Scilab Textbook Companion for
Signals and Systems
by P. R. Babu and R. Anandanatarajan[1]

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Scilab numbering policy used in this document and the relation to the above book.

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

AP Appendix to Example(Scilab Code that is an Appednix to a particular Example of the above book)

For example, Exa 3.51 means solved example 3.51 of this book. Sec 2.3 means a scilab code whose theory is explained in Section 2.3 of the book.

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List of Scilab Codes

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Chapter 1

Signals an introduction

Scilab code Exa 1.7 Sketch the following signals

```
1  //Example 1_7_<i>
2  //Sketch the following signal.
3  clc;
4  clear all;
5  t=-5:1/1000:5;
6  for i=1:length(t)
7      if t(i)>1 then
8          x(i)=0;
9      else
10         x(i)=1;
11     end
12  end
13  f=scf(0);
14  plot2d(t,x);
15  plot(t,x,'red');
16  xtitle('Required figure','t','x(t)');
17  xgrid();
18  xs2jpg(0, 'problem1_7_i-plot.jpg');
19  //Example 1_7_<ii>
20  //Sketch the following signal.
21  clc;
```

```
22 t = -5:1/1000:5;
23 for i =1: length (t)
24     if t(i) <1 then
25         x(i) =0;
26     else
27         x(i) =1;
28     end
29 end
30 for i =1: length (t)
31     x1(i) = -2* x(i);
32 end
33 // figure
34 f = scf (0);
35 plot2d (t,x);
36 xtitle ('required figure ','t ','x(t) ');
37 xs2jpg (0, 'problem1.7.2 − plot −a.jpg ');
38 // figure
39 f = scf (1);
40 plot2d (t,x1);
41 plot (t,x1,'blue ');
42 xtitle ('Required figure ','t ','x1(t) ');
43 xs2jpg (1, 'problem1.7.2 − plot −b.jpg ');
```

Scilab code Exa 1.8 `Sketch the following signals`

```
1 // Example 1.8. < i >
2 // Sketch the following signal
3 clc ;
4 clear all ;
5 t = -10:.001:10;
6 for i =1: length (t)
7     if t(i) >=-2 & t(i) <3 then
8         x(i) =1;
9     else
10        x(i) =0;
```

```
11        end
12  end
13  // figure
14  f = scf (0) ;
15  plot2d (t ,x) ;
16  xtitle ('Required figure ','t','x(t)') ;
17  xs2jpg(0, 'EX1_8_1-plot.jpg') ;
18  //Example 1.8.<ii>
19  //Sketch the following signal.
20  clc ;
21  clear all ;
22  t = -10:.001:10;
23  for i =1: length (t)
24        if t(i) >=0 & t(i) <=2 then
25             x(i) =1;
26        else
27             x(i) =0;
28        end
29  end
30  // figure
31  f = scf (0) ;
32  plot2d (t ,x ,1) ;
33  xtitle ('Required figure ','t','x(t)') ;
34  xs2jpg(0, 'EX1_8_2-plot.jpg') ;
```

Scilab code Exa 1.12 Check whether the given signal is periodic or not

```
1  //Example 1.12<i>
2  //check whether the given signal is periodic or not
3  clc ;
4  t = -5:.01:5;
5  x=%i*(exp(%i*5*t)) ;
6  subplot (311)
7  plot (t ,x) ;
8  disp ('(a)This shows that the given signal is
```

```
       periodic with priod (.4*%pi)');
 9 //Example 1.12<ii>
10 //Show whether the given signal is periodic or not
11 clc;
12 t=-1/5:0.001:1/5;
13 x=sin(50*%pi*t);
14 subplot(312)
15 plot(t,x);
16 disp('(b)the plotting shows that the given signal is
        periodic with period 1/25');
17 //Example 1.12.<iii>
18 //Check whether the given signal is periodic or not
19 clc;
20 t=-1:0.01:1;
21 x=20*cos((10*%pi*t)+(%pi/6));
22 subplot(313)
23 plot(t,x);
24 disp('(c)Plot shows that the given signal is
      periodic with period .2');
25
26 disp('In the figure we have the plots of part (a) -
      (c) in clockwise order strating from the top left
      ')
```

Scilab code Exa 1.13 Check whether the given signal is periodic or not

```
1 //Example 1.13<i>
2 //Check whether the given signal is periodic or not
3 clc;
4 t1=-10:.01:10;
5 y1=2*cos(10*t1+1)-sin(4*t1-1);
6 subplot(221)
7 plot(t1,y1);
8 disp('(a) The following signal is periodic with
      period %pi' );
```

```
 9  //Example  1.13<ii >
10  //Show  whether  the  given  signal  is  periodic  or  not
11  clc;
12  t2=-1:.01:1;
13  x2=cos(60*%pi*t2)+sin(50*%pi*t2);
14  subplot(222)
15  plot(t2,x2);
16  disp('(b)Ther  following  figure  shows  that  the  given
        signal  is  periodic  with  the  following  period');
17  //Example1.13<iv>
18  //Check  whether  the  given  signal  is  periodic  or  not
19  clc;
20  t3=-10:0.01:10;
21  x3=3*cos(4*t3)+2*sin(%pi*t3);
22  subplot(223)
23  plot(t3,x3);
24  disp('(c)The  signal  is  not  periodic  since  ratio  of
        two  time  periods  is  %pi/4  which  is  not  rational
        number');
25  //Example  1.13<v>
26  //Check  whether  the  given  signal  is  periodic  or  not
27  clc;
28  t=0:10;
29  for  i=1:length(t)
30      u(i)=1;
31      x(i)=u(i)-(1/2);
32  end
33
34  subplot(224)
35  plot(t,x);
36  disp('(d)The  signal  is  not  periodic  as  seen  from
        figure');
37
38  disp('In  the  figure  we  have  the  plots  of  part  (a) -
        (d)  in  clockwise  order  strating  from  the  top  left
        ')
```

Scilab code Exa 1.14 Check whether the given signal is periodic or not

```scilab
1  //Example 1.14<i>
2  //Find whether the following signal is periodic or
       not
3  clc;
4  n=-10:10;
5  x=cos(2*%pi*n);
6  subplot(321)
7  plot2d(n,x);
8  f=(2*%pi)/(2*%pi);//where f is the no of cycles/
       sample.
9  N=1/f;//where N is the no of samples per cycle.
10 disp('samples',N,'(a)The given signal is periodic');
11 //Example 1.14<ii>
12 //Find whether the following signal is periodic or
       not.
13 clc;
14 n=-20:20;
15 x=exp(%i*6*%pi*n);
16 subplot(322)
17 plot2d3(n,x);
18 f=(6*%pi)/(2*%pi);//where f is the no of cycles per
       sample.
19 N=1/f;//where N is the no of samples per cycle.
20 disp('samples',N,'(b)the given signal is periodic');
21 //example 1.14<1v>
22 //Find whether the given signal is periodic or not
23 clc;
24 n=-30:30;
25 x=exp(%i*(2*%pi/3)*n)+exp(%i*(3*%pi/4)*n);
26 subplot(323)
27 plot2d3(n,x);
28 disp('(c)The given signal is periodic');
```

```
29  //Example 1.14<v>
30  //Find whether the given signal is periodic or not;
31  clc;
32  n=-20:20;
33  x=exp(%i*(3*%pi/5)*(n+1/2));
34  subplot(324)
35  plot(n,x);
36  f=(3*%pi/5)/(2*%pi);//where f is the no of cycles
        per sample.
37  N=1/f;//where n is the no of samples per cycle.
38  disp('samples',N,'(d)the given signal is periodic');
39  //Example1.14<vi>
40  //whether the given signal is periodic or not
41  clc;
42  n=-40:40;
43  x=12*cos(20*n);
44  subplot(325)
45  plot(n,x);
46  f=20/(2*%pi);//where f is the no of cycles per
        sample
47  N=1/f;//where n is the no of sample per cycle
48  disp('samples',N,'(e)the given signal is not peridic
        ');
49
50  disp('In the figure we have the plots of part (a) -
        (d) in clockwise order strating from the top left
        ');
```

Scilab code Exa 1.15 Find the even and odd components of the signals

```
1  //Example 1.15<i>
2  //Find the even and odd components of the signal
3  clc;
4  clear;
5  t=-10:.1:10;
```

```
6  for j=1:length(t)
7      i=t(j);
8      x(j)=cos(i)+sin(i)+cos(i)*sin(i);
9      y(j)=cos(-i)+sin(-i)+cos(-i)*sin(-i);
10     e(j)=(1/2)*(x(j)+y(j));
11     o(j)=(1/2)*(x(j)-y(j));
12 end
13 disp('In the plot even component is in red and odd
         component is in blue')
14 plot(t,e,'red')
15 plot(t,o,'blue')
16 //Example 1.15<ii>
17 //Find the even and odd components of the signal
18 clc;
19 clear;
20 n=-2:2;
21 c=3;
22 x=[-2 1 2 -1 3];
23 for j=1:length(n)
24     i=n(j);
25     xe(j)=(1/2)*(x(c+i)+x(c-i));
26     xo(j)=(1/2)*(x(c+i)-x(c-i));
27 end
28 xe=[xe(c-2),xe(c-1),xe(c+0),xe(c+1),xe(c+2)];
29 xo=[xo(c-2),xo(c-1),xo(c+0),xo(c+1),xo(c+2)];
30
31 disp(xo,'odd component')
32 disp(xe,'even component')
```

Scilab code Exa 1.16 Determine power and rms value of the following signal

```
1  //Example 1.16
2  //Determine the power of the signal
3  clc;
4  A=2;
```

```
5  theta =0;
6  t=0:0.001:10;
7  y=A*cos(2*%pi*t+theta);
8  P=(integrate('A^2*(cos(2*%pi*t))^2','t',0,2*%pi))
      /(2*%pi);
9  disp(P,'power of the signal is:');
10  y=round(P);
11  disp(y,'The given signal is power signal as power is
         finite');
```

Scilab code Exa 1.17 Determine power and rms value of the signals

```
1  //Example 1.17<i>
2  //Determine the power and the rms value of the
      signal
3  clc;
4  t=0:0.001:10;
5  y=5*cos(50*t+%pi/3);
6  P=(integrate('5^2*(cos(50*t))^2','t',0,2*%pi))/(2*
      %pi);
7  rmsvalue=sqrt(P);
8  disp(P,'The power of the given signal is:');
9  disp(rmsvalue,'the rms value is:');
10  //Example 1.17<ii>
11  //Determine the power amd rms value of the signal
12  clc;
13  t=0:0.001:10;
14  x1=10*sin(50*t+%pi/4);
15  x2=16*cos(100*t+%pi/3);
16  P1=(integrate('10^2*(sin(50*t))^2','t',0,2*%pi))/(2*
      %pi);
17  P2=(integrate('16^2*(cos(100*t))^2','t',0,2*%pi))
      /(2*%pi);
18  P=P1+P2;
19  rmsvalue=sqrt(P);
```

```
20  disp (P , 'The power of the given signal is : ');
21  disp (rmsvalue , 'the rms value is : ');
22  //Example 1.17 <iii >
23  //Determine the power and rms value of the signal
24  clc ;
25  t =0:0.001:10;
26  x1 =5* cos (15* t );
27  x2 =5* cos (5* t );
28  P1 =( integrate ( '5^2*( cos (15* t ))^2 ', 't ',0,2*%pi ))/(2*
        %pi );
29  P2 =( integrate ( '5^2*( cos (5* t ))^2 ', 't ',0,2*%pi ))/(2*
        %pi );
30  P=P1+P2 ;
31  rmsvalue = sqrt (P );
32  disp (P , 'The power of the given signal is : ');
33  disp (rmsvalue , 'the rms value is : ');
```

Scilab code Exa 1.19.a Sketch the followins signal and calculate the energy

```
1  //Example 1.19.1
2  //whether the signal is energy signal or power
        signal
3  clc ;
4   t =0:0.001:10;
5   y= exp (-10* t );
6   E= integrate ( ' ( exp(-10* t )) ^2 ' , ' t ' ,0 ,2*
        %pi );
7  disp (E , ' Energy o f the s i g n a l i s ' );
8   disp ( 'since the energy is finite hence it is
        energy signal ');
9   figure
10  plot (t ,y , 'red ');
11  xtitle ('Required figure ');
```

