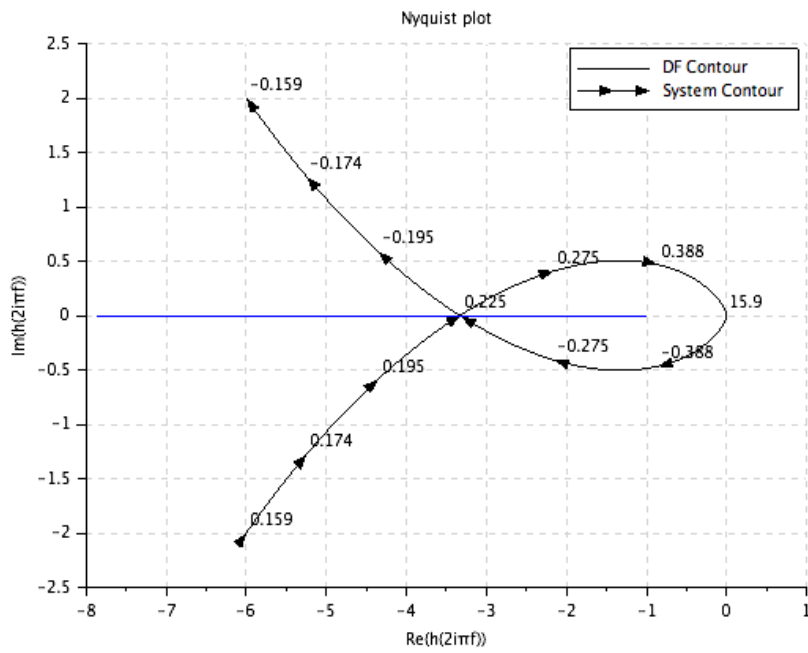


Figure 7.1: Lab07

Experiment: 8

To demonstrate the stability of the system using Lyapunov equation.

Scilab code Solution 8.01 Lab08

```
1 //Lab. 08: To check the stability of the system
   using Lyapunov equation.
2
3 //scilab - 5.5.0
4 // Operating System : Windows 7, 32-bit
5
6 clc;
7 clear all;
8
9 //System model
10
11 a=[0 1 0;0 0 1;-2 -3 -2];
12 q=-eye(3,3);
13 p=lyap(a,q,'c');
14
15 // For a stable system matrix p should be positive
   definite for
```

```
16 //which all the principle minors or all eigen values
    of the matrix p should be positive
17 eig_val=spec(p);
18 m=length(eig_val);
19 stable=0;
20 for i=1:m;
21     if real(eig_val(i))>0 then
22         stable=stable+1;
23     end
24 end
25 if stable==m then
26     disp('The system is asymptotically stable')
27 else
28     disp('The system is unstable or critically
        stable ')
29 end
```

Experiment: 9

Stabilization of double integrator system using variable structure control.

This code can be downloaded from the website www.scilab.in

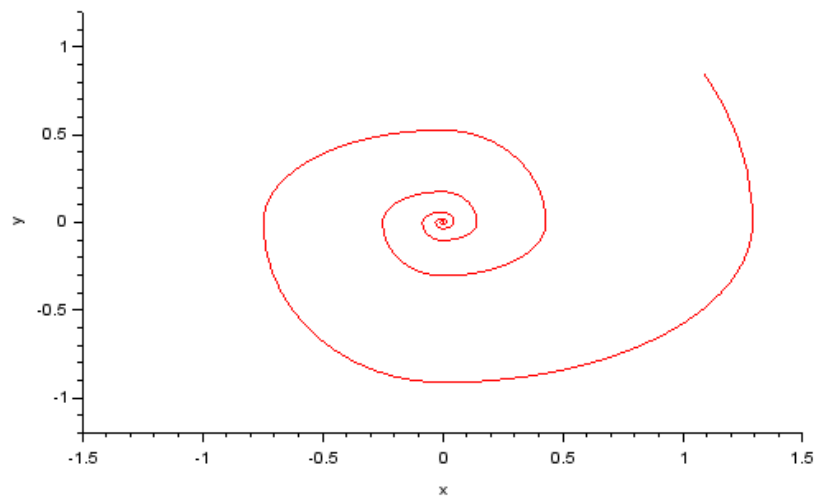


Figure 9.1: Lab09

Experiment: 10

Design the exact feedback linearizing controller for the non linear system.

