Scilab Textbook Companion for Digital Principals And Applications by D. P. Leach And A. P. Malvino[1]

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May 16, 2016

[1]Funded by a grant from the National Mission on Education through ICT, http://spoken-tutorial.org/NMEICT-Intro. This Textbook Companion and Scilab codes written in it can be downloaded from the "Textbook Companion Project" section at the website http://scilab.in

Book Description

Title: Digital Principals And Applications

Author: D. P. Leach And A. P. Malvino

Publisher: Tata McGraw - Hill, New Delhi

Edition: 6

Year: 2006

ISBN: 0-07-060175-5

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.

Contents

List of Scilab Codes

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Chapter 1

Digital Principles

Scilab code Exa 1.1 Finding duty cycle

```
1 //Example 1.1
2 clc;
3 clear;
4 f= 5 * 10^6  ; //given
5 T=1/f; // caculating the time period .
6 H = 0.05 * 10^-6 / T ;
7 printf('Time period of the waveform is T = %f us\n',
     T); //displaying results
8 printf(" Duty cycle H = %f %%",H*100);
```

Scilab code Exa 1.2 Maximum decimal count for a counter

```
1 //Example 1.2
2 clc;
3 clear;
4 n=8; // given no of flip flops
5 max_count = 2^n -1 ;
6 printf("Maximum count = %d",max_count);
```

Chapter 2

Digital Logic

Scilab code Exa 2.1 7404 waveform

```
1  //exmaple 2.1
2  //7404
3  clc
4  close
5  clear
6  //frq= input('Enter the square wave frequency in KHz
       :');
7  frq=1 ;// frequency in KHz
8  t=(1/frq)*100;
9  t=round(t)
10 for r=1:t*10
11     inputc(r)=0;
12     outputc(r)=0;
13 end
14 p=1;
15 while p<t*10                          // making arrays
       to plot the curve
16     if p==1 | modulo(p,t)==0 then
17         for k=1:t/2
```

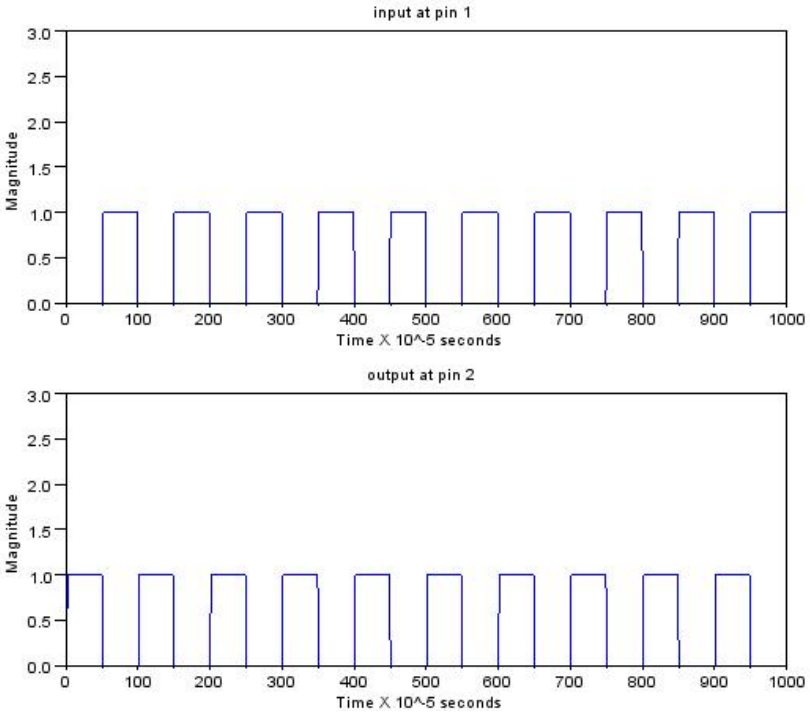

Figure 2.1: 7404 waveform

```
18              inputc(p+k)=0;
19              outputc(p+k)=1;
20          end
21          p=p+t/2;
22          else
23              inputc(p)=1;
24              outputc(p)=0;
25              p=p+1;
26          end
27  end
28  y=[3 3];
29  subplot(2,1,1)       //ploting the curves
30  title('input at pin 1')
31  xlabel('Time X 10^-5 seconds');
32  ylabel('Magnitude')
33  plot(inputc)
34  plot(y)
35  subplot(2,1,2)
36  title('output at pin 2')
37  xlabel('Time X 10^-5 seconds');
38  ylabel('Magnitude')
39  plot(outputc)
40  plot(y)
```

Scilab code Exa 2.2 7404 waveform

```
1  //exmaple 2.2
2  //7404
3  clc
4  close
5  clear
6  //frq= input('Enter the square wave frequency in KHz
       :');
```

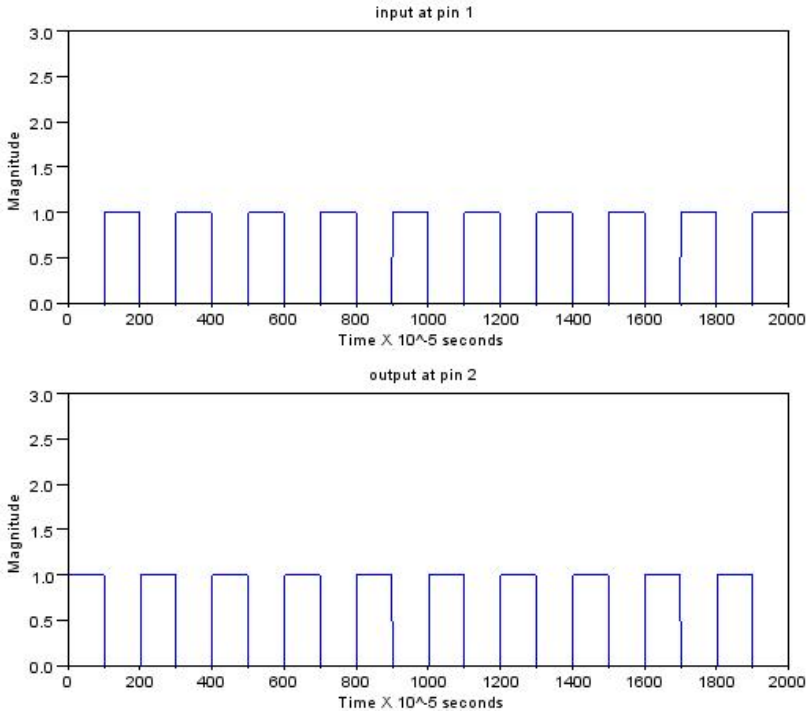

Figure 2.2: 7404 waveform

```
frq=0.5 ;//KHz
t=(1/frq)*100;
t=round(t)
for r=1:t*10
    inputc(r)=0;
    outputc(r)=0;
end
p=1;
while p<t*10                                          //
   making arrays t plot the curve
    if p==1 | modulo(p,t)==0 then
        for k=1:t/2
            inputc(p+k)=0;
            outputc(p+k)=1;
        end
        p=p+t/2;
        else
            inputc(p)=1;
            outputc(p)=0;
            p=p+1;
        end
end
y=[3 3];
subplot(2,1,1)    //ploting the graphs
title('input at pin 1')
xlabel('Time X 10^-5 seconds');
ylabel('Magnitude')
plot(inputc)
plot(y)
subplot(2,1,2)
title('output at pin 2')
xlabel('Time X 10^-5 seconds');
ylabel('Magnitude')
plot(outputc)
plot(y)
```

Scilab code Exa 2.3 truth table for given figure

```
1  // exmple 2.3
2  clc
3  clear
4  close
5  a=[0 0 1 1];
6  b=[0 1 0 1];
7  for i=1:4
8      r(i)= bitor(bitcmp(a(i),1), bitcmp(b(i),1))
          // given expression
9  end
10 disp('   A      B      Y')
11 for i = 1 : 4
12          Y(i,1)=a(i);
13          Y(i,2)=b(i);
14          Y(i,3)=r(i);
15          end
16 disp(Y);  //displaying truth table
17 disp('''1'' represents a HIGH(H) and ''0''
     represents a LOW(L)')
```

Scilab code Exa 2.4 truth table for given figure

```
1  // exmple 2.4
2  clear
3  clc
4  a=[0 0 1 1];
5  b=[0 1 0 1];
6  for i=1:4
7      r(i)= bitand(bitcmp(a(i),1), bitcmp(b(i),1)) //
          given expression
```

```
end
disp('   A      B      Y')
for i = 1 : 4
        Y(i,1)=a(i);
        Y(i,2)=b(i);
        Y(i,3)=r(i);
        end
disp(Y);  //displaying truth table
disp('''1'' represents a HIGH(H) and ''0''
   represents a LOW(L)')
```

Scilab code Exa 2.9 proving two circuits are logically equal

```
//Example 2.9
clc
clear
close
a=[0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1];
b=[0 0 0 0 1 1 1 1 0 0 0 0 1 1 1 1];
c=[0 0 1 1 0 0 1 1 0 0 1 1 0 0 1 1];
d=[0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1];
for i=1:16       // finding Y for all 16 cases
    x=bitor(a(i),b(i));
    y=bitor(c(i),d(i));
    r(i)=bitand(x,y);
    x1=bitcmp(x,1);
    y1=bitcmp(y,1);
    z=bitor(x1,y1);
    r1(i)=bitcmp(z,1);
end
disp('   Y    Y1');
for i = 1 : 16
        Y(i,1)=r1(i);
        Y(i,2)=r(i);
        end
```

```
23 disp(Y); //displaying result
24 disp('Both are logically equivalent');
```

Scilab code Exa 2.10 truth table for NOR NOR circuit

```
1  // exmple 2.10
2  clc
3  clear
4  a=[0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1];
5  b=[0 0 0 0 1 1 1 1 0 0 0 0 1 1 1 1];
6  c=[0 0 1 1 0 0 1 1 0 0 1 1 0 0 1 1];
7  d=[0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1];
8  for i=1:16
9      x=bitor(a(i),b(i));
10     y=bitor(c(i),d(i));
11     r(i)=bitand(x,y);
12 end
13 disp('Truth table :');
14 disp('   A     B     C     D     Y')
15 for i = 1 : 16  //displaying truth table
16         Y(i,1)=a(i);
17         Y(i,2)=b(i);
18         Y(i,3)=c(i);
19         Y(i,4)=d(i);
20         Y(i,5)=r(i);
21         end
22 disp(Y);
```

Scilab code Exa 2.11 timing diagram for NOR NOR

```
1  // exmple 2.11
```

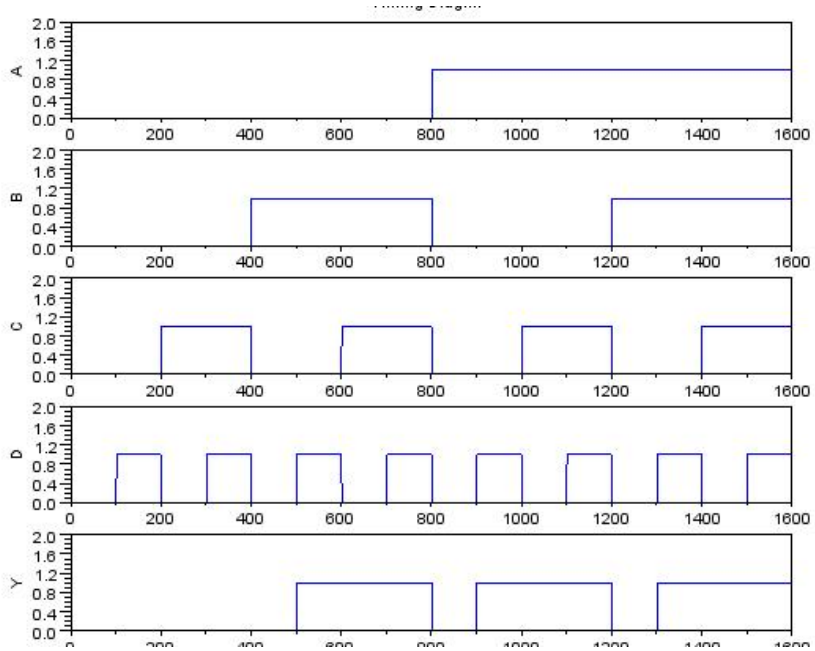

Figure 2.3: timing diagram for NOR NOR

```
clc
clear
close
a=[0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1];
b=[0 0 0 0 1 1 1 1 0 0 0 0 1 1 1 1];
c=[0 0 1 1 0 0 1 1 0 0 1 1 0 0 1 1];
d=[0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1];
for i=1:16
    x=bitor(a(i),b(i));
    y=bitor(c(i),d(i));
    r(i)=bitand(x,y);
end
Y=r
ap=1;
bp=1;
cp=1;
dp=1;Yp=1;
for i=1:16      //Making array to plot the timing
```

```
    diagram
20      if a(i)==1 then
21          for o=1:100
22          a1(ap)=1;
23          ap=ap+1;
24          end
25      else
26          for o=1:100
27          a1(ap)=0;
28          ap=ap+1;
29          end
30  end
31  if b(i)==1 then
32          for o=1:100
33          b1(bp)=1;
34          bp=bp+1;
35                  end
36      else
37          for o=1:100
38          b1(bp)=0;
39          bp=bp+1;
40          end
41
42  end
43  if c(i)==1 then
44          for o=1:100
45          c1(cp)=1;
46          cp=cp+1;
47          end
48      else
49          for o=1:100
50          c1(cp)=0;
51          cp=cp+1;
52          end
53  end
54  if d(i)==1 then
55          for o=1:100
56          d1(dp)=1;
```

```
57          dp=dp+1;
58          end
59      else
60          for o=1:100
61          d1(dp)=0;
62          dp=dp+1;
63          end
64      end
65  if Y(i)==1 then
66          for o=1:100
67          Y1(Yp)=1;
68          Yp=Yp+1;
69          end
70      else
71          for o=1:100
72          Y1(Yp)=0;
73          Yp=Yp+1;
74          end
75      end
76  end
77  z=[2 2];
78  subplot(5,1,1);    //plotting timing diagram
79  title('Timing Diagrm');
80  plot(z);
81  plot(a1);
82  ylabel('A');
83  subplot(5,1,2);
84  plot(z);
85  ylabel('B');
86  plot(b1);
87  subplot(5,1,3);
88  plot(z);
89  ylabel('C');
90  plot(c1);
91  subplot(5,1,4);
92  plot(z);
93  ylabel('D');
94  plot(d1);
```

```
95 subplot(5,1,5);
96 plot(z);
97 ylabel('Y');
98 xlabel('Time in milli seconds');
99 plot(Y1);
```