Scilab code Exa 1.21 Sketch the followins signal and calculate the energy

```
1  //Example 1.21<i>
2  //whether the signal is energy signal
3  clc ;
4   t =0:0.001:10;
5   y= exp (-3*t);
6   E= integrate ( ' ( exp(-3*t)) ^2 ' , ' t ' ,0 ,2*
       %pi );
7  disp (E, ' Energy o f the s i g n a l i s ' );
8   disp ( 'since the energy is finite , hence it is
       energy signal ');
9   //example1.21<iii>
10 //show whethet x(t)=cost is a power or energy signal
11 clc;
12 t=0:0.01:100;
13 x=cos(t);
14 P=(integrate('cos(t)^2','t',0,2*%pi))/(2*%pi);
15 disp(P,'The power of the signal is:');
16 E=(integrate('cos(t)^2','t',0,2*%pi));
17 disp(E,'The energy is:');
18 disp('As t tends to infinity energy also tends to
       iinfinity but power remains finite.hence it is
       power signal');
19 //Example 1.21<iv>
20 //Find the energy of the signal
21 clc;
22 E=0;//initialize
23 for n=0:200
24     x(n+1)=(1/3)^n;
25 end
26 for n=0:200
27     E=E+x(n+1)^2;
28 end
```

18

```
29  if E<%inf then
30      disp(E,'The energy of the signal is;');
31  else disp('The given signal is not energy signal');
32  end
```

Scilab code Exa 1.22 Find which of the following signal is causal or non causal

```
1   //Example 1.22<i>
2   //Find whether the given signal is causal or not.
3   clear all;
4   clc;
5   t=-10:10;
6   a=.5;
7   for i=1:length(t)
8       if t(i)<0 then
9           x1(i)=0;
10      else
11          x1(i)=exp(a.*t(i));
12      end
13  end
14  causal=%t;
15  for i=1:length(t)
16      if t(i)<0 & x1(i)~=0 then
17          causal=%f;
18      end
19  end
20  disp(causal,"The statement that the system is causal
        is:");
21  //Example 1.22<ii>
22  //Find whether the given signal is causal or not.
23  clear all;
24  clc;
25  t=-10:10;
26  for i=1:length(t)
27      if t(i)>0 then
```

```scilab
28              x2(i)=0;
29          else
30              x2(i)=exp(-2.*t(i));
31          end
32  end
33  causal=%t;
34  for i=1:length(t)
35      if t(i)<0 & x2(i)~=0 then
36              causal=%f;
37      end
38  end
39  disp(causal,"The statement that the system is causal
        is:");
40  //Example 1.22<iii>
41  //Find whether the given signal is causal or not.
42  clear all;
43  clc;
44  t=-10:10;
45  c=2;
46  for i=1:length(t)
47      x3(i)=sin(c.*t(i));
48      end
49  causal=%t;
50  for i=1:length(t)
51      if t(i)<0 & x3(i)~=0 then
52              causal=%f;
53      end
54  end
55  disp(causal,"The statement that the system is causal
        is:");
56  //Example 1.22<iv>
57  //Find whether the given signal is causal or not.
58  clear all;
59  clc;
60  n=-10:10;
61  for i=1:length(n)
62      if n(i)<-3 | n(i)>2 then
63              x1(i)=0;
```

```scilab
64      else
65          x1(i)=1;
66      end
67      end
68  causal=%t;
69  for i=1:length(n)
70      if n(i)<0 & x1(i)~=0 then
71          causal=%f;
72      end
73  end
74  disp(causal,"The statement that the system is causal
        is:");
75  //Example 1.22<v>
76  //Find whether the given signal is causal or not.
77  clear all;
78  clc;
79  n=-10:10;
80  for i=1:length(n)
81      if  n(i)>-2 then
82          x2(i)=(1/2)^n(i);
83      else
84          x2(i)=0;
85      end
86      end
87  causal=%t;
88  for i=1:length(n)
89      if n(i)<0 & x2(i)~=0 then
90          causal=%f;
91      end
92  end
93  disp(causal,"The statement that the system is causal
        is:");
```

Chapter 2

Systems an introduction

Scilab code Exa 2.2 Find which of the following signal is causal or non causal

```
1  //Example 2.2<i>
2  //Find whether the given signal is causal or not.
3  clear all;
4  clc;
5  n=10; x1(1)=1; x2(1)=1;
6  for i=2:length(n)
7     x1(i)=i;
8      x2(i)=i-1;
9      y(i)=x1(i)+1 ./x2(i);
10       end
11 causal=%t;
12 for i=1:length(n)
13      if n(i)<0 &y(i)~=0 then
14           causal=%f;
15      end
16 end
17 disp(causal,"The statement that the system is causal
        is:");
18 //Example 2.2<ii>
19 //Find whether the given signal is causal or not.
20 clear all;
```

```
21  clc;
22  n=10; x1(1)=1; x2(1)=-1;
23  for i=2:length(n)
24     x1(i)=i;
25      x2(i)=i-2;
26      y(i)=x1(i).*x1(i)+x2(i);
27        end
28  causal=%t;
29  for i=1:length(n)
30       if n(i)<0 &y(i)~=0 then
31            causal=%f;
32       end
33  end
34  disp(causal,"The statement that the system is causal
         is :");
35  //Example 2.2<vi>
36  //Find whether the given signal is causal or not.
37  clear all;
38  clc;
39  n=-10:10;
40  for i=1:length(n)
41     x(i)=i;
42      y(i)=(i.^2);
43        end
44  causal=%t;
45  for i=1:length(n)
46       if n(i)<0 &y(i)~=0 then
47            causal=%f;
48       end
49  end
50  disp(causal,"The statement that the system is causal
         is :");
```

Scilab code Exa 2.3 Check whether the following systems are linear or not

```
1   //Example 2.3<v>
2   //Check whether the following signal is linear or
        not.
3   clear;
4   close;
5   clc;
6   T=20;//length of the signal
7   A=5;
8   B=4;
9   for n=1:T
10      x(n)=n;
11      y(n)=A*x(n)+B;
12  end
13  x1=x;
14  y1=y;
15  for n=1:T
16      x2(n)=2;y2(n)=A*x2(n)+B;
17  end
18  z=y1+y2;
19  for n=1:T
20      y3(n)=A*(x1(n)+x2(n))+B;
21  end
22  if z==y3 then
23      disp('The following signal is linear');
24  else
25      disp('The following signal is non linear');
26  end
27  //Example 2.3<vi>
28  //Check whether the following signal is linear or
        not.
29  clear;
30  close;
31  clc;
32  T=20;//length of the signal
33  x1(1)=1;
34  x2(1)=2;
35  for n=2:T
36      x1(n)=n;
```

```scilab
37      x2(n)=2*n;
38      y1(n)=(2*(x1(n)))+(1/x1(n-1));
39      y2(n)=(2*(x2(n)))+(1/x2(n-1));
40  end
41  z=y1+y2;
42  for n=2:T
43      y3(n)=(2*(x1(n)+x2(n)))+(1/(x1(n-1)+x2(n-1)));
44  end
45  if z==y3 then
46      disp('The following signal is linear');
47  else
48      disp('The following signal is non linear');
49  end
50  //Example 2.3<vii>
51  //Check whether the following signal is linear or
        not.
52  clear;
53  close;
54  clc;
55  T=20;//length of the signal
56  for n=1:T
57      x(n)=n;
58      y(n)=n*x(n);
59  end
60  x1=x;
61  y1=y;
62  for n=1:T
63      x2(n)=2;y2(n)=n*x2(n);
64  end
65  z=y1+y2;
66  for n=1:T
67      y3(n)=n*(x1(n)+x2(n));
68  end
69  if z==y3 then
70      disp('The following signal is linear');
71  else
72      disp('The following signal is non linear');
73  end
```

Scilab code Exa 2.4 Check whether the following systems are linear or not

```
1  //Example 2.4<i>
2  //Check whether the following signal is linear or
       not.
3  clear;
4  close;
5  clc;
6  T=20;//length of the signal
7  for n=1:T
8      x1(n)=n;x2(n)=2*n;
9      y1(n)=exp(x1(n));
10     y2(n)=exp(x2(n));
11 end
12 z=y1+y2;
13 for n=1:T
14     y3(n)=exp(x1(n)+x2(n));
15 end
16 if z==y3 then
17     disp('The following signal is linear');
18 else
19     disp('The following signal is non linear');
20 end
21 //Example 2.4<ii>
22 //Check whether the following signal is linear or
       not.
23 clear;
24 close;
25 clc;
26 T=20;//length of the signal
27 for n=1:T
28     x1(n)=n;x2(n)=2*n;
29     y1(n)=x1(n)*x1(n);
30     y2(n)=x2(n)*x2(n);
```

```
31  end
32  z = y1 + y2 ;
33  for  n = 1 : T
34      y3 ( n ) = ( x1 ( n ) + x2 ( n ) ) ^2;
35  end
36  if  z == y3  then
37      disp ( 'The  following  signal  is  linear ' );
38  else
39      disp ( 'The  following  signal  is  non  linear ' );
40  end
41  // Example  2.4 < iii >
42  // Check  whether  the  following  signal  is  linear  or
        not .
43  clear ;
44  close ;
45  clc ;
46  T =20; // length  of  the  signal
47  for  n = 1 : T
48      x1 ( n ) = n ; x2 ( n ) =2* n ;
49      y1 ( n ) = n ^2*( x1 ( n ) );
50      y2 ( n ) = n ^2*( x2 ( n ) );
51  end
52  z = y1 + y2 ;
53  for  n = 1 : T
54      y3 ( n ) = n ^2*( x1 ( n ) + x2 ( n ) );
55  end
56  if  z == y3  then
57      disp ( 'The  following  signal  is  linear ' );
58  else
59      disp ( 'The  following  signal  is  non  linear ' );
60  end
```

Scilab code Exa 2.5 Determine whether the following systems are time invariant or

```
1  // Example  2.5 < i >
```

27

```scilab
2   //Determine whether the following system is time
        invariant or not.
3   clc;
4   clear  all;
5   T=20;//length of the signal.
6   s=2;// shift
7   for n=1:T
8       x(n)=n;
9       y(n)=n*x(n);
10  end
11  IP=x(T-s);
12  OP=y(T-s);
13  if IP==OP then
14      disp('The given system is time invariant');
15  else
16      disp('The given system is  time variant');
17  end
18  //Example 2.5<ii>
19  //Determine whether the following system is time
        invariant or not.
20  clc;
21  clear  all;
22  T=-10:10;//length of the signal.
23  s=2;// shift
24  for n=1:length(T)
25      x(n)=2;
26      y(n)=x(n)*cos(50*%pi.*T(n));
27  end
28  IP=x(T(n)-s);
29  OP=y(T(n)-s);
30  if IP==OP then
31      disp('The given system is time invariant');
32  else
33      disp('The given system is  time variant');
34  end
35  //Example 2.5<vi>
36  //Determine whether the following signal is time
        invariant or not.
```

```scilab
37  clc;
38  clear all;
39  N=10;
40  s=1//shift;
41  k=2;
42  for n=1:N
43      x(n)=n;
44  end
45  for n=1:(N/k)
46      y(n)=x(k*n);
47  end
48  ip=x(N-s);
49  op=y((N/k)-s);
50  if(ip==op) then
51      disp('the following signal is time invariant');
52  else
53      disp('The given signal is time variant');
54  //Example 2.5<vii>
55  //Determine whether the following signal is time
        invariant or not.
56  clc;
57  clear all;
58  T=20;
59  s=4;//shift
60  x(1)=1
61  for n=2:T
62      x(n)=n;
63      y(n)=x(n-1).*x(n-1);
64  end
65  inputshift=x(T-s);
66  outputshift=y(T-s);
67  if (inputshift==outputshift) then
68      disp('The given signal is time invariant');
69  else
70      disp('The given signal is  time variant');
71  end
```