This code can be downloaded from the website www.scilab.in

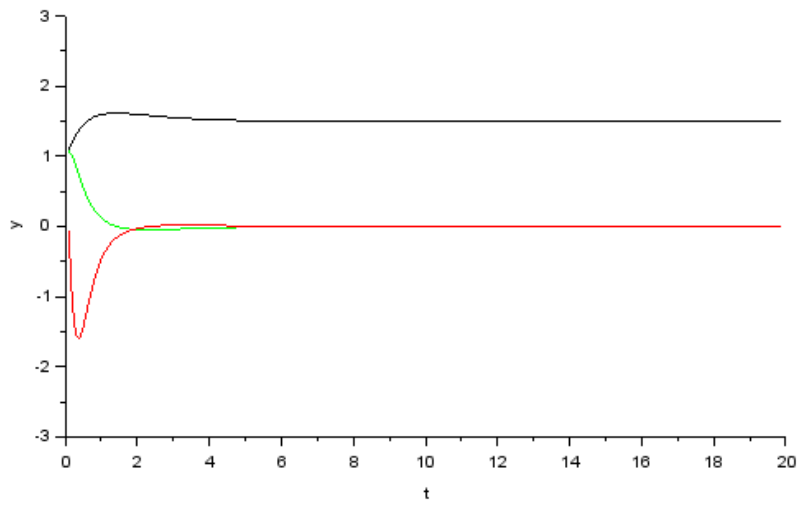


Figure 10.1: Lab10

Experiment: 11

**To design sliding mode
controller for a linear system.**

This code can be downloaded from the website www.scilab.in

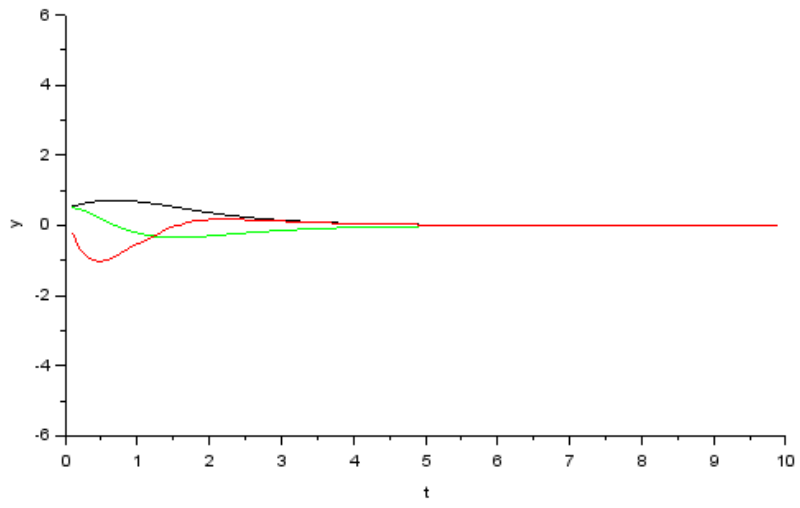


Figure 11.1: Lab11

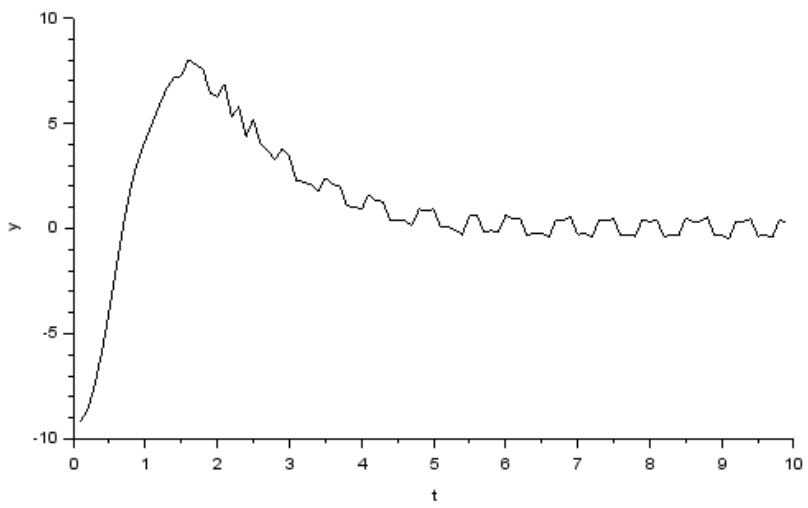


Figure 11.2: Lab11

Experiment: 12

**To demonstrate model
reference adaptive control
system.**

This code can be downloaded from the website www.scilab.in

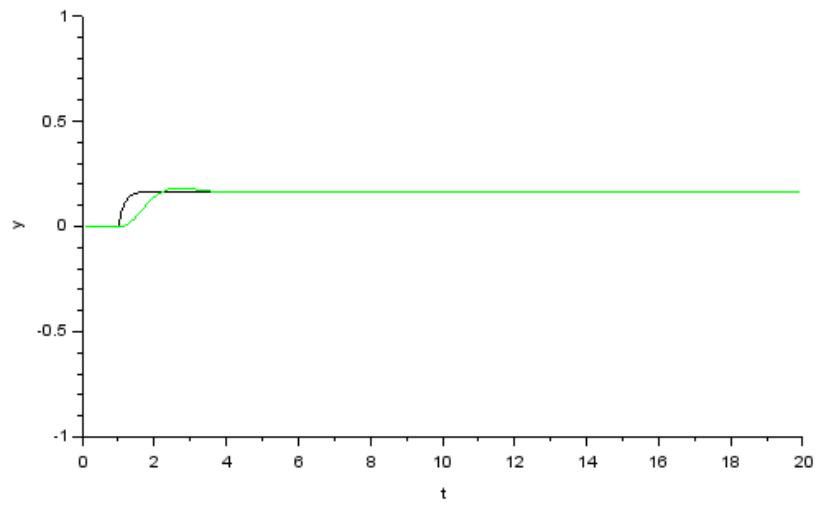


Figure 12.1: Lab12