Scilab code Exa 2.12 proving two circuits are logically equal

```
1  //Example 2.12
2  clc
3  clear
4  a=[0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1];
5  b=[0 0 0 0 1 1 1 1 0 0 0 0 1 1 1 1];
6  c=[0 0 1 1 0 0 1 1 0 0 1 1 0 0 1 1];
7  d=[0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1];
8  for i=1:16 // finding Y and y1 for all possible inpt
       cases
9      x=bitand(a(i),b(i));
10     y=bitand(c(i),d(i));
11     r(i)=bitor(x,y);
12     x1=bitcmp(x,1);
13     y1=bitcmp(y,1);
14     z=bitand(x1,y1);
15     r1(i)=bitcmp(z,1);
16 end
17 disp('   Y    Y1');
18 for i = 1 : 16 // displaying result
19         Y(i,1)=r(i);
20         Y(i,2)=r1(i);
21         end
22 disp(Y);
23 disp('Both are logically equivalent');
```

Scilab code Exa 2.13 truth table for NAND NAND circuit

```
// exmple 2.13
//NAND - NAND
clc
clear
close
a=[0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1];
b=[0 0 0 0 1 1 1 1 0 0 0 0 1 1 1 1];
c=[0 0 1 1 0 0 1 1 0 0 1 1 0 0 1 1];
d=[0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1];
for i=1:16
    x=bitand(a(i),b(i));
    y=bitand(c(i),d(i));
    r(i)=bitor(x,y);
end
disp('Truth table :');
disp('   A     B     C     D     Y')
for i = 1 : 16   // displaying the truth table
        Y(i,1)=a(i);
        Y(i,2)=b(i);
        Y(i,3)=c(i);
        Y(i,4)=d(i);
        Y(i,5)=r(i);
end
disp(Y);
```

Scilab code Exa 2.14 timing diagram for NAND NAND circuit

```
// exmple 2.14
clc
clear
close
```

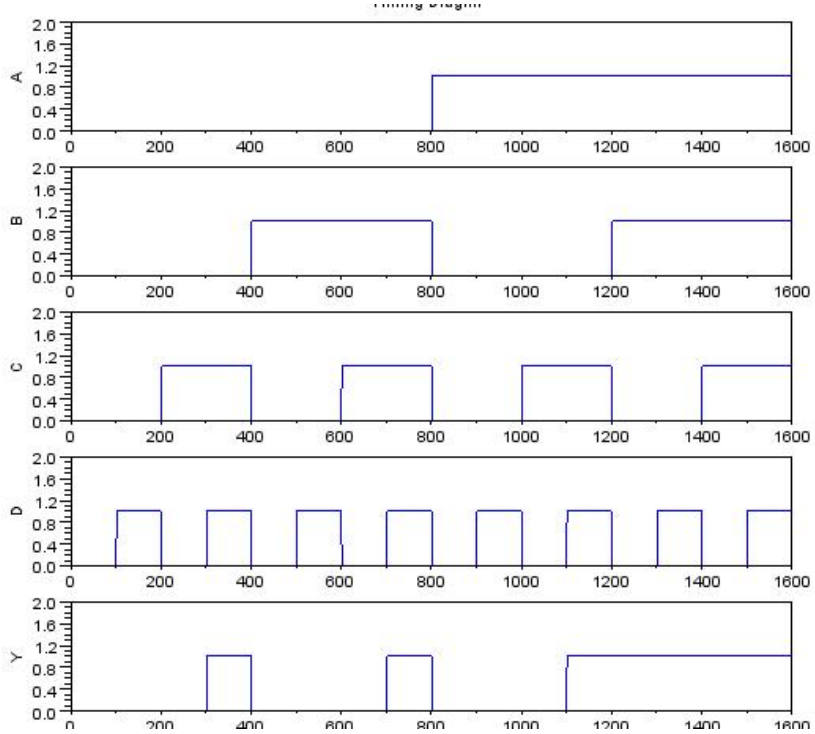

Figure 2.4: timing diagram for NAND NAND circuit

```
a=[0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1];
b=[0 0 0 0 1 1 1 1 0 0 0 0 1 1 1 1];
c=[0 0 1 1 0 0 1 1 0 0 1 1 0 0 1 1];
d=[0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1];
for i=1:16
    x=bitand(a(i),b(i));
    y=bitand(c(i),d(i));
    r(i)=bitor(x,y);
end
Y=r
ap=1;
bp=1;
cp=1;
dp=1;Yp=1;
for i=1:16     //Making arrays to plot the timing
   diagram
    if a(i)==1 then
        for o=1:100
        a1(ap)=1;
        ap=ap+1;
        end
    else
        for o=1:100
        a1(ap)=0;
        ap=ap+1;
        end

end
if b(i)==1 then
        for o=1:100
        b1(bp)=1;
        bp=bp+1;
        //z(bp)=3
        end
    else
        for o=1:100
        b1(bp)=0;
        bp=bp+1;
```

```
42          //z(bp)=3
43          end
44
45  end
46  if c(i)==1 then
47          for o=1:100
48          c1(cp)=1;
49          cp=cp+1;
50          end
51      else
52          for o=1:100
53          c1(cp)=0;
54          cp=cp+1;
55          end
56
57  end
58  if d(i)==1 then
59          for o=1:100
60          d1(dp)=1;
61          dp=dp+1;
62          end
63      else
64          for o=1:100
65          d1(dp)=0;
66          dp=dp+1;
67          end
68
69      end
70  if Y(i)==1 then
71          for o=1:100
72          Y1(Yp)=1;
73          Yp=Yp+1;
74          end
75      else
76          for o=1:100
77          Y1(Yp)=0;
78          Yp=Yp+1;
79          end
```

```
80
81      end
82
83  end
84  z=[2 2];
85  subplot(5,1,1);    //plotting timing diagram
86  title('Timing Diagrm');
87  plot(z);
88  plot(a1);
89  ylabel('A');
90  subplot(5,1,2);
91  plot(z);
92  ylabel('B');
93  plot(b1);
94  subplot(5,1,3);
95  plot(z);
96  ylabel('C');
97  plot(c1);
98  subplot(5,1,4);
99  plot(z);
100 ylabel('D');
101 plot(d1);
102 subplot(5,1,5);
103 plot(z);
104 ylabel('Y');
105 xlabel('Time in milli seconds');
106 plot(Y1);
```

Scilab code Exa 2.15 detecting all bits low in a register

```
1  //example 2.15
2  clc
3  clear
4  s=0; // s from the register
5  s(1)=input('Enter the value at S0 :')
```

```
s(2)=input('Enter the value at S1 :')
s(3)=input('Enter the value at S2 :')
s(4)=input('Enter the value at S3 :')
s(5)=input('Enter the value at S4 :')
s(6)=input('Enter the value at S5 :')
s(7)=input('Enter the value at S6 :')
s(8)=input('Enter the value at S7 :')
count =0;
for i =1 :8 //loop to detect a '1'
    if s(i)==1 then
        disp('ZERO is LOW');
        break;
    end
    count =count+1;
end
if count==8 then
    disp('ZERO is HIGH');
end;
```

Chapter 3

Combinational Logic Circuits

Scilab code Exa 3.1 Boolean Algebra

```
1 //example 3.1
2 clc;
3 clear;
4 disp("we can minimize the given equation as:");
5 disp('Y = AB'' + AB  = A(B'' + B)');
6 disp('Therefore,    Y =  A(1) = A');
7 disp('this says that output Y equals to A, so all we
     hve to do is connect a wire between input A and
    output Y.');
```

Scilab code Exa 3.2 Boolean Algebra

```
1 //example 3.2
2
3 clc;
4 clear;
5 disp("Multipl the factors of the foregoing equation
    to get");
```

```
disp('Y = A''A + A''B + BA +BB');
disp('it becomes,    Y =  A''B + AB + B ');
disp('We can factor the foregooing equation as
   follows :');
disp('Y =  B(A'' + A) + B = B + B = B ');
disp('this says that output Y equals to B, so all we
    have to do is connect a wire between input B and
    output Y.');
```

Scilab code Exa 3.3 Testing a circuit using logic clip

```
//example 3.3
clc;
clear;
//disp(' Enter the inputs for AND gate ');
//for i=1:7
//printf("Enter wether the led %d is on or off (1 or
    0) :",i);
//a(i)=input('');
//end;
//disp('Enter the inputs for OR gate' )
//for i=1:7
//printf("Enter wether the led %d is on or off (1 or
    0) :",i);
//b(i)=input('');
//end;
a= [0 1 0 1 1 0 0]; //lights on a logic clip
b= [0 0 0 0 1 1 0];
k=bitand(a(1),a(2));
k2 = bitand(a(4),a(5));
k3=bitor(b(1),b(2));
k4 = bitor(b(4),b(5));
if a(3) ~= k then // checking which gate is faulty
    disp("The first  AND gate is diffective ");
elseif  a(6) ~= k2 then
```

```
23          disp("The second AND gate is diffective ");
24   elseif b(3) ~= k3 then
25       disp("The first OR gate is diffective ");
26  elseif  b(6) ~= k4 then
27          disp("The second OR gate is diffective ");
28       else
29          disp('All the gates are working correctly');
30  end
```

Scilab code Exa 3.4 Sum of Products

```
1  //example 3.4
2  clc;
3  clear;
4  disp('Given the truth table has high output for
       following conditons :');
5  a=[0 0 0 ; 0 1 0 ; 1 0 0 ; 1 1 0 ] //given iput
       conditions for which output is high
6  disp(a)
7  for (i=1:4)
8       if  a(i,1)==1 then
9           b(i,1)= 'A'
10      else
11          b(i,1)= 'A^'
12      end
13      if  a(i,2)==1 then
14          b(i,2)= 'B'
15      else
16          b(i,2)= 'B^'
17      end
18      if  a(i,3)==1 then
19          b(i,3)= 'C'
20      else
21          b(i,3)= 'C^'
22      end
```

```
23 end
24 disp('When you OR these products you get :') //
     displaying sum of products
25 x=strcat([b(1,1) b(1,2) b(1,3) " + " b(2,1) b(2,2) b
     (2,3) " + " b(3,1) b(3,2) b(3,3) " + " b(4,1) b
     (4,2) b(4,3)]);
26 disp(x)
```

Scilab code Exa 3.5 Boolean Algebra

```
1 //example 3.5
2 clc;
3 clear;
4 disp('The boolean equation is :');
5 disp('Y = A''B''C'' + A''BC'' + AB''C'' + ABC''');
6 disp('Since C'' is common to each term, factor as
     follows :');
7 disp('Y = (A''B + A''B + AB'' AB)C''');
8 disp('Again, factor to get :');
9 disp('Y = [A''(B'' + B) + A(B'' + B)]C''');
10 disp('Now, simplify the foregoing as follows :');
11 disp('Y=[A''(1) + A(1)]C'' = (A'' + A)C''');
12 disp(' or   Y= C''');
13 disp('This final equation means that you don''t even
     need a logic circuit. All you need is a wire
     connecting input C'' to output Y.');
```

check Appendix AP 10 for dependency:

`kmap.sci`

check Appendix AP 2 for dependency:

`noof.sci`

Scilab code Exa 3.6 Gives a simplified Boolean equation

```
1 //example 3.6
2 // this program needs kmap.sci and noof.sci
3  clc
4  Y=[7 9 10 11 12 13 14 15];//given logic equation
5  k=[0 0 0 0;0 0 1 0 ; 1 1 1 1; 0 1 1 1]; //
     minimizing it using 4-variable kmap
6  disp("The minimal expression of Y from the
     following Kmap is :');
7  kmap(k); //calling the Kmap function
```

---

check Appendix AP 10 for dependency:

`kmap.sci`

check Appendix AP 2 for dependency:

`noof.sci`

Scilab code Exa 3.7 simplest logic for given Truth table

```
1 //example 3.7
2 // this program needs kmap.sci and noof.sci
3 clc;
4 disp('The kanaurgh map for given truth table will be
     :');
5 disp('      C''D''  C''D  CD  CD'''); //displaying
     the given kmap
6 disp('A''B''    1    0    0   0');
7 disp('A''B     0    0    0   0');
8 disp('AB       x    x    x   x');
9 disp('AB''     0    0    x   x');
10 disp('The truth table has output one only for the
     input condition 0000. The corresponding
     fundamental product is A''B''C''D''');
11 k=[1 0 0 0 ; 0 0 0 0; 0 0 0 0;0 0 0 0];
12 kmap(k);//calling the Kmap function
```

check Appendix AP 10 for dependency:

kmap.sci

check Appendix AP 2 for dependency:

noof.sci

Scilab code Exa 3.8 simplest logic for given logic equation

```
1 //example 3.8
2 // this program needs kmap.sci and noof.sci
3 clc;
4 disp('      C''D''  C''D  CD  CD''');//displaying
     the given kmap
5 disp('A''B''    0    0    0   0');
6 disp('A''B     0    0    1   0');
7 disp('AB       x    x    x   x');
8 disp('AB''     0    0    x   x');
9 k=[0 0 0 0;0 0 1 0;0 0 1 0;0 0 0 0];
10 disp('In a Karnaugh map if don''t care condition
     exits, we may consider them as ones if that gives
      a larger group size.');
11 disp('The minimal expression from the given kmap is
     ');
12 kmap(k); //calling the kamp function
```

Scilab code Exa 3.9 Product of sums

```
1 //example 3.4
2 clc;
3 clear;
```

```
4  disp('Given the truth table has high output for
       following conditons :');
5  a=[0 0 0 ; 0 0 1 ; 0 1 0 ] //given truth table
6  disp(a)
7
8  for (i=1:3) //finding the terms in pos
9      if  a(i,1)==0 then
10         b(i,1)= 'A'
11     else
12         b(i,1)= 'A^'
13     end
14     if  a(i,2)==0 then
15         b(i,2)= 'B'
16     else
17         b(i,2)= 'B^'
18     end
19     if  a(i,3)==0 then
20         b(i,3)= 'C'
21     else
22         b(i,3)= 'C^'
23     end
24 end
25 disp(b)
26 disp('The product-of-sums equation is  :') //
       displaying the POS
27 x=strcat(["(" b(1,1) " + " b(1,2) " + " b(1,3) ")" "
       (" b(2,1) " + " b(2,2) " + " b(2,3) ")" "(" b
       (3,1) " + " b(3,2) " + " b(3,3) ")" ]);
28 disp(x)
```

---

check Appendix AP 10 for dependency:

`kmap.sci`

check Appendix AP 2 for dependency:

`noof.sci`

Scilab code Exa 3.10 sop for the karnaugh map

```
1 //example 3.10
2 // this program needs kmappos.sci and noof.sci
3
4 k=[0 0 0 0;0 0 0 1; 1 1 1 1;1 1 1 1];
5 disp("The minimal expression of Y from the following
      Kmap is :');
6 kmap(k);
7 disp('After complimenting and simplifying the
     Krarnugh map we get Y =:');
8 k=[1 1 1 1;1 1 1 0; 0 0 0 0;0 0 0 0 ];
9 kmap(k); //calling the Kmap function
```

---

check Appendix AP 11 for dependency:

`kmappos.sci`

check Appendix AP 2 for dependency:

`noof.sci`

Scilab code Exa 3.11 POS form of karnaugh map

```
1 //example 3.11
2 // this program needs kmappos.sci and noof.sci
3
4 clc
5 disp('The given kmap is '); //displaying the given
     kmap
6 disp('       C''D''  C''D  CD  CD''');
7 disp('A''B''     0     0     0    0');
8 disp('A''B       0     0     0    1');
9 disp('AB         1     1     1    1');
10 disp('AB''       1     1     1    1');
11 disp("The simplest POS form of following Kmap is :')
     ;
```

```
12
13 k= [0 0 0 0;0 0 0 1 ;1 1 1 1; 1 1 1 1];
14 kmappos(k);//calling the Kmappos function
```

check Appendix AP 11 for dependency:

`kmappos.sci`

check Appendix AP 2 for dependency:

`noof.sci`

Scilab code Exa 3.12 POS form of karnaugh map

```
1 //example 3.12
2 clc
3 disp('The given kmap is '); //displaying the given
    kmap
4 disp('      C''D''  C''D  CD  CD''');
5 disp('A''B''    0    0    1   0');
6 disp('A''B      0    0    1   1');
7 disp('AB        x    x    x   1');
8 disp('AB''      x    x    x   0');
9 disp('In a Karnaugh map if don''t care condition
    exits, we may consider them as zeros if that
    gives a larger group size.');
10 disp("The simplest POS form of following Kmap is :')
    ;
11
12 k= [0 0 1 0;0 0 1 1 ;0 0 1 1; 0 0 1 0];
13 kmappos(k); //calling the Kmappos function
```

Scilab code Exa 3.13 Quine Mc clusky method

```
1  //example 3.1
2  clc;
3  clear;
4  a=[0 0 0 0 1 1 1 1;0 0 1 1 0 0 1 1;0 1 0 1 0 1 0 1];
       //from the truth table given
5  y=[0 0 1 0 0 0 1 1];
6  j=1;
7  for i=1:8 // finding for which input conditions the
       output is high
8       if y(i) == 1 then
9           x(j,:)= [a(1,i) a(2,i) a(3,i)];
10          j=j+1;
11      end
12 end
13 for i=1:j-1;  // finding the first stage
14      f(i)=0;
15      c=0;
16     for m=3:-1:1
17      f(i) = f(i) + x(i,m)*(2^c);
18      c=c+1;
19 end
20 end
21 disp('stage 1'); //displaying first stage
22 x(:,4)=f;
23 disp('    A    B     C');
24 disp(x)
25 count=zeros(j-2,j-2)
26 pos=count;
27 for i=1:j-2 // for second stage comparing with each
       other
28      for k=1:j-i-1
29      for m=1:3
30      if x(i,m)==x(i+k,m)  then
31      count(i,k)=count(i,k)+1;
32      else
33      pos(i,k)=m
34      end
35      end
```

```
36 end
37 end
38 r=1;
39 for i=1:j-2  //making a list of second stage
      elements
40     for m=1:j-2
41     if count(i,m)==2 then
42     posi(r) = pos(i,m);
43     sest(r,1) = x(i,4);
44     sest(r,2) = x(i+m,4);
45     r=r+1;
46     end
47     end
48 end
49 disp('stage 2'); //displaying second stage
50 disp(sest);
51 o=size(sest);
52 fin(1)=sest(1,1);
53 fin(2)=sest(1,2);
54 p=3;
55 for i=2:o(1,1) //removing redundancy in second stage
56     t=0;
57     ts=0;
58     for w=1:p-1
59     if fin(w)== sest(i,1) then
60     t=30;
61     end;
62     if fin(w) == sest(i,2) then
63     ts=40;
64     end
65     end
66     if t==0 then
67     fin(p)=sest(i,1);
68     finn(p-2)=i;
69     p=p+1;
70     end
71     if ts==0 then
72     fin(p)=sest(i,2)
```

```
73      finn(p-2)=i;
74      p=p+1;
75      end
76  end
77  ppp=size(finn) //selecting the prime implicants
78  l=1
79  fina(l)= finn(l);
80  for i=2:ppp(1,1)
81      q=0;
82      for b=1:l
83      if fina(b) == finn(i) then
84      q=89 ;
85      end
86      end
87      if q==0 then
88      fina(l+1)=finn(i);
89      l=l+1;
90      q=0;
91      end
92  end
93  kkk=size(fina);
94  i=1;
95  jj=0;
96  bi(1)=' ';
97  x(i)
98  po=1;
99  for k=1:kkk(1,1)+1
100 for p=1:3    //appending a string to make the
       expression
101     if p ~= posi(i)  then
102     if p == 1 & x(i,p)==1   then
103     bi(po)=strcat([bi(po) 'A']);
104     elseif p== 1 &x(i,p)==0 then
105     bi(po)=strcat([bi(po) 'A'']);
106     end
107     if p == 2 & x(i,p)==1   then
108     bi(po)=strcat([bi(po) 'B']);
109     elseif p== 2 &x(i,p)==0 then
```

```
110      bi(po)=strcat([bi(po) 'B''']);
111      end
112      if p == 3 & x(i,p)==1   then
113      bi(po)=strcat([bi(po) 'C']);
114      elseif p== 3 &x(i,p)==0 then
115      bi(po)=strcat([bi(po) 'C''']);
116      end
117      end
118  end
119  jj=jj+1;
120  if jj<=kkk(1,1) then
121  i=fina(jj);
122  bi(po)=strcat([bi(po) ' + ']);
123  end
124  end;
125  disp('The minimised expression is ');
126  disp(bi);
```

Scilab code Exa 3.14 Dynamic hard

```
1  //example 3.9
2  clc;
3  clear;
4  close;
5  c = [1 1 0 0 0 0 0]; //given values
6  a= [1 1 1 1 1 1 1];
7  b= [1 1 1 1 1 1 1] ;
8  for i=1:7
9      y1(i)=0
10     y2(i)=1
11     y3(i)=0
12     y4(i)=1
13     y(i)=0
```

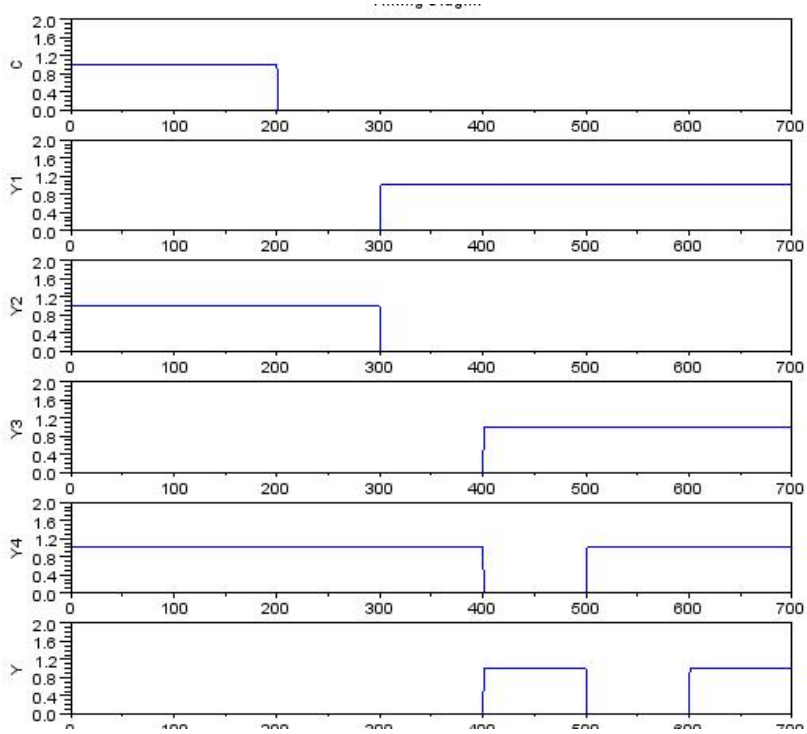

Figure 3.1: Dynamic hard

```
14 end
15 for(i=1: 7) // finding the Y values for next clock
      periods
16 y1(i+1) = bitcmp(c(i),1);
17 y2(i+1) = bitand(a(i),c(i));
18 end;
19 for i=1: 5
20 y3(i+2) = bitand(y1(i+1),b(i));
21 end;
22 for i=1:4
23 y4(i+3) = bitor(y3(i+2),y2(i+2));
24 end;
25 for i=1:3
26 y(i+4)   =  bitand(y4(i+3),y1(i+3));
27 end;
28 y11p=1;
29 y22p=1;
30 y33p=1;
31 y44p=1;
32 cp=1;
33 yf1p=1;
34 for i=1:7  // ploting all of them in to  graph
35     if y1(i)==1 then
36         for o=1:100
37         y11(y11p)=1;
38         y11p=y11p+1;
39         end
40     else
41         for o=1:100
42         y11(y11p)=0;
43         y11p=y11p+1;
44         end
45 end
46 if y2(i)==1 then
47         for o=1:100
48         y21(y22p)=1;
49         y22p=y22p+1;
50         //z(bp)=3
```

```
51          end
52      else
53          for o=1:100
54          y21(y22p)=0;
55          y22p=y22p+1;
56          //z(bp)=3
57          end
58  end
59  if y3(i)==1 then
60          for o=1:100
61          y31(y33p)=1;
62          y33p=y33p+1;
63          //z(bp)=3
64          end
65      else
66          for o=1:100
67          y31(y33p)=0;
68          y33p=y33p+1;
69          //z(bp)=3
70          end
71  end
72  if y4(i)==1 then
73          for o=1:100
74          y41(y44p)=1;
75          y44p=y44p+1;
76          //z(bp)=3
77
78          end
79      else
80          for o=1:100
81          y41(y44p)=0;
82          y44p=y44p+1;
83          //z(bp)=3
84          end
85  end
86  if c(i)==1 then
87          for o=1:100
88          c1(cp)=1;
```

```
89          cp=cp+1;
90          end
91      else
92          for o=1:100
93          c1(cp)=0;
94          cp=cp+1;
95          end
96  end
97  if y(i)==1 then
98          for o=1:100
99          yf1(yf1p)=1;
100         yf1p=yf1p+1;
101         end
102     else
103         for o=1:100
104         yf1(yf1p)=0;
105         yf1p=yf1p+1;
106         end
107     end
108 end
109 z=[2 2];    //ploting the results
110 subplot(6,1,1);
111 title('Timing Diagrm');
112 plot(c1);
113 plot(z);
114 ylabel('C');
115 subplot(6,1,2);
116 plot(y11);
117 ylabel('Y1');
118 plot(z);
119 subplot(6,1,3);
120 plot(y21);
121 ylabel('Y2');
122 plot(z);
123 subplot(6,1,4);
124 plot(z);
125 ylabel('Y3');
126 plot(y31);
```

```
127 subplot(6,1,5);
128 plot(z);
129 ylabel('Y4');
130 xlabel('Time in milli seconds');
131 plot(y41);
132 subplot(6,1,6);
133 plot(z);
134 ylabel('Y');
135 xlabel('Time in milli seconds');
136 plot(yf1);
```

Chapter 4

Data processing circuits

Scilab code Exa 4.1 4 to 1 mux using 2 to 1 mux

```
1 //example 4.1
2 clc;
3 clear;
4 disp('Logic equation for 2-to-1 Multiplexer :')
5 printf(' Y = A''D0 + AD1\n');
6 disp('Logic equation for 4-to-1 Multiplexer :')
7 printf(' Y = A''B''D0 + A''BD1 + AB''D2 + ABD3\n');
8 disp('This can be rewritten as,')
9 printf(' Y= A''(B''D0 + BD1) + A(B''D2 + BD3)\n');
10 disp('Compare this with equation of 2-to-1 mux. We
    need two 2-to-1 multiplexer to realize the
    bracketed terms where B serves as select input.
    The output of these two multiplexers can be sent
    to a third multiplexer as data inputs where A
    serves as select input and we get the 4-to-1
    multiplexer.');
```

Scilab code Exa 4.2 Realizing boolean equation using 8 to 1 mux

```
1  //example 4.2
2  clc;
3  clear
4  a(1,1)=0 // taking input in this  form 1 if A, 0if A
       ' and 2 if no A in the term
5  a(1,2)=1
6  a(1,3)=2
7  a(2,1)=2
8  a(2,2)=0
9  a(2,3)=0
10 a(3,1)=1
11 a(3,2)=1
12 a(3,3)=1
13 p=3;
14 for i=1:3  // finding the minterms here
15      coun =0;
16      for j=1:3
17      if a(i,j)==2 then
18      coun = coun+1
19      end
20  end
21  if coun == 2  then
22       p=p+3
23  else if coun==1 then
24     p=p+1
25  end
26 end
27 end
28 n=4;
29 for m=4:p
30      for l=1:3
31          a(m,l)=0;
32      end
33 end
34 for i= 1:p
35      for j=1:3
36          if a(i,j) ==2 then
37              for k=1:3
```

```
38                  a(n,k)=a(i,k)
39              end
40              a(i,j) = 0;
41              a(n,j)=1;
42              n=n+1;
43          end
44      end
45  end
46  for h=1:p
47      f(h)=0
48      c=2;
49  for m=1:3  //finding equivlent decimal values for
       the minterms
50      f(h)= f(h) + a(h,m)*(2^c);
51      c=c-1;
52  end
53  end
54  disp('The min terms are :') //displaying the min
       terms
55  disp('   A     B     C')
56  disp(a)
57  l=1
58  o(1,l)= f(l);  // removing the repetations in
       minterms
59  for i=2:p
60      q=0;
61          for b=1:l
62          if o(1,b) == f(i) then
63              q=89 ;
64          end
65      end
66      if q==0 then
67          o(1,l+1)=f(i);
68          l=l+1;
69          q=0;
70      end
71  end
72  disp('The following data lines are to be given ''1''
```

```
    and remaining should be given ''0''); //
    displying the decimal equivlent of minterms
disp(o);
disp('For a 4-1 mux, we should give D0 =C'',D1 = ''1
    '',D2 = C'' and D3 = C with A and B as data
    selector inputs ');
```