Scilab code Exa 2.7 Check for the following systems

```scilab
1  //Check for the following system.
2  //Example 2.7 <i>
3  clc;
4  clear ;//a>check whether static or dynamic
5  t=-10:.1:10;T=length(t)
6  s=2;
7  for i=1:length(t)
8      x(i)=i;
9      y(i)=abs(x(i));
10 end
11 if y(2)==x(2)& y(2)==x(1) then
12     disp('The given signal is dynamic' );
13 else
14     disp('the given signal is static');
15 end
16 //b>check whether linear or non linear
17 x1=x;
18 y1=y;
19 for i=1:length(t)
20     x2(i)=-2;
21     y2(i)=abs(x2(i));
22 end
23 for i=1:length(t)
24 z(i)=y1(i)+y2(i);
25 end
26 for i=1:length(t)
27     y3(i)=abs(x1(i)+x2(i));
28 end
29 if z==y3 then
30     disp('The given signal is linear');
31 else
32     disp('Not linear');
```

```
33  end
34  //c>check whether time invariant or not
35  IP=x(T-s);
36  OP=y(T-s);
37  if IP == OP then
38  disp('the given signal is time invariant');
39  else
40        disp('The given signal is not time invariant')
             ;
41      end
42  //Check for the following systems
43  //Example 2.7 <ii>
44  clc;
45  clear all;//a>check whether static or dynamic
46  t=0:5;T=length(t);w=1;
47  s=2;
48  for i=1:length(t)
49      x(i)=i;
50      y(i)=x(i)*cos(w*t(i));
51  end
52  if y(2)==x(2)& y(2)==x(1) then
53      disp('The given signal is dynamic' );
54  else
55      disp('the given signal is static');
56  end
57  //b>check whether linear or non linear
58  x1=x;
59  y1=y;
60  for i=1:length(t)
61      x2(i)=2*i;
62      y2(i)=x2(i)*cos(w*t(i));
63      y3(i)=cos(w*t(i))*(x1(i)+x2(i));
64  end
65  z=y1+y2;
66  if z~=y3 then
67      disp('The given signal is not linear');
68  else
69      disp('linear');
```

```
70  end
71  //c>check  whether  time  invariant  or  not
72  IP=x(T-s);
73  OP=y(T-s);
74  if  IP  ==  OP  then
75  disp('the  given  signal  is  time  invariant');
76  else
77          disp('The  given  signal  is  not  time  invariant')
                ;
78      end
```

Chapter 3

Time domain analysis of discrete time systems

Scilab code Exa 6.0 Example 6 0f question and answer section

```
1  //Example 6 0f question and answer section
2  clc;
3  clear; close;
4  n=-5:.01:5;
5  for i=1:length(n)
6      if n(i)<0 then
7          x(i)=0;h1(i)=0;h2(i)=0;
8      else
9          x(i)=1;h1(i)=2;h2(i)=3;
10     end
11     h3(i)=h1(i)+h2(i)//when in parallel
12     h4(i)=h1(i).*h2(i)//when in series
13 end
14 y1=convol(x,h3);
15 y2=convol(x,h4);
16 subplot(4,2,1);
17 plot(n,x,'black');
18 xtitle('x[n]');
19 subplot(4,2,2);
```

```
20  plot(n,h1,'red');
21  xtitle('h1[n]');
22  subplot(4,2,3);
23  plot(n,h2,'red');
24  xtitle('h2[n]');
25  subplot(4,2,4);
26  plot(n,h3,'blue');
27  xtitle('h3[n]');
28  subplot(4,2,5);
29  plot(n,h4,'blue');
30  xtitle('h4[n]');
31  subplot(4,2,6);
32  n1=-10:.01:10;
33  plot(n1,y1,'green');
34  xtitle('y1[n]');
35  subplot(4,2,7);
36  n1=-10:.01:10;
37  plot(n1,y2,'green');
38  xtitle('y2[n]');
```

Scilab code Exa 3.13 Represent the sequence as sum of shifted unit impulse

```
1  //example 3.13
2  //Represent the sequence as sum of shifted unit
       impulse.
3  clear ;
4   close ;
5   clc ;
6   t= -1:1:4;T=3;
7   x=[3 2 -1 2 4 1];
8   for i =1: length (t)
9   if modulo(t(i),3)==0 then
10  h(i)=1;
11  else
12   h(i)=0;
```

```
13    end
14    end
15    y = convol(x,h);
16    //figure
17    f=scf(0);
18    plot2d (t,h)
19    xtitle ( ' Input Re spons e ' , ' t ' , ' h ( t ) '
         );
20     xs2jpg(0, 'problem38-plot-a.jpg');
21  // figure
22  f=scf(1);
23    plot2d (t,x)
24    xtitle ( ' Input Re spons e ' , ' t' , ' x ( t ) '
        );
25     xs2jpg(1, 'problem38-plot-b.jpg');
26    //figure
27    f=scf(2);
28    a= gca ();
29    t1 =-2:1:8;
30    plot2d (t1 ,y)
31    xtitle ( ' Output Re spons e ' , ' t ' , ' y ( t) '
         );
32     xs2jpg(2, 'problem38-plot-c.jpg');
```

Scilab code Exa 3.15 Determine the convolution sum of two sequences

```
1  //Example 3.15
2  //Determine the convolution sum of two sequences.
3  clc;
4  x=[1 4 3 2];
5  h=[1 3 2 1];
6  y=convol(x,h);
7  disp(y,'Convolution sum of the above two sequences
     is:");
```

Scilab code Exa 3.16 Determine the output response

```
1 //Example 3.16
2 //Determine the output response.
3 clc;
4 x=[1 2 3 2];
5 h=[1 2 2];
6 y=convol(x,h);
7 disp(y,'convolution of the above two sequences is:')
    ;
```

Scilab code Exa 3.17 Find the convolution of the sequences

```
1 //Example 3.17
2 //Find the convolution of the sequences.
3 x1=[1 -1 2 3];
4 x2=[1 -2 3 -1];
5 y=convol(x1,x2);
6 disp(y,'The convolution of the above sequences is:')
    ;
```

Scilab code Exa 3.18 Find the convolution

```
1 //Example 3.18
2 //Find the convolution.
3 clc;
4 x1=[1 -2 3 1];
5 x2=[2 -3 -2];
6 y=convol(x1,x2);
```

36

```
7 disp(y,'The convolution of the above two sequences
      is:');
```

Scilab code Exa 3.19 Find the convolution of the following sequence

```
1 //Example 3.19
2 //Find the convolution of the following sequence.
3 x=[2 -1 1 3];
4 h=[3 4 2];
5 y=convol(x,h);
6 disp(y,'the convolution of the above sequence is:');
```

Scilab code Exa 3.20 Find the convolution

```
1 //Example 3.20
2 //Find the convolution of h(n)=a^n*u(n) and x(n)=b^n
      *u(n)
3 clear;
4 clc;
5 close;
6 n=-10:1/100:10;
7 a=5;
8 b=3;
9 for i =1:length(n)
10      if n(i)<0 then
11          h(i)=0;
12          x(i)=0;
13      else
14          h(i)=a^n(i);
15          x(i)=b^n(i);
16      end;
17      end;
18      y=convol(h,x);
```

```
19  //      figure
20      f = scf (0) ;
21      plot ( n , h , ' black ') ;
22      xtitle ( ' input  response1 ' , 'n ' , ' h ( n ) ') ;
23      xs2jpg (0 ,  ' problem29−plot−a . jpg ') ;
24  //      figure
25      f = scf (1) ;
26      plot ( n , x , ' red ') ;
27      xtitle ( ' input  response2 ' , 'n ' , ' x ( n ) ') ;
28      xs2jpg (1 ,  ' problem29−plot−b . jpg ') ;
29      n1 = -20:1/100:20;
30  //      figure
31      f = scf (2) ;
32      plot ( n1 , y , ' green ') ;
33      xtitle ( ' output  response ' , ' n1 ' , ' y ( n ) ') ;
34      xs2jpg (2 ,  ' problem29−plot−c . jpg ') ;
```

Scilab code Exa 3.21 Determine the response of the below relaxed system

```
1  // Example  3.21
2  // Determine  the  response  of  the  below  relaxed  system
        .
3  clc ;
4  close ;
5   n = -10:.01:10;
6   for  i =1: length ( n )
7       if  n ( i ) <0  then
8            h ( i ) =0; x ( i ) =0;
9       else
10            h ( i ) =(1/3) ^ n ( i ) ;
11            x ( i ) =2^ n ( i ) ;
12       end
13   end
14   y = convol ( h , x ) ;
15   // figure
```

38

```
16   f=scf(0);
17   plot(n,h,'black');
18   xtitle('input response1','n','h(n)');
19   xs2jpg(0, 'problem29-plot-a.jpg');
20   // figure
21   f=scf(1);
22   plot(n,x,'red');
23   xtitle('input response2','n','x(n)');
24   xs2jpg(1, 'problem29-plot-b.jpg');
25   // figure
26   f=scf(2);
27   n1=-20:.01:20;
28   plot(n1,y,'green');
29   xtitle('output response','n','y(n)');
30   xs2jpg(2, 'problem29-plot-c.jpg');
```

Scilab code Exa 3.22 Find the response

```
1   //Example 3.22
2   clear ;
3    close ;
4    clc ;
5    t = -5:1/100:5;
6    for i =1: length (t)
7    if t(i) <0 then
8    h(i)=0;
9    x(i)=0;
10   else
11   h(i)=1;
12   x(i)=1;
13   end
14   end
15   y = convol (x,h) ;
16   //figure
17   f=scf(0);
```

```
18   plot2d (t,h)
19   xtitle ( ' Input Re spons e ' , ' t ' , ' h ( t )  '
          );
20   xs2jpg(0, 'problem31-plot-a.jpg');
21   //figure
22   f=scf(1);
23   plot2d (t,x)
24   xtitle ( ' Input Re spons e ' , ' t ' , ' x ( t )  '
          );
25   xs2jpg(0, 'problem31-plot-b.jpg');
26   //figure
27   f=scf(2);
28   a= gca ();
29   t1 = -10:1/100:10;
30   plot2d (t1 ,y)
31   xtitle ( ' Output Re spons e ' , ' t ' , ' y ( t )
          ' );
32   xs2jpg(0, 'problem31-plot-c.jpg');
```

Scilab code Exa 3.23 Find the convolution of the following sequences

```
1   //example 3.23<i>
2   //Find the convolution sum
3   clear ;
4    close ;
5    clc ;
6    t= -5:1/100:5;
7    for i =1: length (t)
8    if t(i) <0 then
9    h(i)=0;
10   x(i)=0;
11   else
12   h(i)=2^t(i);
13   x(i)=1;
14   end
```

```
15  end
16  y = convol (x,h) ;
17  //figure
18  f=scf(0);
19  plot2d (t,h)
20  xtitle ( ' Input Re spons e ' , ' t ' , ' h ( t ) '
        );
21  xs2jpg(0, 'problem32−plot−a.jpg');
22  //figure
23  f=scf(1);
24  plot2d (t,x)
25  xtitle ( ' Input Re spons e ' , ' t' , ' x ( t ) '
        );
26  xs2jpg(1, 'problem32−plot−b.jpg');
27  //figure
28  f=scf(2);
29  a= gca ();
30  t1 = -10:1/100:10;
31  plot2d (t1 ,y)
32  xtitle ( ' Output Re spons e ' , ' t ' , ' y ( t) '
        );
33  xs2jpg(2, 'problem32−plot−c.jpg');
34  //example 3.23<ii>
35  //Find the response using convolution sum
36  clear ;
37  clc;
38   close ;
39   t = -5:1/100:5;
40   for i =1: length (t)
41   if t(i) <0 then
42   h(i)=0;
43   x(i)=0;
44   elseif t(i)<3 then
45   h(i)=0;
46   x(i)=1;
47   else h(i)=1;x(i)=1;
48   end
49   end
```

41

```
50  y = convol (x,h) ;
51  //figure
52  f=scf(0);
53  plot2d (t,h)
54  xtitle ( ' Input Re spons e ' , ' t ' , ' h ( t ) '
        );
55  xs2jpg(0, 'problem33−plot−a.jpg');
56  //figure
57  f=scf(1);
58  plot2d (t,x)
59  xtitle ( ' Input Re spons e ' , ' t ' , ' x ( t ) '
        );
60  xs2jpg(1, 'problem33−plot−b.jpg');
61  //figure
62  f=scf(2);
63  a= gca ();
64  t1 = -10:1/100:10;
65  plot2d (t1 ,y)
66  xtitle ( ' Output Re spons e ' , ' t ' , ' y ( t )
        ' );
67  xs2jpg(2, 'problem33−plot−c.jpg');
68  //example 3.23<iii>
69  //Find the response using convolution sum
70  clear ;
71  close ;
72  clc ;
73  t = -5:1/100:5;
74  for i =1: length (t)
75  if t(i) <0 then
76  h(i)=0;
77  x(i)=0;
78  elseif t(i)<1 then
79  h(i)=0;
80  x(i)=1;
81  elseif t(i)<=4 then h(i)=1;x(i)=1;
82  elseif t(i)<=7 then
83      h(i)=0;
84      x(i)=1;
```

42

```
85   end
86   end
87   y = convol (x,h) ;
88   //figure
89    f=scf(0);
90   plot2d (t,h)
91   xtitle ( ' Input Re spons e ' , ' t ' , ' h ( t ) '
          );
92   xs2jpg(0, 'problem34-plot-a.jpg');
93   // figure
94   f=scf(1);
95   plot2d (t,x)
96   xtitle ( ' Input Re spons e ' , ' t ' , ' x ( t ) '
          );
97   xs2jpg(1, 'problem34-plot-b.jpg');
98    //figure
99    f=scf(2);
100  t1 = -10:1/100:10;
101  plot2d (t1 ,y)
102  xtitle ( ' Output Re spons e ' , ' t ' , ' y ( t )
          ' );
103  xs2jpg(2, 'problem34-plot-c.jpg');
```

Scilab code Exa 3.25 Find whether the systems are causal and stable

```
1  //Example 3.25<i>
2  //Find whether the system is causal and stable.
3  clear all;
4   clc ;
5   n = -5:5;
6   for i =1: length (n)
7   if(n(i) <=0)
8   h(i)=  2^n(i);
9   else
10  h(i)=0;
```

43

```scilab
11   end
12   end
13   causal =%t ;
14   for i =1: length (n)
15   if n(i) <0 & h(i) ~=0 then
16   causal =%f ;
17   end
18   end
19   disp ( causal , 'The statement that the system is
        causal is : ') ;
20    n =0:100000;
21   for i =1: length (n)
22   if(n(i) <=0)
23   h(i)=  2^n(i) ;
24   else
25   h(i)=0;
26   end
27   end
28   bibo =sum(h) ;
29   if (bibo < %inf ) then
30   disp (" system is bibo stable ") ;
31   else
32   disp (" systes not stable ") ;
33   end
34   //Example 3.25< ii >
35   //Find whether the system is causal and stable .
36   clear all ;
37    clc ;
38    n = -5:5;
39    for i =1: length (n)
40    if(n(i) >=1)
41    h(i)=  exp(2*n(i)) ;
42    else
43    h(i)=0;
44    end
45    end
46    causal =%t ;
47    for i =1: length (n)
```

```scilab
48   if n(i) <0 & h(i) ~=0 then
49   causal =%f;
50   end
51   end
52   disp (causal,'The statement that the system is
        causal is:');
53    n =0:100000;
54   for i =1: length (n)
55   if(n(i) >=1)
56   h(i)=  exp(2*n(i));
57   else
58   h(i)=0;
59   end
60   end
61   bibo =sum(h);
62   if (bibo < %inf ) then
63   disp (" system is bibo stable ");
64   else
65   disp (" system not stable ");
66   end
67   //Example 3.25< iii >
68   //Find whether the system is causal and stable .
69   clear all;
70    clc ;
71    n = -5:5;
72    for i =1: length (n)
73    if(n(i) <=3)
74    h(i)=  (5*n(i));
75    else
76    h(i)=0;
77    end
78    end
79    causal =%t;
80    for i =1: length (n)
81    if n(i) <0 & h(i) ~=0 then
82    causal =%f;
83    end
84    end
```

```
85   disp (causal, 'The statement that the system is
         causal is:');
86    n =0:100000;
87   for i =1: length (n)
88   if(n(i) <=1)
89   h(i)=  (5*n(i));
90   else
91   h(i)=0;
92   end
93   end
94   bibo =sum(h);
95   if (bibo < %inf ) then
96   disp (" system is bibo stable ");
97   else
98   disp (" system not stable ");
99   end
100  //Example 3.2<iv>
101  //Find whether the system is causal and stable.
102  clear all;
103   clc ;
104   n = -5:5;
105   for i =1: length (n)
106   h(i)=  exp(-6*abs(n(i)));
107   end
108   causal =%t;
109   for i =1: length (n)
110   if n(i) <0 & h(i) ~=0 then
111   causal =%f;
112   end
113   end
114   disp (causal, 'The statement that the system is
         causal is:');
115    n =0:100000;
116   for i =1: length (n)
117   h(i)= exp(-6*abs(n(i)));
118   end
119   bibo =sum(h);
120   if (bibo < %inf ) then
```

```
121    disp (" system is bibo stable ");
122    else
123    disp (" system not stable ");
124    end
```

Scilab code Exa 3.26 Find the step response

```
1  //Find the step response.
2  //Example 3.26<i>
3  clear;
4  close;
5  clc;
6  n=-5:.01:5;
7  for i=1:length(n)
8      if n(i)==2 then
9          del1(i)=1;
10         del2(i)=0;
11     elseif n(i)==3 then
12         del1(i)=0;del2(i)=1;
13     else
14         del1(i)=0;del2(i)=0;
15     end
16     x1(i)=del1(i)+del2(i);
17     if n(i)<0 then
18         x2(i)=0;
19     else
20         x2(i)=1;
21     end
22  end
23  y=convol(x1,x2);
24  //figure
25  f=scf(0);
26  plot(n,x1,'black');
27  xtitle('Delta function as input');
28   xs2jpg(0, 'problem39-plot-a.jpg');
```

47

```scilab
29  // figure
30  f = scf (1);
31  plot (n , x2 , 'red ');
32  xtitle ('Unit function as input ');
33   xs2jpg (1 , 'problem39 - plot - b . jpg ');
34  // figure
35  f = scf (2);
36  n1 = -10:.01:10;
37  plot (n1 , y , 'green ');
38  xtitle ('Step function as output ');
39   xs2jpg (2 , 'problem39 - plot - c . jpg ');
40  // Example 3.26 < ii >
41  // Find the step response .
42  clc ;
43  clear ;
44  close ;
45  n = -5:.01:5;
46  a =6;
47  for i =1: length ( n )
48      if n ( i ) <0 then
49          h ( i ) =0; x ( i ) =0;
50      else
51          h ( i ) =( -a )^ n ( i );
52          x ( i ) =1;
53      end
54  end
55  s = convol (h , x );
56  // figure
57  f = scf (0);
58  plot (n ,h , 'red ');
59  xtitle ('h ( n ) ');
60   xs2jpg (0 , 'problem40 - plot - a . jpg ');
61  // figure
62  f = scf (1);
63  plot (n ,x , 'green ');
64  xtitle ('x ( n ) ');
65   xs2jpg (1 , 'problem40 - plot - b . jpg ');
66  // figure
```

```scilab
67  f = scf (2) ;
68  n1 = -10:.01:10;
69  plot ( n1 , s , 'blue ') ;
70  xtitle ( 's(n) ') ;
71   xs2jpg(2, 'problem40-plot-c.jpg');
72  // Example  3.26< iii >
73  // Find  the  step  response  of  the  system .
74  clc ;
75  clear ;
76  close ;
77  n = -5:.01:5;
78  for  i =1: length ( n )
79      if  n(i) <0  then
80          h(i)=0; x(i)=0;
81      else
82          h(i)=1;
83          x(i)=1;
84      end
85  end
86  s = convol (h , x ) ;
87  // figure
88  f = scf (0) ;
89  plot (n ,h , 'black ') ;
90  xtitle ( 'h[n] ') ;
91  xs2jpg(0, 'problem41-plot-a.jpg');
92  // figure
93  f = scf (1) ;
94  plot (n ,x , 'red ') ;
95  xtitle ( 'x[n] ') ;
96  xs2jpg(1, 'problem41-plot-b.jpg');
97  // figure
98  f = scf (2) ;
99  n1 = -10:.01:10;
100 plot ( n1 ,s , 'green ') ;
101 xtitle ( 's[n] ') ;
102 xs2jpg(2, 'problem41-plot-c.jpg');
103 // Example  3.26  <iv>
104 // Find  the  step  response .
```

```
105 clc;
106 clear;
107 close;
108 n=-5:.01:5;
109 for i=1:length(n)
110     if n(i)<0 then
111         h(i)=0;x(i)=0;
112     else
113         h(i)=((1/2)^n(i))+((-(1/3))^n(i));
114         x(i)=1;
115     end
116 end
117 s=convol(h,x);
118 //figure
119 f=scf(0);
120 plot(n,h,'red');
121 xtitle('h(n)');
122 xs2jpg(0, 'problem42-plot-a.jpg');
123 //figure
124 f=scf(1);
125 plot(n,x,'green');
126 xtitle('x(n)');
127 xs2jpg(1, 'problem42-plot-b.jpg');
128 //figure
129 f=scf(2);
130 n1=-10:.01:10;
131 plot(n1,s,'blue');
132 xtitle('s(n)');
133 xs2jpg(2, 'problem42-plot-c.jpg');
```

Scilab code Exa 3.27 Find the convolution of the following sequences

```
1 //example 3.27<i>
2 //Find the convolution sum
3 clear ;
```

50

```scilab
 4 clc;
 5  close ;
 6  t= -10:1/100:10;
 7  for i =1: length (t)
 8  if t(i) <0 then
 9  h(i)=0;
10  x(i)=0;
11  else
12  h(i)=(1/2)^t(i);
13  x(i)=cos(%pi*t(i));
14  end
15  end
16  y = convol (x,h) ;
17 // figure
18   f=scf(0);
19  plot2d (t,h)
20  xtitle ( ' Input Re spons e ' , ' t ' , ' h ( t ) '
        );
21  xs2jpg(0, 'EX3_27_1-plot-a.jpg');
22  //figure
23    f=scf(1);
24  plot2d (t,x)
25  xtitle ( ' Input Re spons e ' , ' t' , ' x ( t ) '
        );
26  xs2jpg(1, 'EX3_27_1-plot-b.jpg');
27  //figure
28    f=scf(2);
29  t1 = -20:1/100:20;
30  plot2d (t1 ,y)
31  xtitle ( ' Output Re spons e ' , ' t ' , ' y ( t) '
        );
32  xs2jpg(2, 'EX3_27_1-plot-c.jpg');
33 //example 3.27<ii>
34 //Find the response using convolution sum
35 clear ;
36  close ;
37  clc ;
38  t = -10:1/100:10;
```

51

```scilab
39  for i =1: length (t)
40  if t(i) <0 then
41  h(i)=0;
42  x(i)=(1/3)^(-t(i));
43  elseif t(i)==0 then
44  h(i)=0;
45  x(i)=0;
46  else h(i)=1;x(i)=0;
47  end
48  end
49  y = convol (x,h) ;
50  //figure
51  f=scf(0);
52  plot2d (t,h)
53  xtitle ( ' Input Re spons e ' , ' t ' , ' h ( t ) '
        );
54   xs2jpg(0, 'EX3_27_2-plot-a.jpg');
55  //figure
56  f=scf(1);
57  plot2d (t,x)
58  xtitle ( ' Input Re spons e ' , ' t ' , ' x ( t ) '
        );
59   xs2jpg(1, 'EX3_27_2-plot-b.jpg');
60  //figure
61  f=scf(2);
62  a= gca ();
63  t1 = -20:1/100:20;
64  plot2d (t1 ,y)
65  xtitle ( ' Output Re spons e ' , ' t ' , ' y ( t )
        ' );
66   xs2jpg(2, 'EX3_27_2-plot-c.jpg');
67 //example 3.27< iii >
68 //Find the response using convolution sum
69 clear ;
70  close ;
71  clc ;
72  t = -5:1/100:5;
73  for i =1: length (t)
```

```
74   if t(i) <0 then
75   h(i)=0;
76   x(i)=0;
77   elseif t(i)<=10 then
78   x(i)=(1/2)^t(i);
79   h(i)=1;
80  else
81      h(i)=0;
82      x(i)=(1/2)^t(i);
83   end
84   end
85   y = convol (x,h) ;
86   //figure
87   f=scf(0);
88   plot2d (t,h)
89   xtitle ( ' Input Re spons e ' , ' t ' , ' h ( t ) '
        );
90   xs2jpg(0, 'EX3_27_3-plot-a.jpg');
91  // figure
92  f=scf(1);
93   plot2d (t,x)
94   xtitle ( ' Input Re spons e ' , ' t ' , ' x ( t ) '
        );
95   xs2jpg(1, 'EX3_27_3-plot-b.jpg');
96   //figure
97   f=scf(2);
98   a= gca ();
99   t1 = -10:1/100:10;
100   plot2d (t1 ,y)
101   xtitle ( ' Output Re spons e ' , ' t ' , ' y ( t )
        ' );
102   xs2jpg(2, 'EX3_27_3-plot-c.jpg');
```