Scilab code Exa 4.3 32 t0 1 mux using 16 to 1 and 2 to 1 muxes

```
//example 4.3
clc;
clear;
m(1)=32;//tking the given values
m(2)=log2(m(1)) // making necessary calculations
m(3)=m(2)-1;
m(4)=m(1)/2;
printf('A %d-to-1 multiplexer requires',m(1));printf
    (' %d select lines, The lower',m(2));printf(' %d
    select lines choose',m(3));printf(' %d-to-1
    multiplexer outputs. The 2-to-1 multiplexers
    chooses one of the outpt of two',m(4));printf('
    %d-to-1 multiplexers depending on what appears in
     the',m(4));printf(' %dth select line.', m(2));
    //displaying the result
```

Scilab code Exa 4.4 74154 IC y12

```
//example 4.4
clc;
clear;
r= input('Enter the value of R (0 or 1) :'); //
    accepting the inputs from the user
t= input('Enter the value of T (0 or 1) :');
```

```
6  sel = input('Enter the values of ABCD :');
7  strb = bitcmp(bitand(r,t),1);
8  if strb==0  then // checking whether strobe is high
      or low
9      if sel ==1100 then
10         y='The two pulses are steered to the Y12
              output';
11     else
12         y='The output Y12 remains in the High state'
              ;
13     end
14     else
15     y='The output Y12 remains in the High state';
16 end
17 disp(y) //displaying result
```

Scilab code Exa 4.7 realizing boolean equation using 3 to 8 decoder

```
1  //example 4.7
2  clc;
3  clear;
4  n=input('Enter the no.of terms in ur expression :');
      //accepting input from user
5  for i=1:n
6  a(1,i)=input('Enter the term (0-9) :');
7  end;
8  disp ('Since at the decoder output we get all the
      minterms we use them to get the required boolean
      functions by giving the output lines numbered ' )
      ;
9  disp(a);     //displying the result
10 disp('to a mlti-input OR gate.');
```

Scilab code Exa 4.8 current in LED

```
1 //example 4.8
2 clc;
3 clear;
4 //r=input('Enter the values of resistance in Kohms
    :');
5 //v=input('Enter the forward voltage drop of LED(in
    volts) :' );
6 r=1//taking the given values for r and v
7 v=2
8 i=5-v/r; //calculating I
9 printf('The current through a LED is : %f mA', i);
    //displaying I
```

Scilab code Exa 4.9 which LED lights up for given input conditions

```
1 //example 4.9
2 clc;
3 clear;
4
5 sel = input(' Enter the values of ABCD :');
6 a=sel;
7 q=1;
8 while(a>0) // finding the decimal equivlent
9     r=modulo(a,10);
10    b(1,q)=r;
11    a=a/10;
12    a=floor(a);
13    q=q+1;
14 end
15 f=0;
16 for m=1:q-1
17     c=m-1
18    f = f + b(1,m)*(2^c);
```

```
19 end
20 if f >9 then //checking the invalid condition
21     disp('Its a invalid input. Therefore,none of the
         LEDs is on because all outputs lines are
        high' );
22 else  //displaying the LED no if the inputs are
    valid
23     printf('\n LED %d lights up all. All other LEDs
        remain off because the other outputs are high
        .',f);
24 end
```

Scilab code Exa 4.10 output of 74147 when button 6 is pressed

```
1 //example 4.10
2 clc;
3 clear;
4 //sel= input('Enter which is pressed(1 - 9) : ');
5 sel=6;
6 aa=sel;
7 for i=4:-1:1 //converting the sel input to binary
    notation
8     a(1,i)=modulo(aa,2);
9     b(1,i)=bitcmp(a(1,i),1);
10    aa=aa/2;
11    aa=floor(aa);
12 end
13 printf('When switch %d is pressed the ABCD output is
    :',sel);
14 disp(b); //displaying the result
15 printf(' Which is equivalent to %d when the output
    is complimented.In the output above a ''0''
    represents a LOW and a ''1'' represents a HIGH. '
    ,sel );
```

check Appendix AP 9 for dependency:

`kmapsx.sci`

check Appendix AP 2 for dependency:

`noof.sci`

Scilab code Exa 4.11 priority encoder

```
1  //example 4.11
2  //uses functions kmap.sci and noof.sci so run them
       before running this program ..
3  clc;
4  s=[0  1 1 1 1 ];
5  x1=[0 1 0 0 0 ];
6  x2=[0 0 1 0 0 ];
7  x3=[0 0 0 1 0 ];
8  for i=1:5
9      if s(i)==1  then    // finding output A and B
10         if x1(i) == 1  then
11             a(i)=0;
12             b(i)=1;
13         elseif x2(i) == 1  then
14             a(i)=1;
15             b(i)=0;
16         elseif x3(i) == 1 then
17             a(i)=1;
18             b(i)=1;
19         else
20             a(i)=0;
21             b(i)=0;
22         end
23 else
24             a(i)=0;
25             b(i)=0;
```

```
26 end
27 end
28 for i = 1 : 5    //printin the state table
29         Y(i,1)=s(i);
30         Y(i,2)=x1(i);
31         Y(i,3)=x2(i);
32         Y(i,4)=x3(i);
33         Y(i,5)=a(i);
34         Y(i,6)=b(i);
35     end
36 disp('           Input                Output  ');
37 disp('   S      X1     X2     X3     A      B ');
38     disp(Y);
39 kmp =[0 0 0 0;0 0 0 1 ;0 0 0 1;0 0 0 1]; //finding
   minimized expressin using 4-varible kmap
40     disp("The minimal expression of A from the
          following Kmap is :');
41     kmapsx(kmp);
42     kmp=[0 0 1 0;0 0 1 1 ;0 0 1 0;0 0 1 0]; //
          finding minimized expressin using 4-varible
          kmap
43     printf('\n');
44    disp( 'The minimal expression of B from the
         following Kmap is :')
45    kmapsx(kmp);
```

Chapter 5

Number Systems and Codes

Scilab code Exa 5.1 Binary to decimal conversion

```
1 //Example 5.1
2 clc

    //clears the command window
3 clear

    //clears all the variables
4 p=1;

    //initialising variables
5 q=1;
6 z=0;
7 b=0;
8 w=0;
9 f=0;
10 format('v',18);

    //increasing the precision to 18 .
11 //bin= input ("Enter the binary no to be converted
    to its decimal equivalent : ")    // accepting
    the binary input from user
```

```
12 bin=110.001;
13 d= modulo(bin,1);

      //separating the decimal part and the integer
      part
14 d=d*10^10;
15 a=floor(bin);

      //removing the decimal part
16 while(a>0)

      //Loop to take the binary bits of integer in to a
       matrix
17      r=modulo(a,10);
18      b(1,q)=r;
19      a=a/10;
20      a=floor(a);
21      q=q+1;
22 end
23 for m=1:q-1

      //multipliying the bits of integer with their
      position values and adding
24        c=m-1;
25      f = f + b(1,m)*(2^c);
26 end
27 while(d>0)

      //Loop to take the binary bits of decimal in to a
       matrix
28      e=modulo(d,2)
29      w(1,p)=e
30      d=d/10;
31      d=floor(d)
32      p=p+1;
33      end
34 for n=1:p-1
```

```
    //multipliying the bits of decimal with their
    position values and adding
35      z=z+w(1,n)*(0.5)^(11-n);
36  end
37  z=z*10000;

    //rounding of to 4 decimal values
38  z=round(z);
39  z=z/10000;
40  printf("The Decimal equivalent of the Binary number
    given is = %f",f+z);        //Displaying the final
     result
```

Scilab code Exa 5.2 Binary to decimal conversion

```
1  //Example 5.2
2  clc

    //clears the command window
3  clear

    //clears all the variables
4  p=1;

    //initialising variables
5  q=1;
6  z=0;
7  b=0;
8  w=0;
9  f=0;
10 format('v',18);

    //increasing the precision to 18 .
11 //bin= input ("Enter the binary no to be converted
    to its decimal equivalent : ")    // accepting
```

```
      the binary input from user
12 bin=1011.11;
13 d= modulo(bin,1);

      //separating the decimal part and the integer
      part
14 d=d*10^10;
15 a=floor(bin);

      //removing the decimal part
16 while(a>0)

      //Loop to take the binary bits of integer in to a
       matrix
17      r=modulo(a,10);
18      b(1,q)=r;
19      a=a/10;
20      a=floor(a);
21      q=q+1;
22 end
23 for m=1:q-1

      //multipliying the bits of integer with their
      position values and adding
24        c=m-1;
25      f = f + b(1,m)*(2^c);
26 end
27 while(d>0)

      //Loop to take the binary bits of decimal in to a
       matrix
28      e=modulo(d,2)
29      w(1,p)=e
30      d=d/10;
31      d=floor(d)
32      p=p+1;
33      end
34 for n=1:p-1
```

```
    //multipliying the bits of decimal with their
    position values and adding
35      z=z+w(1,n)*(0.5)^(11-n);
36  end
37  z=z*10000;

    //rounding of to 4 decimal values
38  z=round(z);
39  z=z/10000;
40  printf("The Decimal equivalent of the Binary number
    given is = %f",f+z);

    //Displaying the final result
```

Scilab code Exa 5.3 decimal equivalent of 2 Mb

```
1  //Example 5.3
2  clc

    //clears the command window .
3  clear

    //clears all the variables .
4  format('v',18);

    //increasing the precision to 18 .
5  n=2; /// given 2 mb
6  dec = n * 2^20 ;
7  printf("The decimal equivalent of 2Mb is = %f ",dec)
    ;

    //displaying the value.
```

Scilab code Exa 5.4 Decimal to binary conversion

```
1 //Example 5.3
2 clc

    //clears the command window
3 clear

    //clears all the variables
4 q=0;
5 b=0;
6 s=0;
7 format('v',18);

    //increasing the precision to 18 .
8 //a=input("Enter the decimal no to be converted to
    its binary equivalent : "); // accepting
    the decimal input from user
9 a=23.6;
10 d=modulo(a,1);

    //separating the decimal part and the integer
    part
11 a=floor(a);

    //removing the decimal part
12
13 while(a>0)

    //taking integer part in to a matrix and convert
    to equivalent binary
14   x=modulo(a,2);
15   b= b + (10^q)*x;
16   a=a/2;
```

```
17      a=floor(a);
18      q=q+1;
19  end
20
21
22
23  for i=1:10

    // For values after decimal point converting to
    binary
24      d=d*2;
25      q=floor(d);
26      s=s+q/(10^i);
27      if d>=1 then
28          d=d-1;
29      end
30   end
31   k=b+s;
32  printf("The binary equivalent of the given decimal
    number is = %f",k);

    // displaying the final result.
```

Scilab code Exa 5.5 Binary number having all ones

```
1  //Example 5.5
2  clc

    //clears the command window
3  clear

    //clears all the variables
4  format('v',18)

    //increasing the precision
```

```
5 n=32; // given 32 1's
6 dec=2^n - 1 ;
7 printf("The decimal equivalent of 32 bit number with
      all 1s is = %f ",dec);      // displaying the
     result
```

Scilab code Exa 5.6 Decimal to binary conversion

```
1 //Example 5.6
2 clc

     //clears the command window
3 clear

     //clears all the variables
4 q=0;
5 b=0;
6 s=0;
7 format('v',18);

     //increasing the precision to 18 .
8 //a=input("Enter the decimal no to be converted to
     its binary equivalent : ");          // accepting
     the decimal input from user
9 a=363;

     //taking the value given in problem
10 d=modulo(a,1);

     //separating the decimal part and the integer
     part
11 a=floor(a);

     //removing the decimal part
12
```

```
13 while(a>0)

   //taking integer part in to a matrix and convert
   to equivalent binary
14   x=modulo(a,2);
15   b= b + (10^q)*x;
16   a=a/2;
17   a=floor(a);
18   q=q+1;
19 end
20
21
22
23 for i=1:10

   // For values after decimal point converting to
   binary
24     d=d*2;
25     q=floor(d);
26     s=s+q/(10^i);
27     if d>=1 then
28         d=d-1;
29     end
30  end
31  k=b+s;
32  disp("The give decimal number is 363")
33 printf(" The binary equivalent of the given decimal
   number is = %f",k);

   // displaying the final result.
```

Scilab code Exa 5.7 binary to hexadecimal

```
1 //Example 5.7
2 clc
```

```
    //clears the command window
clear

    //clears all the variables
q=1;
b=0;
f=0;
bin=input("Enter the 8-bit binary address :");
                                    // Taking the input
    binary bits from the user
a=floor(bin)
while(a>0)

    //Loop to take the binary bits in to a matrix(
    array)
     r=modulo(a,10);
     b(1,q)=r;
     a=a/10;
     a=floor(a);
     q=q+1;
end
for m=1:q-1

    // converrting to decimal
     c=m-1;
     f = f + b(1,m)*(2^c);
end
c=dec2hex(f);
printf("The hexadecimal equivalent of the given
    binary number is : %s",c);              //
    displaying the value
```

Scilab code Exa 5.8 hexadecimal to decimal

```
1 //Example 5.8
2 clc

    //clear the command window
3 clear

    //clear the variables
4 a=input("Enter the hexadecimal number to be
    converted into decimal(enter in a single
    quotation) : ")          // taking the input from
    user
5 d=hex2dec(a);
6 printf("The decimal equivalent is : %d",d);

    //displaying the output
```

Scilab code Exa 5.9 decimal to hexadecimal and binary

```
1 //Example 5.9
2 clc                                    //clears the
     command window
3 clear                                   //clears
    the variables
4 q=0;
5 b=0;
6 //a=input("enter the decimal no:")
7 a=65535;                                //
    giving the value specified in the problem
8 temp =a;
9 format('v',18)                          //
    increasing the precision to 18
10 a=floor(a);
11 h=dec2hex(a);
12 while(a>0)                              //
    converting to binary
```

```
13      x=modulo(a,2);
14      b= b + (10^q)*x;
15      a=a/2;
16      a=floor(a);
17      q=q+1;
18  end
19  printf("Given decimal number is : %d\n",temp)
20  printf('The hexadecimal equivalent is = %s\n',h);
                                                    //
    displaying the results
21  printf('The binary equivalent is = %f',b );
```

Scilab code Exa 5.10 decimal to hexadecimal and binary

```
1  //Example 5.10
2  clc                                    //clears the
       command window
3  clear                                   //clears
     the variables
4  q=0;
5  b=0;
6  //a=input("enter the decimal no:")
7  a=56000;                                //
     giving the value specified in the problem
8  temp=a;
9  format('v',18)                          //
     increasing the precision to 18
10 a=floor(a);
11 h=dec2hex(a);
12 while(a>0)                               //
     converting to binary
13      x=modulo(a,2);
14      b= b + (10^q)*x;
15      a=a/2;
16      a=floor(a);
```

```
17      q=q+1;
18  end
19  printf("Given decimal number is : %d\n",temp)
20  printf("The hexadecimal equivalent is = %s\n",h)
21    //displaying the results
22  printf("The binary equivalent is = %f\n",b);
```

Scilab code Exa 5.11 decimal to hexadecimal and binary

```
1  //chapter 5
2  //Example 5.11
3  //Q.convert decimal numbers to its hexadecimal and
       binary equivalent ?
4  //solution :
5  clc                                          //clears the
       command window
6  clear                                         //clears
       the variables
7  q=0;
8  b=0;
9  a=input("Enter the decimal no:")              //Enter
       the decimal nuber
10 format('v',18)                               //
       increasing the precision to 18
11 a=floor(a);
12 h=dec2hex(a);
13 while(a>0)                                    //
       converting to binary
14     x=modulo(a,2);
15     b= b + (10^q)*x;
16     a=a/2;
17     a=floor(a);
18     q=q+1;
19 end
20 printf("The hexadecimal equivalent is = %s\n",h)
```

```
21                                                    //
                                                          displaying
                                                           the
                                                          results

22  printf("The binary equivalent is = %f",b)
```

Chapter 6

Arithmetic Circuits

Scilab code Exa 6.1 8bit binary adder

```
1  //exmple 6.1
2  clc;
3  clear;
4  //a=input("enter the first 8 bit number :");
5  //b=input("enter the second 8 bit number :");
6  a=01010111;  // taking given inputs
7  b=00110101;
8  for i=1:8
9      a1(i)=modulo(a,10);
10     a=a/10;
11     a=round(a);
12     b1(i)=modulo(b,10);
13     b=b/10;
14     b=round(b);
15 end
16 car(1)=0;
17 for i=1:8    // adding both the inputs (binary
       addition)
18     c1(i)=car(i)+a1(i)+ b1(i);
19     if c1(i)== 2 then
20         car(i+1)= 1;
```

```
21          c1(i)=0;
22      elseif c1(i)==3 then
23           car(i+1)= 1;
24          c1(i)=1;
25      else
26          car(i+1)=0;
27      end
28  end
29  c1(9)=car(9);
30  re=0;
31  format('v',18);
32  for i=1:9
33      re=re+(c1(i)*(10^(i-1)))
34  end
35  printf('The sum of given two binary numbers is %d\n'
       ,re );
36  q=1;
37  b=0;
38  f=0;
39  a=re;
40  while(a>0)          // converting the result to a
       hexadecimal no
41      r=modulo(a,10);
42      b(1,q)=r;
43      a=a/10;
44      a=floor(a);
45      q=q+1;
46  end
47  for m=1:q-1
48       c=m-1;
49      f = f + b(1,m)*(2^c);
50  end
51  hex=dec2hex(f);
52  printf(' The sum in hexadecimal notation is %s \n',
       hex); //displaying result
```

Scilab code Exa 6.2 16 bit binary adder

```
1  //exmple 6.2
2  clc;
3  clear;
4  //a=input("enter the first 16 bit binary number :");
5  //b=input("enter the second 16 bit binarynumber :");
6  a=0000111110101100;
7  b=0011100001111111;
8  for i=1:16
9      a1(i)=modulo(a,10);
10     a=a/10;
11     a=round(a);
12     b1(i)=modulo(b,10);
13     b=b/10;
14     b=round(b);
15 end
16 car(1)=0;
17 for i=1:16      /// adding both the 16-bit inputs (
       binary addition)
18     c1(i)=car(i)+a1(i)+ b1(i);
19     if c1(i)== 2 then
20         car(i+1)= 1;
21         c1(i)=0;
22     elseif c1(i)==3 then
23          car(i+1)= 1;
24         c1(i)=1;
25     else
26         car(i+1)=0;
27     end
28 end
29 c1(17)=car(17);
30 re=0;
31 format('v',25);
```

```
32 for i=1:17
33     re=re+(c1(i)*(10^(i-1)))
34 end
35 printf('The sum of given two binary numbers is %f\n'
     ,re );
36 q=1;
37 b=0;
38 f=0;
39 a=re;
40 while(a>0)     // converting the result to a
     hexadecimal no
41     r=modulo(a,10);
42     b(1,q)=r;
43     a=a/10;
44     a=floor(a);
45     q=q+1;
46 end
47 for m=1:q-1
48      c=m-1
49     f = f + b(1,m)*(2^c);
50 end
51 hex=dec2hex(f);
52 printf(' Sum in decimal notation is %d\n',f);
53 printf(' Sum in hexadecimal notation is %s \n',hex);
     //displaying result
```

Scilab code Exa 6.3 first generation microcomputers addition

```
1 //example 6.3
2 clc;
3 clear;
4 //a=input("enter the first 8 bit number :");
5 //b=input("enter the second 8 bit number :");
6 a=0000111110101100;
7 b=0011100001111111;
```

```
for i=1:16
    a1(i)=modulo(a,10);
    a=a/10;
    a=round(a);
    b1(i)=modulo(b,10);
    b=b/10;
    b=round(b);
end
car(1)=0;
for i=1:8
    c1(i)=car(i)+a1(i)+ b1(i);    // adding the
       Higher bytes
    if c1(i)== 2 then
        car(i+1)= 1;
        c1(i)=0;
    elseif c1(i)==3 then
         car(i+1)= 1;
        c1(i)=1;
    else
        car(i+1)=0;
    end
end
c1(9)=car(9)
re=0;
format('v',18);
for i=1:9
    re=re+(c1(i)*(10^(i-1)))
end

printf('The sum of lower bytes of two binary numbers
    is %d\n',re );
printf(' with a carry is %d\n',car(9));
re=re-(c1(9)*(10^(8)))
for i=9:16    // adding the Higher bytes
    c1(i)=car(i)+a1(i)+ b1(i);
    if c1(i)== 2 then
        car(i+1)= 1;
        c1(i)=0;
```

```
44      elseif c1(i)==3 then
45           car(i+1)= 1;
46          c1(i)=1;
47      else
48          car(i+1)=0;
49      end
50  end
51  c1(17)=car(17);
52  format('v',25);
53  ree=0;
54  for i=9:17
55      ree=ree+(c1(i)*(10^(i-9)));
56  end
57  for i=9:17
58      re=re+(c1(i)*(10^(i-1)))
59  end
60  printf(' The sum of upper  bytes of the given
       numbers is %d\n',ree);
61  printf(' with a carry is %d\n',car(17)); //
       displaying results
62  printf(' The total sum is %f',re );
```

Scilab code Exa 6.4 binary subtraction

```
1  //exmple 6.4
2  clc;
3  clear;
4  a=0;
5  b=0;
6  q=0;
7  //bb=input(" Enter the first no (in decimal) :");
8  //aa=input(" Enter the number from which first no
       has to substracted:");
9  aa=200; // taking the given input
10 bb=125;
```

```
11 while(aa>0)     // converting the inputs in to binary
       numbers
12      x=modulo(aa,2);
13      a= a + (10^q)*x;
14      aa=aa/2;
15      aa=floor(aa);
16      q=q+1;
17 end
18 q=0;
19 while(bb>0)
20      x=modulo(bb,2);
21      b= b + (10^q)*x;
22     bb=bb/2;
23      bb=floor(bb);
24      q=q+1;
25 end
26 printf(' \nThe binary equivalent of first no is %f\n
      \n',b);
27 printf(' The binary equivalent of secnd no is %f\n\n
      ',a);
28 for i=1:40
29      a1(i)=modulo(a,10);
30      a=a/10;
31      a=round(a);
32      b1(i)=modulo(b,10);
33      b=b/10;
34      b=round(b);
35 end
36 bro(1)=0;
37 for i=1:40
38      c1(i)=a1(i)- b1(i)-bro(i); // finding the
           difference of the given inputs
39      if c1(i)== -1 then
40          bro(i+1)= 1;
41          c1(i)=1;
42      elseif c1(i)==-2 then
43           bro(i+1)= 1;
44          c1(i)=0;
```

```
45      else
46          bro(i+1)=0;
47      end
48
49  end
50  re=0;
51  format('v',18);
52  for i=1:40
53      re=re+(c1(i)*(10^(i-1)))
54  end
55  printf(' The diference of given two numbers is %f\n\
       n',re );
56  q=1;
57  b=0;
58  f=0;
59  a=re;
60  while(a>0)
61      r=modulo(a,10);
62      b(1,q)=r;
63      a=a/10;
64      a=floor(a);
65      q=q+1;
66  end
67  for m=1:q-1
68       c=m-1
69      f = f + b(1,m)*(2^c);
70  end
71  hex=dec2hex(f);
72  printf(' Sum in decimal notation is %d\n\n',f); //
       displaying the results
73  printf(' Sum in hexadecimal notation is %s \n',hex);
```

Scilab code Exa 6.5 adding 8 bit unsigned numbers

```
1  //example 6.5
```

```
2
3  clc;
4  clear;
5  a=0;
6  b=0;
7  q=0;
8
9  //aa=input(" Enter the first no (in decimal) :");
10 //bb=input(" Enter the number from which first no
      has to substracted:");
11 aa=150;
12 bb=85;
13 while(aa>0)                  // converting the inputs in
      to binary numbers
14      x=modulo(aa,2);
15      a= a + (10^q)*x;
16      aa=aa/2;
17      aa=floor(aa);
18      q=q+1;
19 end
20 q=0;
21 while(bb>0)
22      x=modulo(bb,2);
23      b= b + (10^q)*x;
24     bb=bb/2;
25      bb=floor(bb);
26      q=q+1;
27 end
28 printf(' \n The binary equivalent of first no is %f\
      n\n',a);
29 printf(' The binary equivalent of secnd no is %f\n\n
      ',b);
30 for i=1:40
31      a1(i)=modulo(a,10);
32      a=a/10;
33      a=round(a);
34      b1(i)=modulo(b,10);
35      b=b/10;
```

```
36      b=round(b);
37  end
38
39  car(1)=0;
40  for i=1:40
41      c1(i)=car(i)+a1(i)+ b1(i); // addng both the
           inputs
42      if c1(i)== 2 then
43          car(i+1)= 1;
44          c1(i)=0;
45      elseif c1(i)==3 then
46           car(i+1)= 1;
47          c1(i)=1;
48      else
49          car(i+1)=0;
50      end
51  end
52  c1(41)=car(41);
53  re=0;
54  format('v',18);
55  for i=1:41
56      re=re+(c1(i)*(10^(i-1)))
57  end
58  printf(' The sum of given two binary numbers is %f\n
       \n',re );
59  q=1;
60  b=0;
61  f=0;
62  a=re;
63  while(a>0)
64      r=modulo(a,10);
65      b(1,q)=r;
66      a=a/10;
67      a=floor(a);
68      q=q+1;
69  end
70  for m=1:q-1
71       c=m-1;
```

```
72      f = f + b(1,m)*(2^c);
73  end
74  printf(' Sum in decimal notation is %d\n\n',f);  //
       displaying results
75  hex=dec2hex(f);
76  printf(' The sum in hexadecimal notation is %sH \n',
       hex);
```

Scilab code Exa 6.6 subtraction of unsigned numbers

```
1   //exmple 6.6
2   clc;
3   clear;
4   a=0;
5   b=0;
6   q=0;
7   //bb=input(" Enter the first no (in decimal) :");
8   //aa=input(" Enter the number from which first no
       has to substracted:");
9   aa=150;
10  bb=85;
11  while(aa>0)  //// converting the inputs in to binary
       numbers
12      x=modulo(aa,2);
13      a= a + (10^q)*x;
14      aa=aa/2;
15      aa=floor(aa);
16      q=q+1;
17  end
18  nn=a
19  q=0;
20  while(bb>0)
21      x=modulo(bb,2);
22      b= b + (10^q)*x;
23     bb=bb/2;
```

```
24      bb=floor(bb);
25      q=q+1;
26  end
27  printf(' \nThe binary equivalent of first no is %f\n
       \n',b);
28  printf(' The binary equivalent of secnd no is %f\n\n
       ',a);
29  for i=1:40
30      a1(i)=modulo(a,10);
31      a=a/10;
32      a=round(a);
33      b1(i)=modulo(b,10);
34      b=b/10;
35      b=round(b);
36  end
37
38  bro(1)=0;
39  for i=1:40
40      c1(i)=a1(i)- b1(i)-bro(i);
41      if c1(i)== -1 then
42          bro(i+1)= 1;
43          c1(i)=1;
44      elseif c1(i)==-2 then
45           bro(i+1)= 1;
46          c1(i)=0;
47      else
48          bro(i+1)=0;
49      end
50
51  end
52  re=0;
53  format('v',18);
54  for i=1:40
55      re=re+(c1(i)*(10^(i-1)))
56  end
57  printf(' The diference of given two numbers is %f\n\
       n',re );
58  q=1;
```

```
59 b=0;
60 f=0;
61 a=re;
62 while(a>0) // converting the binary result to
      decimal then to hexadecimal
63     r=modulo(a,10);
64     b(1,q)=r;
65     a=a/10;
66     a=floor(a);
67     q=q+1;
68 end
69 for m=1:q-1
70      c=m-1
71     f = f + b(1,m)*(2^c);
72 end
73 hex=dec2hex(f);
74 printf(' Sum in decimal notation is %d\n\n',f);
75 printf(' Sum in hexadecimal notation is %s \n',hex);
```