Scilab code Exa 3.28 Find the convolution

```
1  //Example 3.28
2  //Find the convolution.
3  clc;
4  clear;
5  close;
6  n=-5:.01:5;
7  for i=1:length(n)
8      if n(i)<0 then
9          x1(i)=0;
10     else
11         x1(i)=1;
12     end
13     if n(i)<3 then
14         x2(i)=0;
15     else
16         x2(i)=2;
17     end
18     if n(i)<6 then
19         x3(i)=0;
20     else
21         x3(i)=1;
22     end
23     x(i)=x1(i)-x2(i)+x3(i);
24     if n(i)<-2 | n(i)>9 then
25         h(i)=0;
26     else
27         h(i)=1;
28     end
29 end
30 y=convol(x,h);
31 //figure
32 f=scf(0);
33 plot(n,h,'red');
34 xtitle('h[n]');
35 xs2jpg(0, 'problem43-plot-a.jpg');
36 //figure
37 f=scf(1);
38 plot(n,x,'blue');
```

```
39  xtitle('x[n]');
40  xs2jpg(1, 'problem43-plot-b.jpg');
41  //figure
42  f=scf(2);
43  n1=-10:.01:10;
44  plot(n1,y,'green');
45  xtitle('y[n]');
46  xs2jpg(2, 'problem43-plot-c.jpg');
```

Scilab code Exa 3.31 Find the cross correlation of two finite length sequences

```
1  //Example 3.31
2  //Find the cross correlation of two finite length
       sequences.
3  clc;
4  x=[1 2 1 1];
5  y=[1 2 1 1];
6  z=convol(x,y);
7  disp(z);
```

Scilab code Exa 3.32 Find the input signal

```
1  //Example 3.32
2  //Find the input signal
3  clc;t=1:7;
4  y=[1 5 10 11 8 4 1];
5  h=[1 2 1 0 0 0 0];
6  Y=fft(y,-1);//-1 is taken to obtain the fourier
       transform of y.
7  H=fft(h,-1);
8
9  X=Y./H;
```

```
10  x=fft(X,1);//1 is taken to obtain the inverse
        fourier transform of X.
11  s=round(x);
12  disp(s,'The deconvolution of the above two sequences
        is :');
```

Chapter 4

Time domain analysis of continuous time systems

Scilab code Exa 4.4.2 Find the step response of the following impulse response

```scilab
1  //Example  4.4  <ii>
2  //Find  the  step  response  of  the  following  impulse
       response .
3  clc ;
4  t = -1:.01:1;
5  for  i =1: length ( t )
6      if  t ( i ) ==0  then
7          del1 ( i ) =1; del2 ( i ) =0;
8      elseif  t ( i ) ==1  then
9          del1 ( i ) =0; del2 ( i ) =1;
10     else
11         del1 ( i ) =0; del2 ( i ) =0;
12 end
13 h ( i ) = del1 ( i ) - del2 ( i ) ;
14 if  t ( i ) <0  then
15     u ( i ) =0;
16 else
17     u ( i ) =1;
18 end
```

```
19  end
20  s=convol(h,u);
21  t1=-10:.05:10;
22  f=scf(0);
23  plot(t1,s,'red');
24  xtitle('s[t]');
25  xs2jpg(0, 'EX4_4_2-plot-a.jpg');
```

Scilab code Exa 4.6 Find the convolution of the following signals

```
1  //Find the covolution Of the following signals.
2  //Example 4.6<i>
3  clc;
4  clear;
5  close;
6  a=.5;
7  b=.6;
8  t=-4:.01:4;
9  for i=1:length(t)
10      if t(i)<0 then
11          x1(i)=0;x2(i)=0;
12      else
13          x1(i)=exp(-a.*t(i));
14          x2(i)=exp(-b.*t(i));
15      end
16  end
17  y=convol(x1,x2);
18  f=scf(0);
19  subplot(3,1,1);
20  plot(x1,t,'red');
21  xtitle('x1[t]');
22  subplot(3,1,2);
23  plot(x2,t,'blue');
24  xtitle('x2[t]');
25  subplot(3,1,3);
```

```scilab
26  t1 = -8:.01:8;
27  plot(t1,y,'green');
28  xtitle('y[n]');
29  xs2jpg(0, 'EX4_6_1-plot-a.jpg');
30  //Find the covolution Of the following signals.
31  //Example 4.6<ii>
32  clc;
33  clear;
34  close;
35  t = -4:.01:4;
36  for i=1:length(t)
37      if t(i)<0 then
38          x1(i)=0;x2(i)=0;
39      else
40          x1(i)=1;
41          x2(i)=1;
42      end
43  end
44  y=convol(x1,x2);
45  f=scf(0);
46  subplot(3,1,1);
47  plot(x1,t,'red');
48  xtitle('x1[t]');
49  subplot(3,1,2);
50  plot(x2,t,'blue');
51  xtitle('x2[t]');
52  subplot(3,1,3);
53  t1 = -8:.01:8;
54  plot(t1,y,'green');
55  xtitle('y[n]');
56  xs2jpg(0, 'EX4_6_2-plot-a.jpg');
57  //Find the covolution Of the following signals.
58  //Example 4.6<iii>
59  clc;
60  clear;
61  close;
62  t = -4:.01:4;
63  for i=1:length(t)
```

```scilab
64      if t(i)<0 then
65          x1(i)=0;x2(i)=0;
66      else
67          x1(i)=t(i);
68          x2(i)=1;
69      end
70  end
71  y=convol(x1,x2);
72  f=scf(0);
73  subplot(3,1,1);
74  plot(x1,t,'red');
75  xtitle('x1[t]');
76  subplot(3,1,2);
77  plot(x2,t,'blue');
78  xtitle('x2[t]');
79  subplot(3,1,3);
80  t1=-8:.01:8;
81  plot(t1,y,'green');
82  xtitle('y[n]');
83  xs2jpg(0, 'EX4_6_3-plot-a.jpg');
84  //Find the covolution Of the following signals.
85  //Example 4.6<iv>
86  clc;
87  clear;
88  close;
89  t=-4:.01:4;
90  for i=1:length(t)
91      if t(i)<0 then
92          x1(i)=0;x2(i)=0;
93      else
94          x1(i)=sin(t(i));
95          x2(i)=1;
96      end
97  end
98  y=convol(x1,x2);
99  f=scf(0);
100 subplot(3,1,1);
101 plot(x1,t,'red');
```

```
102  xtitle('x1[t]');
103  subplot(3,1,2);
104  plot(x2,t,'blue');
105  xtitle('x2[t]');
106  subplot(3,1,3);
107  t1=-8:.01:8;
108  plot(t1,y,'green');
109  xtitle('y[n]');
110  xs2jpg(0, 'EX4_6_4-plot-a.jpg');
```

Scilab code Exa 4.7 Find the convolution of the following signals

```
1  //Find the covolution Of the following signals.
2  //Example 4.7<i>
3  clc;
4  clear;
5  close;
6  t=-4:.01:4;
7  //Define signal h(t)=u(t+2)
8  for i=1:length(t)
9      if t(i)<-2 then
10          h(i)=0;
11      else
12          h(i)=1;
13      end
14      //Define signal x(t)=exp^(-2*t)*u(t)
15      if t(i)<0 then
16      x(i)=0;
17  else
18      x(i)=exp(-2.*t(i));
19  end
20  end
21  y=convol(h,x);//convolution is done
22  f=scf(0);
23  subplot(3,1,1);
```

```
24  plot(h,t,'red');
25  xtitle('h[t]');
26  subplot(3,1,2);
27  plot(x,t,'blue');
28  xtitle('x[t]');
29  subplot(3,1,3);
30  t1=-8:.01:8;
31  plot(t1,y,'green');
32  xtitle('y[n]');
33  xs2jpg(0, 'problem52-plot.jpg');
34  //Find the covolution Of the following signals.
35  //Example 4.7<iii>
36  clc;
37  clear;
38  close;
39  t=-4:.01:4;
40  //Define signal h(t)=u(t-2)
41  for i=1:length(t)
42      if t(i)<-1 then
43          h(i)=0;
44      else
45          h(i)=1;
46      end
47      //Define signal x(t)=u(t+1)
48      if t(i)<2 then
49      x(i)=0;
50  else
51      x(i)=1;
52  end
53  end
54  y=convol(h,x);//The convolution is done here.
55  subplot(3,1,1);
56  plot(h,t,'red');
57  xtitle('input response 2','t','h[t]');
58  subplot(3,1,2);
59  plot(x,t,'blue');
60  xtitle('input response 2','t','x[t]');
61  subplot(3,1,3);
```

```
62  t1 = -8:.01:8;
63  plot ( t1 , y , 'green ');
64  xtitle ('output response ','t ','y[t1]');
65  //Find the covolution Of the following signals.
66  //Example 4.7< ii >
67  clc ;
68  clear ;
69  close ;
70  t = -4:.01:4;
71  for i =1: length (t)
72          x(i)=exp(-abs (t(i)));
73          if t(i)<-1   then
74        h(i)=0;
75          else
76           h(i)=exp(-2.*(t(i)+1))  ;
77          end
78      end
79  y=convol (h,x);//Here convolution of the above two
        signals is done
80  subplot (3 ,1 ,1);
81  plot (h ,t , 'red ');
82  xtitle ('input response 2 ','t ','h[t]');
83  subplot (3 ,1 ,2);
84  plot (x ,t , 'blue ');
85  xtitle ('input response 2 ','t ','x[t]');
86  subplot (3 ,1 ,3);
87  t1 = -8:.01:8;
88  plot ( t1 , y , 'green ');
89  xtitle ('output response ','t ','y[t1]');
```

Scilab code Exa 4.8 Find the covolution Of the following signals

```
1  //Find the covolution Of the following signals.
2  //Example 4.8
3  clc ;
```

```
4  clear;
5  close;
6  t=-4:.01:4;
7  for i=1:length(t)
8      if t(i)>=0 & t(i)<=2 then
9          x(i)=1;
10     else
11         x(i)=0;
12     end
13     if t(i)>=0 & t(i)<=3 then
14     h(i)=1;
15 else
16     h(i)=0;
17 end
18 end
19 y=convol(h,x);//Convolution of the above two signals
       is done.
20 subplot(3,1,1);
21 plot(t,h,'red');
22 xtitle('input response 2','t','h[t]');
23 subplot(3,1,2);
24 plot(t,x,'blue');
25 xtitle('input response 2','t','x[t]');
26 subplot(3,1,3);
27 t1=-8:.01:8;
28 plot(t1,y,'green');
29 xtitle('output response','t','y[t1]');
```

Scilab code Exa 4.9 Find the covolution Of the following signals

```
1  //Find the covolution Of the following signals.
2  //Example 4.9
3  clc;
4  clear;
5  close;
```

```
6  t=-10:.01:10;
7  //input signal:x(t)=u(t-3)-u(t-5)
8  for i=1:length(t)
9      if t(i)<3 | t(i)>5 then
10          x(i)=0;
11     else
12          x(i)=1;
13     end
14     //h(t)=exp(-3*t)*u(t)
15     if t(i)>=0 then
16     h(i)=exp(-3.*t(i));
17 else
18     h(i)=0;
19 end
20 end
21 y=convol(h,x);//cconvolution of the above two
      signals
22 subplot(3,1,1);
23 plot(t,h,'red');
24 xtitle('input response 2','t','h[t]');
25 subplot(3,1,2);
26 plot(t,x,'blue');
27 xtitle('input response 2','t','x[t]');
28 subplot(3,1,3);
29 t1=-20:.01:20;
30 plot(t1,y,'green');
31 xtitle('output response','t','y[t1]');
```

Scilab code Exa 4.10 Find the covolution Of the following signal

```
1  //Find the covolution Of the following signals.
2  //Example 4.10
3  clc;
4  clear;
5  close;
```

```
 6  t = -20:.01:20;
 7  for i =1: length (t)
 8       if t(i) <0 | t(i) >2 then
 9            x(i) =0;
10       else
11            x(i) =1;
12       end
13       if t(i) >=10 then
14       h(i) =1;
15  else
16       h(i) =0;
17  end
18  end
19  y= convol (h,x);
20  subplot (3 ,1 ,1) ;
21  plot (t,h, 'red ');
22  xtitle ('input response 2 ','t ','h[t] ') ;
23  subplot (3 ,1 ,2) ;
24  plot (t,x, 'blue ');
25  xtitle ('input response 2 ','t ','x[t] ') ;
26  subplot (3 ,1 ,3) ;
27  t1 = -40:.01:40;
28  plot (t1 ,y, 'green ');
29  xtitle ('output response ','t ','y[t1] ') ;
```

Scilab code Exa 4.11 Find the covolution Of the following signals

```
1  //Find the covolution Of the following signals.
2  //Example 4.11
3  clc ;
4  clear ;
5  close ;
6  t = -5:.01:5;
7  for i =1: length (t)
8       if t(i) <0 | t(i) >2 then
```