Scilab code Exa 6.7 overflow case

```
1 //example 6.7
2 clc;
3 clear;
4 a=0;
5 b=0;
6 q=0;
7 //aa=input(" Enter the first no (in decimal) :");
8 //bb=input(" Enter the number from which first no
     has to substracted:");
9 aa=175;
10 bb=118;
11 while(aa>0)    // converting the inputs in to binary
      numbers
12     x=modulo(aa,2);
```

```
13      a= a + (10^q)*x;
14      aa=aa/2;
15      aa=floor(aa);
16      q=q+1;
17  end
18  q=0;
19  while(bb>0)
20      x=modulo(bb,2);
21      b= b + (10^q)*x;
22     bb=bb/2;
23      bb=floor(bb);
24      q=q+1;
25  end
26  printf(' \n The binary equivalent of first no is %f\
       n\n',a);
27  printf(' The binary equivalent of secnd no is %f\n\n
       ',b);
28  for i=1:8
29      a1(i)=modulo(a,10);
30      a=a/10;
31      a=round(a);
32      b1(i)=modulo(b,10);
33      b=b/10;
34      b=round(b);
35  end
36
37  car(1)=0;
38  for i=1:8
39      c1(i)=car(i)+a1(i)+ b1(i);//adding the binary
           numbers (binary addtion)
40      if c1(i)== 2 then
41          car(i+1)= 1;
42          c1(i)=0;
43      elseif c1(i)==3 then
44           car(i+1)= 1;
45          c1(i)=1;
46      else
47          car(i+1)=0;
```

```
48      end
49  end
50  c1(9)=car(9);
51  re=0;
52  format('v',18);
53  for i=1:8
54      re=re+(c1(i)*(10^(i-1)))
55  end
56  printf('If only 8 bits are taken the result will be
       as shown below \n\n');
57  printf(' and the sum of given two binary numbers
       will be %f\n\n',re );
58  q=1;
59  b=0;
60  f=0;
61  a=re;
62  while(a>0) //converting the binary output to
       hexadecimal
63      r=modulo(a,10);
64      b(1,q)=r;
65      a=a/10;
66      a=floor(a);
67      q=q+1;
68  end
69  for m=1:q-1
70       c=m-1;
71      f = f + b(1,m)*(2^c);
72  end
73  printf(' Sum in decimal notation is %d\n\n',f);
74  hex=dec2hex(f);
75  printf(' The sum in hexadecimal notation is %sH \n',
       hex);
76  printf(' \n with an overflow of %d\n\n',car(9));
```

Scilab code Exa 6.8 2s compliment

```
1  //example 6.8
2  clc;
3  clear;
4  re=0;
5  aaa=input('enter the number(in decimal) :');//
       taking the signed number
6  m=aaa;
7  if aaa<0 then
8      aa=-1*aaa;
9      else aa=aaa;
10 end
11 a=0;
12 q=0;
13 while(aa>0)                //converting from decimal to
       binary
14     x=modulo(aa,2);
15     a= a + (10^q)*x;
16     aa=aa/2;
17     aa=floor(aa);
18     q=q+1;
19 end
20 mm=a;
21 for i=1:8
22     a1(i)=modulo(a,10);
23     a=a/10;
24     a=round(a);
25     b1(i)=0;
26 end
27 b1(1)=1;
28 if aaa<0 then  // making two's complement if the
       number is less than zero
29     for i=1:8
30         a1(i)=bitcmp(a1(i),1);
31         end
32     car(1)=0;
33 for i=1:8
34     c1(i)=car(i)+a1(i)+ b1(i);  // adding one (as a
           part of finding 2's compliment
```

```
35      if c1(i)== 2 then
36          car(i+1)= 1;
37          c1(i)=0;
38      elseif c1(i)==3 then
39           car(i+1)= 1;
40          c1(i)=1;
41      else
42          car(i+1)=0;
43      end;
44  end;
45  c1(9)=car(9);
46  re=0;
47  format('v',18);
48      for i=1:9
49          re=re+(c1(i)*(10^(i-1)))
50          end;
51           printf('\nThe binary contents are %d\n\n',
                re );
52  else
53      re=mm;
54     end;
55     if(aaa>0)
56    printf('\nThe biary contents are %d\n\n',mm);
57  end;
58  q=1;
59  b=0;
60  f=0;
61  a=re;
62  while(a>0)  // converting the result to decimal then
        to hexadecimal
63      r=modulo(a,10);
64      b(1,q)=r;
65      a=a/10;
66      a=floor(a);
67      q=q+1;
68  end
69  for m=1:q-1
70       c=m-1
```

```
71      f = f + b(1,m)*(2^c);
72  end
73  hex=dec2hex(f);
74  printf('The Hexadecimal contents are %sH',hex) ;//
       displayin the result
```

Scilab code Exa 6.9 2s compliment

```
1  //example 6.9
2  clc;
3  clear;
4  //aaa=input('enter the number(in decimal) :');
5  aaa=-19750  // given input
6  aa=-1*aaa;
7  format('v',18);
8  a=0;
9  q=0;
10 while(aa>0)                  // converting  it to binary
11      x=modulo(aa,2);
12      a= a + (10^q)*x;
13      aa=aa/2;
14      aa=floor(aa);
15      q=q+1;
16 end
17 for i=1:16
18      a1(i)=modulo(a,10);
19      a=a/10;
20     a=round(a);
21      b1(i)=0;
22 end
23 b1(1)=1;
24 for i=1:16                  /// finding the 2's
       compliment
25           a1(i)=bitcmp(a1(i),1);
26           end
```

```
27      car(1)=0;
28  for i=1:16
29      c1(i)=car(i)+a1(i)+ b1(i);
30      if c1(i)== 2 then
31          car(i+1)= 1;
32          c1(i)=0;
33      elseif c1(i)==3 then
34           car(i+1)= 1;
35          c1(i)=1;
36      else
37          car(i+1)=0;
38      end;
39  end;
40  c1(17)=car(17);
41  re=0;
42      for i=1:17
43          re=re+(c1(i)*(10^(i-1)))
44          end;
45           printf('\n The 2''s compliment is');
46           disp(re);
47           q=1;
48  b=0;
49  f=0;
50  a=re;
51  while(a>0)    // converting to hexadecimal
52      r=modulo(a,10);
53      b(1,q)=r;
54      a=a/10;
55      a=floor(a);
56      q=q+1;
57  end
58  for m=1:q-1
59       c=m-1
60      f = f + b(1,m)*(2^c);
61  end
62  hex=dec2hex(f);
63  printf('\n In Hexadecimal notation is %sH\n\n',hex)
     ;// displaying the result
```

```
64 disp('As the memory of a first generation
      microcumputer is orgnised in bytes . The lower
      byte is stored in 2000 address and the higher
      byte is stored in 2001 address.');
```

Scilab code Exa 6.10 2s compliment subtraction

```
1  //example  6.10
2  clc;
3  clear;
4  format('v',18);
5  //bb=input('enter the first number(in decimal):' );
6  //aaa=input('enter the second number(negative) :');
7  aaa=-12618
8  bb=18357;
9  aa=-1*aaa;
10 a=0;
11 q=0;
12 while(aa>0)                  // finding the binary
      equivalents
13     x=modulo(aa,2);
14     a= a + (10^q)*x;
15     aa=aa/2;
16     aa=floor(aa);
17     q=q+1;
18 end
19 r=0;
20 b=0;
21 while(bb>0)
22     x=modulo(bb,2);
23     b= b + (10^r)*x;
24     bb=bb/2;
25     bb=floor(bb);
26     r=r+1;
27 end
```

```
28 m=b
29 for i=1:16
30     a1(i)=modulo(a,10);
31     a=a/10;
32    a=round(a);
33     p1(i)=0;
34     b1(i)=modulo(b,10);
35     b=b/10;
36    b=round(b);
37 end
38 p1(1)=1;
39 for i=1:16              // finding the 2's compliment
       of second number
40         a1(i)=bitcmp(a1(i),1);
41         end
42     car(1)=0;
43 for i=1:16
44     c1(i)=car(i)+a1(i)+ p1(i);
45     if c1(i)== 2 then
46         car(i+1)= 1;
47         c1(i)=0;
48     elseif c1(i)==3 then
49          car(i+1)= 1;
50         c1(i)=1;
51     else
52         car(i+1)=0;
53     end;
54 end;
55 re=0;
56     for i=1:16
57         re=re+(c1(i)*(10^(i-1)))
58     end;
59     printf(' The binary representation of first
          number is ');
60     disp(m);
61          printf(' The 2''s compliment of second
               nmber is ');
62          disp(re);
```

```
63 a1=c1;
64 ar(1)=0;
65 for i=1:8
66     c1(i)=ar(i)+a1(i)+ b1(i);    // addin both the
       nmbers (binary addition)
67     if c1(i)== 2 then            // lower byte
68         ar(i+1)= 1;
69         c1(i)=0;
70     elseif c1(i)==3 then
71          ar(i+1)= 1;
72         c1(i)=1;
73     else
74         ar(i+1)=0;
75     end
76 end
77 c1(9)=ar(9)
78 re=0;
79 format('v',18);
80 for i=1:8
81     re=re+(c1(i)*(10^(i-1)))
82 end
83 printf(' The sum of lower bytes of two binary
     numbers is %d\n',re );
84 printf(' with a carry is %d\n',ar(9));
85 for i=9:16
86     c1(i)=ar(i)+a1(i)+ b1(i);// upper byte
87     if c1(i)== 2 then
88         ar(i+1)= 1;
89         c1(i)=0;
90     elseif c1(i)==3 then
91          ar(i+1)= 1;
92         c1(i)=1;
93     else
94         ar(i+1)=0;
95     end
96 end
97 c1(17)=ar(17);
98 format('v',25);
```

```
99 ree=0;
100 for i=9:16
101     ree=ree+(c1(i)*(10^(i-9)));
102 end
103 for i=9:16
104     re=re+(c1(i)*(10^(i-1)))
105 end
106 printf(' The sum of upper  bytes of the given
    numbers is %d\n',ree);
107 printf(' with a carry is %d\n',ar(17));//displaying
    results
108 printf(' The total sum is ' );
109 disp(re);
110 printf(' with a carry %d',ar(17));
```

Scilab code Exa 6.12 final carry in a CLA

```
1 //exmple 6.12
2 clc;
3 clear;
4 //a=input('Enter the first number A (4 bit ) :');
5 //b=input('Enter the first number B (4 bit ) :');
6 a=1111;// given values for a and b
7 b=0001;
8 for i=1:4
9     a1(i)=modulo(a,10);
10     a=a/10;
11    a=round(a);
12     b1(i)=modulo(b,10);
13     b=b/10;
14    b=round(b);
15 end
16 for i=1:4   //finding the generate and propagate
    values for ech bit
17     g(i)=bitand(a1(i),b1(i));
```

```
18      p(i)=bitor(a1(i),b1(i));
19  end
20  c(1)=0;
21  for i=1:4   // finding the carry
22      c(i+1)= bitor(g(i),bitand(p(i),c(i)));
23  end
24  printf('The final carry is C3 = %d', c(5));//
      displaying the result
```

Chapter 7

Clocks and Timing Circuits

Scilab code Exa 7.1 clock cycle time

```
1 //example 7.1
2 clear;
3 clc;
4  //for 50 kHz clock
5  clk_frq1 = 50000;
6  c_t_500 = 1000/clk_frq1;
7  //for 8-MHz clock
8  clk_frq2 = 8000000;
9  c_t_8 = 10000000/clk_frq2;
10 printf('Cycle time for 500-kHz clock is %f
     milliseconds \n',c_t_500);//displaying results
11 printf(' Cycle time for 8-MHz clock is %f micro
     seconds',c_t_8);
```

Scilab code Exa 7.2 maximum clock frequency

```
1 //example 7.2
2 clc;
```

```
clear;
//prop_delay = input('Enter the propagation delay in
    nano seconds:');
prop_dely=24; // taking the given input
 format('v',18); //setting the precision
max_clk_frq = 1/prop_delay; // making necessary
   calculations
max_clk_frq = max_clk_frq*10^3;
printf('maximum clock frequency is %f KHz',
   max_clk_frq); // displaying the result
```

Scilab code Exa 7.3 frequency limits of the clock

```
//example 7.3
clc;
clear;
//ppm = input('Enter the stability in parts per
   million(PPM):');
//clk_frq = input('Enter the clock frequency in MHz
   :' );
ppm= 5//taking  the given values
clk_frq= 5
mill= clk_frq; //making necessary calculations
pp = mill*ppm;
pp = round(pp);
clk_frq = clk_frq*10^6;
o(1,1)=clk_frq-pp;
o(1,2)=clk_frq+pp;
printf('The clock frequency will be somewhere
   between %d and %d Hz',o);//displaying the result
```

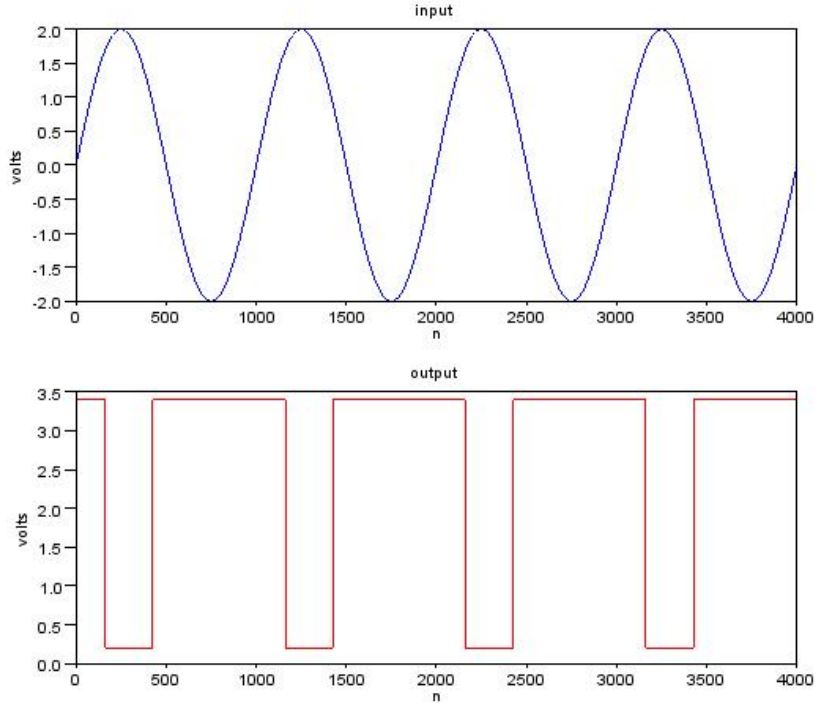

Figure 7.1: Schmitt trigger

Scilab code Exa 7.4 Schmitt trigger

```
1 //example 7.4
2 //schmitt trigger inverter
3 clear;
4 clc;
5 close;
6 //peak= input('Enter the peak voltage of sine wave
     in volts :');
7 //utp = input('Enter the upper trigger point in
     volts :');
8 //ltp = input('Enter the lower trigger point in
     volts :');
9 peak =2; // taking given values for inputs
10 utp=1.7;
11 ltp=0.9;
12 for i=1:4000
13     sinn(i) = peak * sin(i*2*3.1416/1000); //drawing
         a sin wave with given amplitude
14 end
15 for j=1:4000    // making calculations to plot
     output
16     if modulo(j,1000)< 250 then
17     if sinn(j)<utp  then
18         result(j)=3.4;
19       else
20           result(j)=0.2;
21          end
22         elseif sinn(j)>ltp  then
23              result(j)=0.2
24         else
25             result(j)=3.4;
26     end
27 end
28 subplot(2,1,1)
29 plot(sinn); //ploting the input and output curves
30 xlabel('n');
31 title('input')
```

```
32 ylabel('volts');
33
34 subplot(2,1,2);
35 plot(result,'r');
36 xlabel('n');
37 title('output')
38 ylabel('volts');
```

Scilab code Exa 7.5 frequency of oscillation for 555 timer

```
1 //example 7.5
2 clc
3 clear
4 //Ra = input('Enter the value of the resistance RA
     in Kohms :');
5 //Rb = input('Enter the value of the resistance RB
     in Kohms :');
6 //C =input('Enter the value of the Capacitance C in
     micro farads :');
7 Ra=1 //taking the given input
8 Rb=1
9 C= 1 *10^-3
10 T= (Ra + 2*Rb)*C;
11 frq = 1.44 * (1/T); //substituting in the eqution
12 printf('Freqency of oscillation is %f KHz',frq); //
     displaying result
```

Scilab code Exa 7.6 finding Ra and C in 555 timer circuit

```
1 //example 7.6
2 clc
3 clear
```

```
4 //rb=input('Enter the value of the resistance RB in
    Kohms :');
5 //dc =input('Enter required duty cycle in % :');
6 //clk = input('Enter the provided clock frequency in
    MHz:');
7 rb=0.75//taking the given values for input
8 dc=25
9 clk=1
10 ra = (rb*100/dc) - 2*rb;//mking neccesary
    calculations
11  format('v',18);
12 t2 = dc/(clk*10^8);
13 C = t2/(693*rb)
14 C=C*10^12;
15 //C=round(C);
16 printf('The value of RA is %f Kohms\n',ra);//
    displaying the output
17 printf('The value of C is %f pico farads',C);
```

Scilab code Exa 7.7 output pulse width for the timer

```
1 //example 7.7
2 clc
3 clear
4 //Ra = input('Enter the value of the resistance RA
    in Kohms :');
5 //C =input('Enter the value of the Capacitance C in
    micro farads :');
6 Ra=10//taking given values
7 C=0.1
8 pw = 1.1*Ra*C //substituting in the equation
9 printf('pulse width is %f milliseconds',pw);//
    displaying result
```

Scilab code Exa 7.8 value of C necessary to change pulse width to given values

```
1 //example 7.8
2 clc
3 clear
4 //Ra = input('Enter the value of the resistance RA
    in Kohms :');
5 //pw =input('Enter the value of required pulse width
     in millisecndseconds :');
6 Ra=10//taking given values
7 pw=10
8 C = pw/(1.1*Ra); //substituting in the equation
9 printf('The required value of capacitance is %f
    microfarads',C);//displaying result
```

Scilab code Exa 7.9 monostable multivibrator

```
1 //example 7.9
2 clear
3 clc
4 close
5 //R = input('Enter the value of the resistance R in
    Kohms :');
6 //C =input('Enter the value of the Capacitance C in
    micro farads :');
7 sp = input('Enter the spacing between two input
    pulses in micro seconds :');
```

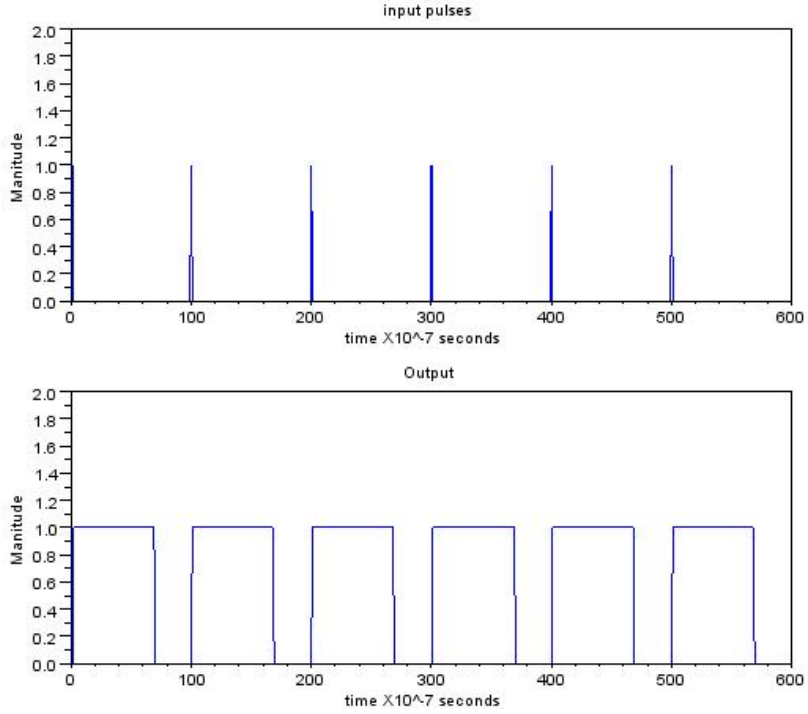

Figure 7.2: monostable multivibrator

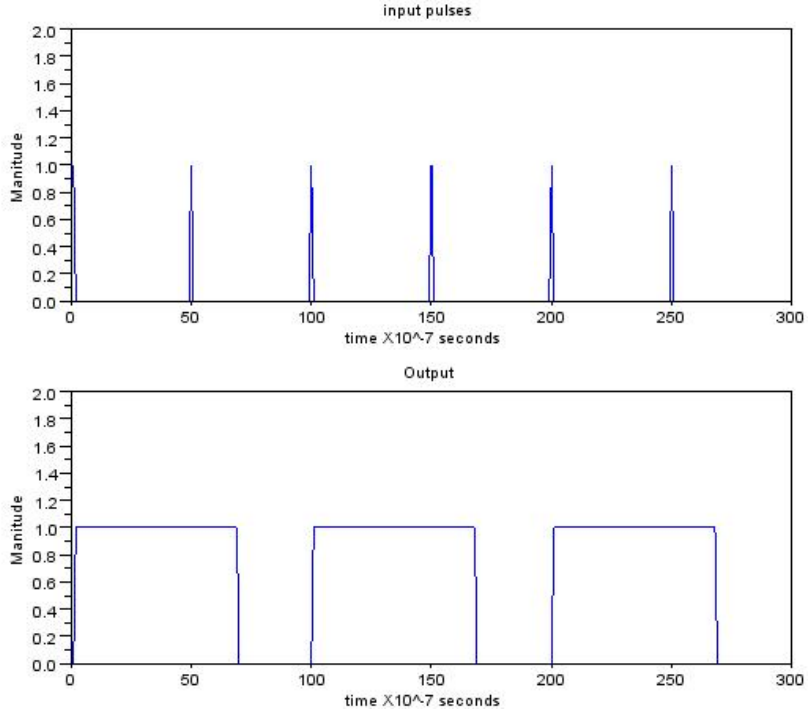

Figure 7.3: monostable multivibrator

```
R=1; //taking give values
C=0.01;
t= 693*R*C;  // calculting time constant
tt=t*10;
p=1;
len=sp*60-1;
q=1;
for j=1:len    //plotin the graphs
    lo = sp*10;
    f=modulo(j,lo);
    if f==0 then
        inpu(j)=1;
    else
        inpu(j)=0;
    end
    inpu(1)=1;
o(j)=2;
end
while q<len
    result(q)=0;
    q=q+1;
end
while p<len
    if inpu(p)==1 then
        for k=1:tt
            result(p+k)=1;
        end
        p=p+tt;
        else
            result(p)=0;
            p=p+1;
        end
    end
subplot(2,1,1); // ploting bothe graphs in same
   window
plot(o);
plot(inpu);
xlabel('time X10^-7 seconds');
```

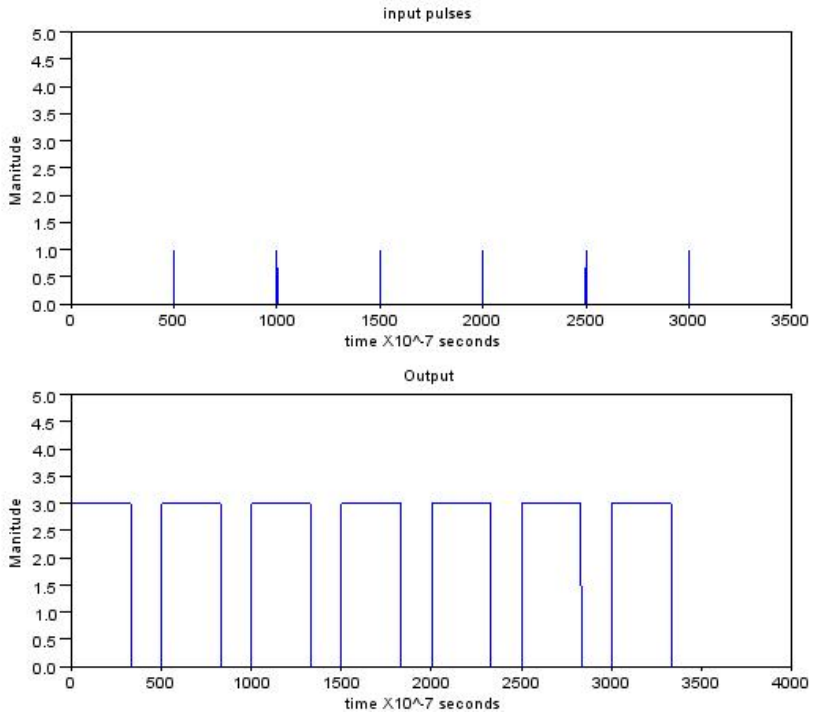

Figure 7.4: 74123

```
45 ylabel('Manitude') ;
46 title('input pulses');
47     subplot(2,1,2);
48     plot(o);
49 plot(result);
50 xlabel('time X10^-7 seconds');
51 ylabel('Manitude') ;
52 title('Output');
```

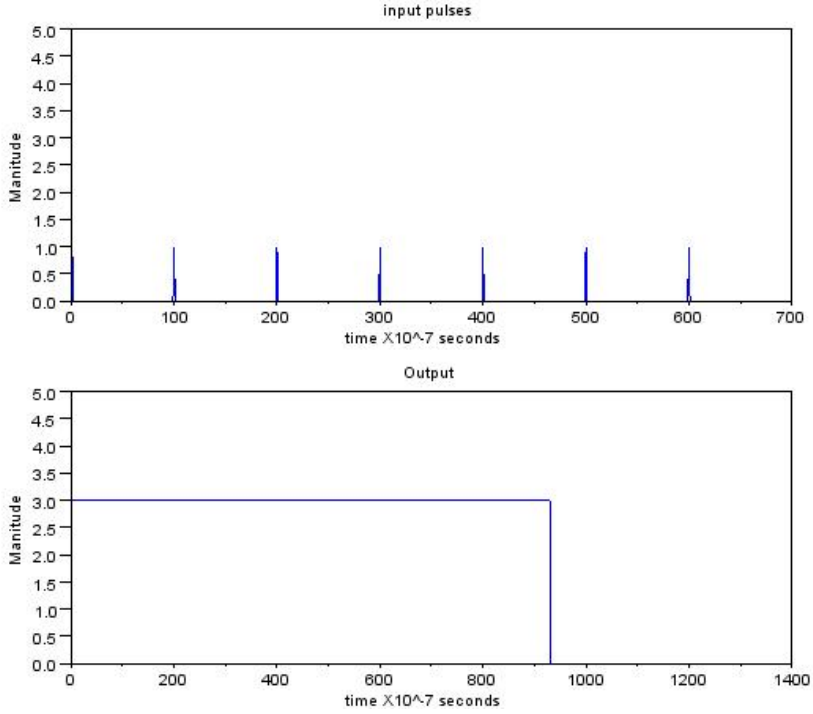

Figure 7.5: 74123

Scilab code Exa 7.10 74123

```
1  //example 7.10
2  clear
3  clc
4  close
5  //R = input('Enter the value of the resistance R in
       Kohms :');
6  //C =input('Enter the value of the Capacitance C in
       micro farads :');
7  sp = input('Enter the spacing between two input
       pulses in micro seconds :');
8  R=10;
9  C=0.01;
10 //sp=50;
11 //sp=10;
12 t= 330*R*C; // calculating time constant
13 printf('The output pulse width will be about %f
       micro seconds ',t);
14 tt=t*10;
15 p=1;
16 len=sp*60+1;
17 q=1;
18 for j=1:len      // making arrays to plot the graphs
19     lo = sp*10;
20     f=modulo(j,lo);
21     if f==0 then
22         inpu(j)=1;
23     else
24         inpu(j)=0;
25     end
26     inpu(1)=1;
27 o(j)=5;
28 end
29 if sp<40 then
30 while q<2*len
31     result(q)=0;
32     q=q+1;
```

```
33 end
34 else
35 while q<1.2*len
36     result(q)=0;
37     q=q+1;
38 end
39 end
40 while p<len
41     if inpu(p)==1 then
42         for k=1:tt
43             result(p+k)=3;
44         end
45         p=p+1;
46         else
47             p=p+1;
48         end
49
50     end
51 subplot(2,1,1); // ploting bothe graphs in same
      window
52 plot(o);
53 plot(inpu);
54 xlabel('time X10^-7 seconds');
55 ylabel('Manitude') ;
56 title('input pulses');
57     subplot(2,1,2);
58     plot(o);
59 plot(result);
60 xlabel('time X10^-7 seconds');
61 ylabel('Manitude') ;
62 title('Output');
```

Scilab code Exa 7.11 finding timing capacitor values

```
1 //example 7.11
```

```
clc
clear
//R = input('Enter the value of the resistance R in
   Kohms :');
//pw =input('Enter the value of required pulse width
    in millisecndseconds :');
R=0.5;//tking the given values
format('v',18);
pw = 1 * 10^-3;
C = pw/(0.33*R); //calculating C
printf('The required value of capacitance is %f
   microfarads\n',C);
printf('The pulse delay capacitor is %f microfarads'
   ,(2*C));
```

Chapter 8

Flip Flops

Scilab code Exa 8.4 RS flipflop

```
1 //example 8.4
2 clc;
3 clear;
4 en=input("Enter the enable input level(1 or 0) : ")
    ;
5 r=input("enter the R input level(1 or 0) : " );//
    accepting the inputs from the user
6 s=input("enter the S input level(1 or 0) : " );
7 qn=input("Enter the previous output value(1 or 0) :
    ");
8
9 if en == 0 then // clculating the output
10     op = qn;
11 elseif (s==0 & r==0) then
12     op=qn;
13 elseif(s==1&r==1) then
14     disp('The inputs are illegal');
15     return;
16 else
17     op=s;
18
```

```
19 end
20
21 printf('\n \noutput (Qn+1) = %d ',op);//displaying
   the output
```