66

```
9            x(i)=0;
10      else
11            x(i)=1;
12      end
13      if t(i)<-1 | t(i)>2 then
14      h(i)=0;
15 else
16      h(i)=2;
17 end
18 end
19 y=convol(h,x);
20 subplot(3,1,1);
21 plot(t,h,'red');
22 xtitle('input response 2','t','h[t]');
23 subplot(3,1,2);
24 plot(t,x,'blue');
25 xtitle('input response 2','t','x[t]');
26 subplot(3,1,3);
27 t1=-10:.01:10;
28 plot(t1,y,'green');
29 xtitle('output response','t','y[t1]');
```

Scilab code Exa 4.12 Find the convolution of the following signals

```
1 //Find the covolution Of the following signals.
2 //Example 4.12 <i>
3 clc;
4 clear;
5 close;
6 t=-5:.01:5;
7 for i=1:length(t)
8      if t(i)>=0 & t(i)<=2 then
9      x(i)=sin(%pi*t(i));
10 else
11      x(i)=0;
```

```
12        end
13  if t(i) <1 | t(i) >3 then
14        h(i)=0;
15  else
16        h(i)=1;
17  end
18  end
19  y=convol(h,x);//convolution of the above two signals
        is done here.
20  subplot(3,1,1);
21  plot(t,h,'red');
22  xtitle('input response 2','t','h[t]');
23  subplot(3,1,2);
24  plot(t,x,'blue');
25  xtitle('input response 2','t','x[t]');
26  subplot(3,1,3);
27  t1=-10:.01:10;
28  plot(t1,y,'green');
29  xtitle('output response','t','y[t1]');
30  //Find the covolution Of the following signals.
31  //Example 4.12 <ii>
32  clc;
33  clear;
34  close;
35  t=-5:.01:5;
36  for i=1:length(t)
37        if t(i) <0   then
38            x(i)=0;
39        elseif   t(i) <1 then
40            x(i)=1+t(i);
41        elseif t(i) <2 then
42        x(i)=1-t(i);
43  else
44        x(i)=0;
45  end
46  if t(i) <0 | t(i) >2 then
47        h(i)=0;
48  else
```

68

```scilab
49        h(i)=1;
50  end
51  end
52  y=convol(h,x);
53  subplot(3,1,1);
54  plot(t,h,'red');
55  xtitle('input response 2','t','h[t]');
56  subplot(3,1,2);
57  plot(t,x,'blue');
58  xtitle('input response 2','t','x[t]');
59  subplot(3,1,3);
60  t1=-10:.01:10;
61  plot(t1,y,'green');
62  xtitle('output response','t','y[t1]');
```

Chapter 7

Laplace Transform Analysis of Signals and Systems

Scilab code Exa 7.1.1 Find the laplace transform and Roc of the following signal

```
1  //Example 7.1.1
2  //Find the laplace transform and Roc of the
       following signal
3  clc;
4  close;
5  syms t;
6  a=5;
7   x=exp(-a*t);
8  b=6;c=7;
9  s=b+c*%i;
10 X=integrate((exp(-(a+s)*t)),'t',0,%inf);
11 disp(X);
12 disp(real(s));
13 disp('Since real(s)>-a,so the integral converges');
```

Scilab code Exa 7.1.2 Find the laplace transform and Roc of the following signal

```
1  //Example 7_1_2
2  //Find the laplace transform and Roc of the
       following signal.
3  clc;
4  t=-10:.01:10;
5  a=4;
6  for i=1:length(t)
7      if t(i)>0 then
8          x(i)=0;
9      else
10          x(i)=-exp(-a*t(i));
11      end
12  end
13  s=%s;
14  numfs=1;
15  denfs=s+.04;
16  fs=syslin('c',numfs/denfs);
17  fs1=csim('impulse',t,fs);
18  f=scf(0);
19  subplot(2,1,1);
20  plot2d(t,x,2);
21  xtitle('Phrasing');
22  xgrid;
23  subplot(2,1,2);
24  plot2d(t,fs1,1);
25  xtitle('Solution');
26  xgrid;
27  disp(fs);
28  disp('As  real(s)<-a,so the integral converges for
       real(s)<-a');
29  xs2jpg(0, 'EX7_1_2-plot-a.jpg');
```

Scilab code Exa 7.2 Find the laplace transform and Roc of the following signal

```
1  //Example 7.2
```

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```
2  //Find the laplace transform and Roc of the
      following signal
3  clc;
4  close;
5  syms t;
6   x=exp(-3*t)+exp(-2*t);
7  b=6;c=7;
8  s=b+c*%i;
9  X=integrate((exp(-(3+s)*t))+(exp(-(2+s)*t)),'t',0,
      %inf);
10 disp(X);
11 disp(real(s));
12 disp('Since real(s)>-2,so the integral converges');
```

Scilab code Exa 7.3 Find the laplace transform and Roc of the following signal

```
1  //Example 7.3
2  //Find the laplace transform and Roc of the
      following signal
3  clc;
4  close;
5  syms t;
6  a=3;b1=-8;
7   x1=exp(-a*t);
8  b=6;c=7;
9  s=b+c*%i;
10 X1=integrate((exp(-(a+s)*t)),'t',0,%inf);
11 x2=exp(-2*t);
12 X2=integrate((exp(-(b1+s)*t)),'t',-%inf,0);
13 disp(X1);
14  disp(X2);
15 X=X1+X2;disp(X);
16 disp(real(s));
17 disp('Since -a< real(s)>-b1,so the integral
      converges');
```

Scilab code Exa 7.4 Find the laplace transform

```
1  //Example 7.4
2  //Find the laplace transform
3  clc;
4  close;
5  syms t;
6  b=4;
7   a=2;c=1;
8  s=a+c*%i;
9  X1=integrate((exp(-(b+s)*t)),'t',0,%inf);
10  X2=integrate((exp(-(s-b)*t)),'t',-%inf,0);
11  disp(X1);
12   disp(X2);
13  X=X1+X2;disp(X)
14  disp(real(s));
15  disp('Since -b< real(s)<b,so the integral converges'
      );
```

Scilab code Exa 7.5 Find the laplace transform of the following signal

```
1  //Example 7.5.2
2  //Find the laplace transform of the following signal
      .
3  clc;
4  close;
5  t=-10:.01:10;
6  for i=1:length(t)
7      if t(i)>=0 then
8          x(i)=1;
9      else
```

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```
10              x(i)=0;
11          end
12   end
13   s=%s;
14   numfs=1;
15   denfs=s;
16   fs=syslin('c',numfs/denfs);
17   fs1=csim('impulse',t,fs);
18   disp(fs);
19   f=scf(0);
20   subplot(2,1,1);
21   plot2d(t,x,2);
22   xtitle('Phrasing');
23   xgrid;
24   subplot(2,1,2);
25   plot2d(t,fs1,1);
26   xtitle('solution');
27   xgrid;
28   xs2jpg(0,  'EX7_5-plot-a.jpg');
```

Scilab code Exa 7.6 Find the laplace transform

```
1   //Example 7.6
2   //Find the laplace transform
3   clc;
4   t=-5:.05:5;
5   w=2*%pi;
6   x=cos(w*t);
7   s=%s;
8   numfs=s;
9   denfs=s^2+w^2;
10  fs=syslin('c',numfs/denfs);
11  disp(fs);
12  fs1=csim('impulse',t,fs);
13  f=scf(0);
```

```
14  subplot(2,1,1);
15  plot2d(t,x,2);
16  xtitle('Phrasing');
17  xgrid;
18  subplot(2,1,2);
19  plot2d(t,fs1,1);
20  xtitle('Solution');
21  xgrid;
22  xs2jpg(0, 'EX7_6-plot-a.jpg');
```

Scilab code Exa 7.7 Find the laplace transform of the following signal

```
1  //Example 7.7.1
2  //Find the laplace transform of the following.
3  clc;
4  close;
5  syms t,;
6   x=1;
7   a=2;c=1;
8   s=a+c*%i;
9  X=integrate((exp(-s*t)),'t',2,%inf);
10   disp(X);
11  //Example 7.7.2
12  //Find the laplace transform .
13  clc;
14  t=-10:.01:10;
15  for i=1:length(t)
16      if t(i)>=0 then
17          x(i)=(t(i)^2)*exp(-2*t(i));
18      else
19          x(i)=0;
20      end
21  end
22  s=%s;
23  numfs=2;
```

```
24 denfs=(s+2)^3;
25 fs=syslin('c',numfs/denfs);
26 fs1=csim('impulse',t,fs);
27 disp(fs);
28 f=scf(0);
29 subplot(2,1,1);
30 plot2d(t,x,2);
31 xtitle('Phrasing');
32 xgrid;
33 subplot(2,1,2);
34 plot2d(t,fs1,1);
35 xtitle('Solution');
36 xgrid;
37 xs2jpg(0, 'EX7_7_2-plot-a.jpg');
```

Scilab code Exa 7.8 Find the laplace transform

```
1 //Example7.8
2 //Find the laplace transform .
3 clc;
4 s=%s;t=-10:10;
5 numfs=2*s;
6 denfs=s^2-8;
7 fs=syslin('c',numfs/denfs);
8 fs1=csim('impulse',t,fs);
9 f=scf(0);
10 plot2d(t,fs1,1);
11 xtitle('Solution');
12 xgrid;
13 xs2jpg(0, 'problem110-plot-a.jpg')
14 disp(fs,'fs=');
```

Scilab code Exa 7.11 find the laplace transform

```
1 //Example 7.11
2 //Find the laplace transform .
3 clc;
4 t=-10:.01:10;
5 for i=1:length(t)
6     if t(i)>=0 then
7         x(i)=exp(-2.*t(i))*sin(2*t(i));
8     else
9         x(i)=0;
10     end
11 end
12 s=%s;
13 numfs=2;
14 denfs=(s+2)^2+4;
15 fs=syslin('c',numfs/denfs);
16 fs1=csim('impulse',t,fs);
17 disp(fs);
18 f=scf(0);
19 subplot(2,1,1);
20 plot2d(t,x,2);
21 xtitle('Phrasing');
22 xgrid;
23 subplot(2,1,2);
24 plot2d(t,fs1,1);
25 xtitle('Solution');
26 xgrid;
27 xs2jpg(0, 'problem109-plot-a.jpg');
```

Scilab code Exa 7.16 Find the laplace transform of the following signals

```
1 //Example7.16.1
2 //Find the laplace transform .
3 clc;
4 s=%s;t=-5:5;
5 numfs=s^2+4*s+3;
```

```
6   denfs =( s ^2+4* s +5) ^2;
7   fs=syslin ( 'c ' , numfs / denfs ) ;
8   fs1=csim ( 'impulse ' , t , fs ) ;
9   plot2d ( t , fs1 ,1) ;
10  xtitle ( 'Solution ' ) ;
11  xgrid ;
12  disp ( fs ) ;
13  //Example7 .16.2
14  //Find the laplace transform .
15  clc ;
16  s=%s ; t =-5:5;
17  numfs =s +3;
18  denfs =( s ^2+6* s +10) ;
19  fs=syslin ( 'c ' , numfs / denfs ) ;
20  fs1=csim ( 'impulse ' , t , fs ) ;
21  f=scf (0) ;
22  plot2d ( t , fs1 ,1) ;
23  xtitle ( 'Solution ' ) ;
24  xgrid ;
25  xs2jpg (0 , 'EX7_16_2−plot−a . jpg ' ) ;
26  disp ( fs ) ;
27  //Example7 .16.3
28  //Find the laplace transform .
29  clc ;
30  s=%s ; t =-5:5;
31  numfs =( s +2) ^2;
32  denfs =( s ^2+4* s +5) ^2;
33  fs=syslin ( 'c ' , numfs / denfs ) ;
34  fs1=csim ( 'impulse ' , t , fs ) ;
35  plot2d ( t , fs1 ,1) ;
36  xtitle ( 'Solution ' ) ;
37  xgrid ;
38  disp ( fs ) ;
```

Scilab code Exa 7.22 Find the laplace transform

```
1  //Example 7.22
2  //Find the laplace transform .
3  clc;
4  t=-10:.01:10;
5  for i=1:length(t)
6      y(i)=exp(-t(i))-2*exp(-2*t(i))+exp(-3*t(i));
7      x(i)=exp(-0.5*t(i));
8  end
9  s=%s;
10 numfs1=1;
11 denfs1=s+0.5;
12 fs=syslin('c',numfs1/denfs1);
13 numfs2=2;
14 denfs2=(s+1)*(s+2)*(s+3);
15 fs1=syslin('c',numfs2/denfs2);
16 hs=fs1/fs;
17 hs1=csim('impulse',t,hs);
18 subplot(3,1,1);
19 plot2d(t,x,2);
20 xtitle('Phrasing');
21 xgrid;
22 subplot(3,1,2);
23 plot2d(t,y,3);
24 xtitle('Phrasing');
25 xgrid;
26 subplot(3,1,3);
27 plot2d(t,hs1,1);
28 xtitle('Solution');
29 xgrid;
30 disp(fs,'fs=:');
31 disp(fs1,'fs1=:');
32 disp(hs,'hs=:');
```

Chapter 8

Fourier analysis of discrete time signals

Scilab code Exa 8.14 Find the convolution of the signals given below using fourier

```
1
2  //Example 8.14
3  //Find the convolution of the signals given below
      using fourier transform
4  clc;
5  clear all;
6  n=-10:10;
7  for i=1:length(n)
8      if n(i)>=0 then
9          x1(i)=(1/2)^n(i);
10         x2(i)=(1/3)^n(i);
11     else
12         x1(i)=0;
13         x2(i)=0;
14     end
15 end
16 subplot(3,2,1)
17 plot(x1,n);
18 xtitle('(a) x1(n)');
```

```
19  subplot(3,2,2)
20  plot(x2,n);
21  xtitle('(b) x2(n)');
22  X1=fft(x1,-1);
23  X2=fft(x2,-1);
24  subplot(3,2,3)
25  plot(X1,n);
26  xtitle('(c) X1(n)');
27  subplot(3,2,4)
28  plot(X2,n);
29  xtitle('(d) X2(n)');
30  X3=X2.*X1;
31  subplot(3,2,5)
32  plot(X3,n);
33  xtitle('(e) X3(n)');
34  x3=fft(X3,1);
35  disp(x3,'The result of convolution is:');
36  subplot(3,2,6)
37  plot(x3,n);
38  xtitle('(f) x3(n)');
```

Scilab code Exa 8.19 Use fourier transform to determine the response of the follow

```
1
2  //Example 8.19.1
3  //Use fourier transform to determine the response of
        the following signal
4  clc;
5  clear all;
6  n=-10:10
7  for i=1:length(n)
8      if n(i)>=1 then
9          x(i)=(3/4)^n(i);
10         h(i)=(1/2)^n(i);
11     else
```

```
12              x ( i ) = 0 ;
13              h ( i ) = 0 ;
14        end
15  end
16  subplot ( 3 , 2 , 1 )
17  plot ( x , n ) ;
18  xtitle ( ' ( a ) x ( n ) ' ) ;
19  subplot ( 3 , 2 , 2 )
20  plot ( h , n ) ;
21  xtitle ( ' ( b ) h ( n ) ' ) ;
22  X = fft ( x , -1 ) ;
23  H = fft ( h , -1 ) ;
24  subplot ( 3 , 2 , 3 )
25  plot ( X , n ) ;
26  xtitle ( ' ( c ) X ( n ) ' ) ;
27  subplot ( 3 , 2 , 4 )
28  plot ( H , n ) ;
29  xtitle ( ' ( d ) H ( n ) ' ) ;
30  Y = H .* X ;
31  subplot ( 3 , 2 , 5 )
32  plot ( Y , n ) ;
33  xtitle ( ' ( e ) Y ( n ) ' ) ;
34  y = fft ( Y , 1 ) ;
35  disp ( y , ' The output response is : ' ) ;
36  subplot ( 3 , 2 , 6 )
37  plot ( y , n ) ;
38  xtitle ( ' ( f ) y ( n ) ' ) ;
39
40
41  clf ( )
42
43  // Example 8.19.2
44  // Use fourier transform to determine the response of
         the following signal
45  clc ;
46  clear ;
47  n = -10:10
48  for i = 1 : length ( n )
```

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```
49      if n(i) >=1 then
50          x(i)=(-1)^n(i);
51          h(i)=(1/2)^n(i);
52      else
53          x(i)=0;
54          h(i)=0;
55      end
56 end
57 subplot(3,2,1)
58 plot(x,n);
59 xtitle('x(n)');
60 subplot(3,2,2)
61 plot(h,n);
62 xtitle('h(n)');
63 X=fft(x,-1);
64 H=fft(h,-1);
65 subplot(3,2,3)
66 plot(X,n);
67 xtitle('X(n)');
68 subplot(3,2,4)
69 plot(H,n);
70 xtitle('H(n)');
71 Y=H.*X;
72 subplot(3,2,5)
73 plot(Y,n);
74 xtitle('Y(n)');
75 y=fft(Y,1);
76 disp(y,'The output response is:');
77 subplot(3,2,6)
78 plot(y,n);
79 xtitle('y(n)');
```

Scilab code Exa 8.25 Find IDFT of the following signals

```
1 //Example 8.25.1
```

```
 2  //Find idft of the following
 3  clc;
 4  X=[1 1-%i*2 -1 1+%i*2];
 5  x=fft(X,1);
 6  disp(x);
 7  //Example 8.25.2
 8  //Find idft of the following
 9  clc;
10  X=[1 0 1 0];
11  x=fft(X,1);
12  disp(x);
```

Scilab code Exa 8.26 Find the circular convolution of two sequences

```
 1
 2  //Example 8.26
 3  //Find the circular convolution of two sequences
 4  clc;
 5  clear all;
 6  x1=[1 2 3 4];
 7  x2=[1 -1 2 1];
 8  X1=fft(x1,-1);
 9  X2=fft(x2,-1);
10  X3=X1.*X2;
11  x3=fft(X3,1);
12  disp(x3,'The circular convolution is:');
```

Scilab code Exa 8.27 Find the circular convolution of the following sequences

```
 1
 2  //Example 8.27
 3  //Find the circular convolution of the following
        sequences
```

```
4  clc ;
5  clear all ;
6  x1 =[1 -1 2 3];
7  x2 =[0 1 2 3];
8  X1=fft(x1,-1);//To obtain fourier transform of x1,
       −1 is taken.
9  X2=fft(x2,-1);
10 X3=X1.*X2;
11 x3=fft(X3,1);//+1 to obtain inverse fourier
       transform.
12 disp(x3,'Circular convolution of the above two
       sequences is:');
```

Scilab code Exa 8.28 Find the linear and circular convolution

```
1
2  //Example 8.28
3  //Find the linear and circular convolution
4  clc ;
5  clear all ;
6  x1 =[1 2 3 4];
7  x2 =[2 3 4 1];
8  //Linear convolution
9  z=convol(x1,x2);
10 disp(z,'The linear convolution is:');
11 //To obtain circular convolution
12 X1=fft(x1,-1);
13 X2=fft(x2,-1);
14 X3=X1.*X2;
15 x3=fft(X3,1);
16 disp(x3,'The circular convolution is:');
```

Scilab code Exa 8.29 Find DFT of the following sequences

```scilab
1  //Find dft of the following sequence
2  //Example 8.29.1
3  clc;
4  n=-10:10;
5  for i=1:length(n)
6      if n(i)==0 then
7          x(i)=1;
8      else
9          x(i)=0;
10      end
11 end
12 y=fft(x,-1);
13 disp(y,'The dft of the sequence is:');
14 //Find dft of the following sequence
15 //Example 8.29.2
16 clc;
17 n=-10:10;n0=2;
18 for i=1:length(n)
19      if n(i)==n0 then
20          x(i)=1;
21      else
22          x(i)=0;
23      end
24 end
25 y=fft(x,-1);
26 disp(y,'The dft of the sequence is:');
27 //Find dft of the following sequence
28 //Example 8.29.3
29 clc;
30 n=-10:10;a=2;
31 for i=1:length(n)
32      x(i)=a^n(i);
33 end
34 y=fft(x,-1);
35 disp(y,'The dft of the sequence is:');
```

Chapter 12

Random processes

Scilab code Exa 12.1 Show whether independent or not

```
1 //Example 12.1
2 //Show whether independent or not
3 disp('Two events are independent if P(A and B)=P(A)P
    (B)')
4 disp(0.28, 'P(A and B)=')
5 disp(0.8*0.35, 'P(A)*P(B)=')
6 disp('Hence A and B are independent')
```

Scilab code Exa 12.2 Find the probability of the problem

```
1 //Example 12.2
2 //Find the probability of the problem.
3 disp('The sample space in this case is:-');
4 disp('(1,1) (1,2) (1,3) (1,4) (1,5) (1,6)');
5 disp('(2,1) (2,2) (3,3) (4,4) (5,5) (6,6)');
6 disp('(3,1) (2,2) (3,3) (4,4) (5,5) (6,6)');
7 disp('(4,1) (2,2) (3,3) (4,4) (5,5) (6,6)');
8 disp('(5,1) (2,2) (3,3) (4,4) (5,5) (6,6)');
```

```
 9  disp('(6,1) (2,2) (3,3) (4,4) (5,5) (6,6)');
10  disp('Implies that N=36');
11  disp('Let A be the event of sum 7' );
12  disp('A={1,6} (2,5) (3,4) (4,3) (5,2) (6,1)} i.e n(A
        )=6' );
13  p_a=6/36;
14  disp(p_a,'Hence the probability of getting a sum 7
        is p(A)=6/36=' );
15  disp('Let B be the event of sum 11' );
16  disp('A={5,6} (6,5) } i.e n(B)=2' );
17  p_b=2/36;
18  disp(p_b,'Hence the probability of getting a sum 2
        is P(B)=2/36=' );
19  disp('Let C be the event of sum 7 or 11' );
20  disp('Probabilty of getting a sum of 7 or 11 ,P(C)=P
        (A)+P(B)' );
21  p_c=p_a+p_b;
22  disp(p_c,'Hence the probability of getting a sum 7
        or 11 is P(C)=' );
23  disp('Let D be the event of sum 3' );
24  disp('A={1,2} (2,1)} i.e n(A)=2' );
25  p_d=2/36;
26  disp(p_d,'Hence the probability of getting a sum 3
        is P(D)=2/36=' );
27  disp('Let E be the event of sum 2 or 12' );
28  disp('Probabilty of getting a sum of 2 or 12 ,P(E)=P
        (sum of 2)+P(sum of 12)' );
29  disp('P(sum of 2)=1/36  P(sum of 12)=1/36')
30  p_e=2/36;
31  disp(p_e,'Hence the probability of getting a sum of
        2 or 12 is P(E)=' );
32  disp('Let F be the event of sum 2 or 3 0r 12' );
33  disp('Probabilty of getting a sum of 2 or 3 or 12 ,P
        (F)=P(D)+P(E)' );
34  p_f=p_d+p_e;
35  disp(p_f,'Hence the probability of getting a sum 2
        or 3 or 12 is P(F)=' );
```

Scilab code Exa 12.3 Find the probability that tails shows up at least once

```
1 //Example12.3
2 //Find the probability that tails shows up at least
     once.
3 disp('Let A be the event that tail shows atleast
     once');
4 disp('Eac toss has two possible outcmes H ,T');
5 disp(2^3,'Hence the total no of outcomes is 2^3=');
6 disp(1-(1/2^3),'P(A)=1-Probability of getting all
     head i.e 1/8=');
```

Scilab code Exa 12.4 Probability to find the required sample size

```
1 //Example 12.4
2 //Probability to find the required sample size.
3 disp('Let A be the event of choosing a sample size
     of 6 containing two red, one green , two blue and
      one white blue ball.');
4 funcprot(0)
5 function c = combination ( n , r )
6 c = prod ( n : -1 : n-r+1 )/ prod (1:r)
7 endfunction
8 disp('The number of combination of choosing 6 balls
     from 14 balls is 14 C 6 ways')
9 disp('The number of combination of choosing 2 red
     balls from 4 balls is 4 C 2 ways')
10 disp('The number of combination of choosing 1 from 3
      green balls is 3 C 1 ways')
11 disp('The number of combination of choosing 2 from 5
      green balls is 5 C 2 ways')
```

```
12 disp('The number of combination of choosing 1 from 2
        white balls is 2 C 1 ways')
13 disp('P(A)={(4 C 2)*(3 C 1)*(5 C 2)*(2 C 1)}/(14 C
      6)=')
14 p=(combination(4,2)*combination(3,1)*combination
      (5,2)*combination(2,1))/combination(14,6);
15 disp(p);
```

Scilab code Exa 12.5 Probability to find the first white ball on the 3rd draw

```
1 //Example 12.5
2 //Probability to find the first white ball on the 3
     rd draw.
3 disp('Let A be the event of drawing the first white
      ball at the third draw from 15 balls ')
4 disp('Let W be the event of drawing a 10 white balls
      ')
5 disp('Let B be the event of drawing a 5 black balls'
     )
6 disp('Hence we have 1st draw :B  2nd Draw :B  3rd
     Draw :W');
7 funcprot(0)
8 function c = combination ( n , r )
9 c = prod ( n : -1 : n-r+1 )/ prod (1:r)
10 endfunction
11 disp('P(A)={(5 C 1)*(5 C 1)*(10 C 1)}/{(15 C 1)*(15
     C 1)*(15 C 1)}=')
12 p=(combination(5,1)*combination(5,1)*combination
     (10,1))/(combination(15,1)*combination(15,1)*
     combination(15,1))
13 disp(p)
```

Scilab code Exa 12.6 To find the required probabilities

```
1 //Example 12.6
2 //To find the required probabilities.
3 disp(100/500,'P(1 kilo-ohms)=100/500=');
4 disp(140/500,'P(20%)=140/500=');
5 disp((125/500)/(260/500),'P(10%/10 kilo-ohms)={P(10%
     )&P(10 kilo-ohms)}/{P(10 kilo-ohms)}=(125/500)
     /(260/500)');
```

Scilab code Exa 12.7 find the required probabilities

```
1 //Example 12.7
2 //find the required probabilities.
3 disp(((1/2)*(1/2))+((2/3)*(1/2)),'P(PMOS is chosen)
     =(P{PMOS/4}/P{4})+(P{PMOS/3}/P{3})=((1/2)*(1/2))
     +((2/3)*(1/2))=');
4 disp('Using Bayes Rule:')
5 disp('P{4/NMOS}=P(NMOS/4)*P(4)/P(NMOS)=')
6 disp('(1/2)*(1/2)/(1-(7/12))=')
7 disp((1/2)*(1/2)/(1-(7/12)))
```

Scilab code Exa 12.8 Find the given probabillities

```
1 //Example 12.8
2 //Find the given probabillities.
3 disp('P{R1/So}=0.15 and P{Ro/S}=0.75');
4 disp((1-0.15),'P{Ro/So}1-P{R1/So}');
5 disp((1-0.075),'P{R1/S1}1-P{Ro/S1}');
6 disp('P{R1}=P{R1/So}P(So)+P{R1/S1}P{S1}=');
7 disp(((0.15)*(0.85)+(0.925)*(1-0.85)),'(0.15)(0.85)
     +(0.925)(1-0.85)=');
8 disp('Using Bayes Rule:')
9 disp('P{S1/R1}=(P{R1/S1}P{S0})/P{R0}=');
10 p=(0.925*0.15/0.266)
```

```
11 disp(p,'(0.925)(1-0.85)/0.266=');
12 disp('P{Ro/So}P{So}/P{Ro}');
13 disp('P{Ro/So}P{So}/(P{Ro/So}P{So}+P{Ro/S1}P{S1}=');
14 p=(0.85)*(0.85)/((0.85)*(0.85)+(0.075)*(0.15))
15 disp(p,'(0.85)(0.85)/((0.85)(0.85)+(0.075)(0.15))=')
      ;
```

Scilab code Exa 12.9 Find the required probabilities

```
1 //Example 12.9
2 //Find the required probabilities.
3 disp('Let H be the event that Husband is alive')
4 disp('Let W be the event that wife is alive')
5 disp('P(H)=0.85    P(W)=0.9')
6 disp(0.85*0.9,'P(both alive)=P(H)P(W)=')
7 disp(0.15*0.1,'P(neither alive)=(1-P(H))(1-P(W))=')
8 disp(0.85+0.9-0.765,'P(Atleast one is alive)=P(H)+P(
    W)-P(both are alive)=')
9 disp('P(only one is alive)=P(Husband is alive and
     wife is dead)OR P(Husband is dead and wife is
     alive)')
10 disp('P(H)(1-P(W))+(1-P(H))P(W)=')
11 disp((0.85)*(1-0.9)+(1-0.85)*(0.9),'(0.85)(1-0.9)
    +(1-0.85)(0.9)=')
```

Scilab code Exa 12.10 find the required probabilities

```
1 //Example 12.10
2 //find the required probabilities.
3 disp('P(Plant shut down)=P(S1&S2&S3 is offline)or P(
    S1&S2 is offline)or P(S1&S3 are offline)=')
4 p=(0.01)*(0.03)*(0.05)+(0.01)*(0.03)*(1-0.05)+(0.01)
    *(1-0.03)*(0.05)
```

```
5  disp('(0.01)*(0.03)*(0.05)+(0.01)*(0.03)*(1−0.05)
       +(0.01)*(1−0.03)*(0.05)=')
6  disp(p)
7  disp(1-p,'P(Plant on line)=1−P(Plant shut down)=')
8  disp('P(plant is online/S1 failed)=')
9  disp((0.01)*(1-0.03)*(1-0.05)/0.01,'P(plant is
       online and S1 failed)/P(S1 failed)=(0.01)
       *(1−0.03)*(1−0.05)/0.01')
```

Scilab code Exa 12.11 Find the required probabilities

```
1  //Exampple 12.11
2  //Find the required probabilities.
3  disp(0.45,'Let SS be the event that Ramesh pass in
       Signal and systems, P(SS)=')
4  disp(0.32,'Let RP be the event that Ramesh pass in
       Random process P(RP)=')
5  disp(0.15,'P(passed in both)=')
6  disp('P(passed in either one subject)=P(SS U RP)')
7  disp(0.45+0.32-0.15,'P(SS)+P(RP)−P(passed in both)
       =0.45+0.32−0.15=')
8  disp(1-0.62,'P(passed in neither of the subjects)=1*
       P(passed in either subjects)=1−0.62=')
9  disp('P( passed in one subject)=');
10 disp(0.45*0.68+0.55*0.32,'P(SS)*P(failed in RP)+P(
       failed in SS)*P(RP)=(0.45)*(1−0.32)+(1−0.45)
       *(0.32)=')
11 disp(1-0.45,'P(failed in SS)=1−P(SS)=1−0.45')
```

Scilab code Exa 12.12 Find the required probabilities

```
1  //Example 12.12
2  //Find the required probabilities.
```

```
3  disp('P(A occurs exactly k times in N trials)=(n C K
      )[P(A)]^k[1-P(A)]^(N-k)')
4  disp('P(A)=1/6   P(~A)=5/6')
5  funcprot(0)
6  function c = combination ( n , r )
7  c = prod ( n : -1 : n-r+1 )/ prod (1:r)
8  endfunction
9  disp('P( 3 shows up exactly twice in 6 trials)=(6 c
      2)*(1/6)^2*(5/6)^4=')
10 p=combination(6,2)*(1/6)^2*(5/6)^4;
11 disp(p);
12 disp('P(4 shows up atleast twice)=1-P(4 does not
      shows up)-P(4 shows up once)')
13 disp('P(4 does not show up)=(6 c 0)*(1/6)^0*(5/6)^6=
      ')
14 p=combination(6,0)*(1/6)^0*(5/6)^6;
15 disp(p);
16 disp('P(4 shows up once)=(6 c 1)*(1/6)^1*(5/6)^5=')
17 p=combination(6,1)*(1/6)^1*(5/6)^5;
18 disp(p);
19 disp('P(4 shows up atleast twice)=1-(5/6)^6-(5/6)^5=
      ')
20 p=1-(5/6)^6-(5/6)^5;
21 disp(p);
```

Scilab code Exa 12.13 Find the required probabilities

```
1  //Example 12.13
2  //Find the required probabilities.
3  disp('P(X>0.6)=1-F(0.6)=')
4  disp(%e^(-1.2),'1-(1-e^(-1.2))=e^(-1.2)=')
5  disp(1-%e^(-0.5),'P(X<=0.25)=(1-e^(2*(-1.2)))=1-e
      ^(-0.5)=')
6  disp('P(0.4<X<=0.8)=F(0.8)-F(0.4)=')
7  disp((1-%e^(-1.6))-(1-%e^(-0.8)),'(1-e^(-1.6))-(1-e
```

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```
^(-0.8))=')
```

Scilab code Exa 12.14 Find the mean value of the current under following condition

```
1 //Example 12.14
2 //Find the mean value of the current under following
       conditions.
3 disp('I=Io[e^(nV)-1]')
4 disp('E[I]=E[Io[e^(nV)-1]]:')
5 Xo=0; X1=2;
6 X=integrate('%e^(10*X)-1','X',Xo,X1);
7 disp(10^(-9)*X/2,'Hence E[I]=')
```

Scilab code Exa 12.16 Find the following

```
1 //Example 12.16
2 //Find the following.
3 Xo=0;X1=1
4 X=integrate('2*X*((1-X)^2)','X',Xo,X1)
5 disp(X,'E[X]=')
6 Xo=0;X1=1
7 X2=integrate('2*X^2*((1-X)^2)','X',Xo,X1)
8 disp(X2,'E[X^2]=')
9 disp(6*X+3*(X2),'E[6X+3X^2]=6E[X]+3E[X^2]=')
10 disp(2*X+3,'E[2*X+3]=2E[X]+3=')
11 x1=2*X+3
12 disp(4*X2+9+12*X,'E[(2*X+3)^2]=E[4*X^2+9+12*X]=')
13 x2=4*X2+9+12*X
14 disp(x2-x1^2,'Variance of (2*X+3)=E[(2*x+3)^2]-{E[2*
       X+3]}^2=')
```

Scilab code Exa 12.17 Probablity that R lies between 110 and 120 ohm

```
1 //Example 12.17
2 //Probablity that R lies between 110 and 120 ohm
3 clc;
4 X0=110;
5 X1=120;
6 X=integrate('1/(130-100)','X',X0,X1);
7 disp(X,'The probability that R lies between 110 and
      120 is :');
```

Scilab code Exa 12.18 Find the mean and variance if they exist

```
1 //Example 12.18
2 //Find the mean and variance ,if they exist.
3 Xo=0;X1=1
4 X=integrate('X*(X^3/12)','X',Xo,X1)
5 disp(X,'E[X]=')
6 Xo=0;X1=1
7 X2=integrate('X^2*(X^3/12)','X',Xo,X1)
8 disp(X2,'E[X^2]=')
9 disp(X2-X^2,'Variance =E[X^2]-E[X]^2=')
10 x=1:1:5;
11 y=sum(x^2)/15;
12 disp(y,'E[X]=sum(x*f(x))=sum(x^2)/15')
13 y1=sum(x^3)/15;
14 disp(y1,'E[X]=sum(x^2*f(x))=sum(x^3)/15')
15 disp(y1-y^2,'Variance =E[X^2]-E[X]^2=')
```

Scilab code Exa 12.19 Find the required values

```
1 //Example 12.19
2 //Find the required values.
```

```
3  x=[0,0;8,8;8,0]
4  y=[0,0;3,3;0,3]
5  deff('z=f(x,y)','z=x/6')
6  I=int2d(x,y,f)
7  disp(I,'E[X]=')
8  deff('z=f(x,y)','z=y/6')
9  I=int2d(x,y,f)
10 disp(I,'E[Y]=')
11 deff('z=f(x,y)','z=x*y/6')
12 I=int2d(x,y,f)
13 disp(I,'E[XY]=')
```

Scilab code Exa 12.20 Find the correlation

```
1  Xo=0;X1=1
2  X=integrate('X*(X+0.5)','X',Xo,X1)
3  disp(X,'E[X]=')
4  Yo=0;Y1=1
5  Y=integrate('Y*(Y+0.5)','Y',Yo,Y1)
6  disp(Y,'E[Y]=')
7  x=[0,0;1,1;1,0]
8  y=[0,0;1,1;0,1]
9  deff('z=f(x,y)','z=x*y*(x+y)')
10 I=int2d(x,y,f)
11 disp(I,'E[XY]=')
12 disp(I-X*Y,'cov(X,Y)=E[XY]-E[X]E[Y]=');
13 cov=I-X*Y
14 Xo=0;X1=1
15 X2=integrate('X^2*(X+0.5)','X',Xo,X1)
16 disp(X2,'E[X^2]=')
17 Yo=0;Y1=1
18 Y2=integrate('Y^2*(Y+0.5)','Y',Yo,Y1)
19 disp(Y2,'E[Y^2]=')
20 disp(X2-X^2,'Variance of X=E[X^2]-E[X]^2)=')
21 v1=X2-X^2
```

```
22  disp(Y2-Y^2,'Variance of Y=E[Y^2]-E[Y]^2)=')
23  v2=Y2-Y^2
24  disp(cov/sqrt(v1*v2),'Correlation coefficient of X
      and Y=cov(X,Y)/(s.d of X*s.d of Y)=')
```

Scilab code Exa 12.52 Find the average power

```
1  //Example 12.52
2  //Find the average power.
3  Xo=-(4*%pi);X1=4*%pi
4  X=integrate('(1-(X/(4*%pi)))','X',Xo,X1)
5  disp(X/(4*%pi),'Average Power=')
```