Scilab code Exa 8.5 positive edge triggred RS flip flop

```
1 //example 8.5
2 clc;
3 clear;
4 disp('Here what happens at each point in time' );
5 disp('Time  t0: S = 0, R = 0,  no change in Q (Q
   remains 0)');
6 disp('Time  t1: S = 1, R = 0,  Q changes from 0 to 1
   ');
7 disp('Time  t2: S = 0, R = 1,  Q resets to 0');
8 disp('Time  t3: S = 1, R = 0,  Q sets to 1 ');
9 disp('Time  t4: S = 0, R = 0,  no change in Q (Q
   remains 1)');
10 disp('Notice that either R or S, or both, are
   allowed to change state at any time, whether C is
    high or low. The only time both R and S must be
   stable (unchanging) is during the short PTs of
   the clock.');
```

Scilab code Exa 8.6 negative edge triggred RS flip flop

```
1 //example 8.6
2 clc;
3 clear;
4 disp('Here what happens at each point in time' );
5 disp('Time  t0: S = 0, R = 0,  no change in Q (Q
   remains 0)');
```

```
6 disp('Time  t1: S = 1, R = 0,  Q changes from 0 to 1
    ');
7 disp('Time  t2: S = 0, R = 1,  Q resets to 0');
8 disp('Time  t3: S = 1, R = 0,  Q sets to 1 ');
9 disp('Time  t4: S = 0, R = 0,  no change in Q (Q
    remains 1)');
10 disp('Notice that either R or S, or both, are
    allowed to change state at any time, whether C is
     high or low. The only time both R and S must be
    stable (unchanging) is during the short NTs of
    the clock.');
```

Scilab code Exa 8.7 T flip flop

```
1 //example 8.7
2 clc;
3 clear;
4 close;
5 printf("For input J and K = 0 otput Qn+1 = Qn i.e
    output does not change its state And for J = K =
    1, The Output Qn+1 = Qn` i.e output toggles " );
```

Scilab code Exa 8.9 JK master slave

```
1 //example 8.9
2 clc
3 close
4 clear
5 disp("since J=K=1, the flip-flop simply toggles ech
    time the clock goes low, The waveform at Q has a
    period twice of that of the  wavefrm. In other
```

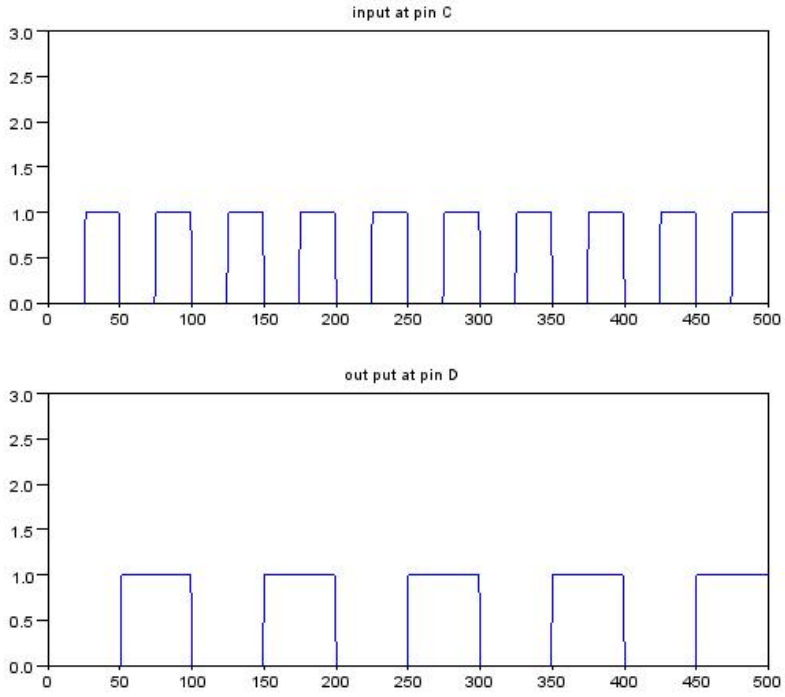

Figure 8.1: JK master slave

```
    words, the frequency of Q id only one-half of
    that of . This circuit acts as a frequency
    divider --the output frequency divide by 2. Note
     that Q changes state on NTs of the clock. The
    waveforms are as shown in the figure ");
t=50; // taken time period
p=1;
while p<t*10  // tking values for ploting the graph
    if p==1 | modulo(p,t)==0 then
        for k=1:t/2
            cin(p+k)=0;
        end
         p=p+t/2;
        else
            cin(p)=1;
            p=p+1;
        end
end
t=100;
p=1;
while p<t*5
    if p==1 | modulo(p,t)==0 then
        for k=1:t/2
            dout(p+k)=0;
        end
         p=p+t/2;
        else
          dout(p)=1;
            p=p+1;
        end
end
y=[3 3];
subplot(2,1,1)  //plotin both the plots in a single
   window
title('input at pin C')
plot(cin)
plot(y)
subplot(2,1,2)
```

```
38 title('out put at pin D')
39 plot(dout)
40 plot(y)
```

Scilab code Exa 8.10 fictitious flip flop excitation table

```
1  //Example 8.10
2  clc
3  clear
4  close
5  b=[0 1 0 1 0 1 0 1];//given truth tble for the
       fictitious flip flop
6  a = [0 0 1 1 0 0 1 1];
7  qn = [0 0 0 0 1 1 1 1];
8  for i=1:8
9  if(a(i)==0 & b(i)==0) then
10     qn1(i) = 0;
11     end;
12 if (a(i)==1 & b(i)== 1) then
13     qn1(i) = 1 ;
14  end;
15  if (a(i)==1 & b(i)== 0) then
16     qn1(i) = bitcmp(qn(i),1) ;
17  end;
18  if (a(i)==0 & b(i)== 1) then
19     qn1(i) = (qn(i)) ;
20  end;
21 end;
22 for i = 1 : 8   // printin the truth table
23         Y(i,1)=qn(i);
24         Y(i,2)=a(i);
25         Y(i,3)=b(i);
26         Y(i,4)=qn1(i);
27         end
28 disp('The given truth table  is :');
```

```
29 disp('  Qn      A      B     Qn+1');
30 disp(Y);
31 disp('The transitions are shown below');
32 c1=0;
33 c2=0;
34 c3=0;
35 c4=0;
36 for j=1:8 //checking all possible cases to make a
      transition table
37               if(qn(j)==0) then
38           if(qn1(j) == 0) then
39               if(c1==0) then
40                   disp('transition from 0 ----> 0');
41                   disp('   A      B ');
42                   c1=1;
43                   end;
44                  disp(Y(j,2:3));
45           end;
46    end;
47 end;
48 for j=1:8
49           if(qn(j)==0) then
50            if(qn1(j) == 1) then
51               if(c2==0) then
52                   disp('transition from 0 ----> 1');
53                   disp('   A      B ');
54                   c2=1;
55                   end;
56                  disp(Y(j,2:3));
57           end;
58    end;
59 end;
60 for j=1:8
61           if(qn(j)==1) then
62            if(qn1(j) == 0) then
63               if(c3==0) then
64                   disp('transition from 1 ----> 0');
65                   disp('   A      B ');
```

```
                    c3=1;
                    end;
                   disp (Y(j,2:3));
          end;
   end;
end;
for j=1:8
          if(qn(j)==1) then
           if(qn1(j) == 1) then
               if(c4==0) then
                    disp('transition from 1 ----> 1');
                    disp('   A     B ');
                    c4=1;
                    end;
                   disp(Y(j,2:3));
          end;
   end;
end;
```

Scilab code Exa 8.12 state transition diagram for given circuit

```
//example 8.12

clc;
clear;
close;
qn=[0,0,1,1];
x=[0,1,0,1];
for i=1:4 // calculating Y for all possible cases
    d(i)= bitxor(x(i),qn(i));
    qn1(i) =d(i);
    y(i)=bitand(x(i),bitcmp(qn(i),1));
end;
for i = 1 : 4  // displaying the state table
         Y(i,1)=qn(i);
```

```
15          Y(i,2)=x(i);
16          Y(i,3)=d(i);
17          Y(i,4)=qn1(i);
18          Y(i,5)= y(i);
19          end
20 disp('The state table is :');
21 disp('  Qn    X     D    Qn+1   Y');
22 disp(Y);
```

Scilab code Exa 8.13 D flip flop to RS flip flop

```
1 //example 8.13
2 clc;
3 clear;
4 disp('For SR flip flop Qn+1 = S + R'Qn and for D
     flip-flop Qn+1 = D .');
5 disp('Thus with D = S + R'Qn we get circuit which
     behaves like SR flip-flop.');
```

Chapter 9

Registers

Scilab code Exa 9.1 shift register serial input

```
1 //example 9.1
2 clc;
3 clear;
4 close ;
5 //s = input ('Enter the number to be serially
     shifted in to the shift register');
6 s=0100; // given serial input
7 for i = 4:-1:1
8     se(i) =modulo(s,10);
9     s=s/10;
10    s=round(s);
11 end
12 se(i+4)=0;
13 k=0;
14 for i = 2:6  // making state table
15    clk(k+1) = k;
16    q(i)=se(i-1);
17    if i>1 then
18        r(i) = q(i-1);
19    else
20        r(i) =0;
```

```
21      end;
22      if i>2 then
23          s(i) = r(i-1);
24      else
25          s(i) =0;
26      end;
27      if i>3 then
28          t(i) =s(i-1);
29      else
30          t(i) =0;
31      end;
32      k=k+1;
33  end
34  for i = 1 : 5 // printing the state table
35          Y(i,1)=clk(i);
36          Y(i,2)=se(i);
37          Y(i,3)=q(i);
38          Y(i,4)=r(i);
39          Y(i,5)= s(i);
40          Y(i,6)=t(i);
41          end
42  disp('The state table  is :');
43  disp('Clock  Input   Q     R     S     T');
44  disp(Y);
```

Scilab code Exa 9.2 shift register serial input and output graph

```
1  //example 9.2
2  clc
3  clear
4  close
5  t1=100; // clock period
6  s=0100; //given serial input
```

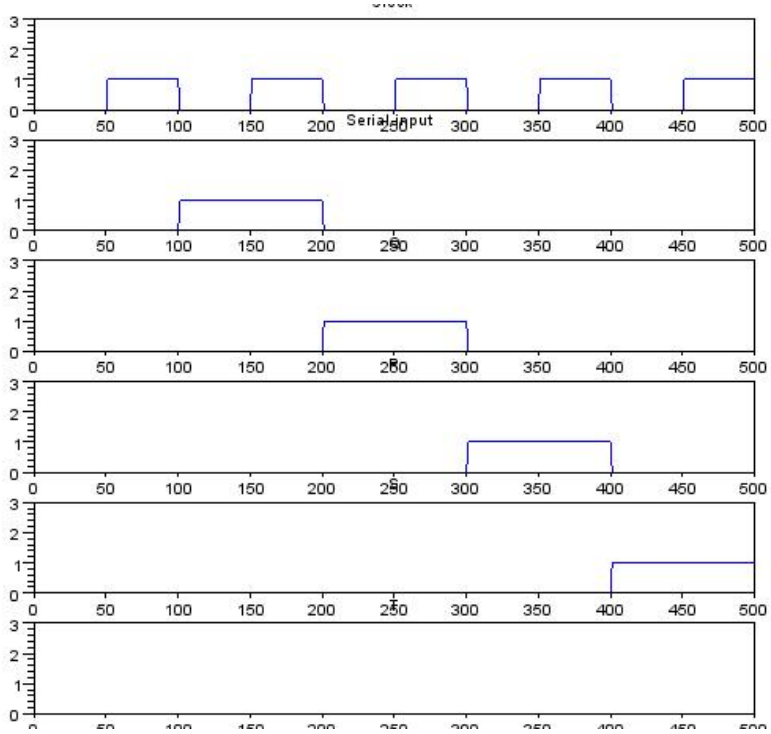

Figure 9.1: shift register serial input and output graph

```
for i = 4:-1:1
    se(i) = modulo(s,10);
    s=s/10;
    s=round(s);
end
se(i+4)=0;
k=0;
for i = 2:6 //initially making a state table
    clk(k+1) = k;
    q(i)=se(i-1);
    if i>1 then
        r(i) = q(i-1);
    else
        r(i) =0;
    end;
    if i>2 then
        s(i) = r(i-1);
    else
        s(i) =0;
    end;
    if i>3 then
        t(i) =s(i-1);
    else
        t(i) =0;
    end;
    k=k+1;
end
for m=1:5    // drawing the graph
    if(se(m)==1) then
       v= ((m-1).*t1)
        for u= 1: t1
            se1(u+v)=1;
            end
        else
            v= ((m-1)*t1)
            for  u= 1: t1
                se1(u+v)=0;
            end
```

```
45          end;
46
47          if(q(m)==1) then
48         v= ((m-1).*t1)
49          for u= 1: t1
50              q1(u+v)=1;
51              end
52          else
53              v= ((m-1)*t1)
54              for  u= 1: t1
55                  q1(u+v)=0;
56              end
57          end;
58          if(r(m)==1) then
59         v= ((m-1).*t1)
60          for u= 1: t1
61              r1(u+v)=1;
62              end
63          else
64              v= ((m-1)*t1)
65              for  u= 1: t1
66                  r1(u+v)=0;
67              end
68          end;
69          if(s(m)==1) then
70         v= ((m-1).*t1)
71          for u= 1: t1
72              s1(u+v)=1;
73              end
74          else
75              v= ((m-1)*t1)
76              for  u= 1: t1
77                  s1(u+v)=0;
78              end
79          end;
80          if(t(m)==1) then
81         v= ((m-1).*t1)
82          for u= 1: t1
```

```
83              t11(u+v)=1;
84              end
85          else
86              v= ((m-1)*t1)
87              for  u= 1: t1
88                  t11(u+v)=0;
89              end
90              end;
91         end;
92 p=1;
93 while p<t1*5
94       if p==1 | modulo(p,t1) == 1 then
95          for k=1:t1/2
96              cin(p+k)=0;
97          end
98           p=p+t1/2;
99          else
100             cin(p)=1;
101             p=p+1;
102         end
103 end
104 y=[3 3];
105 subplot(6,1,1)  // making subplots to draw all
       graphs in a single window
106 title('Clock')
107 plot(cin)
108 plot(y)
109 subplot(6,1,2)
110 title('Serial input')
111 plot(se1)
112 plot(y)
113 subplot(6,1,3)
114 title('Q')
115 plot(q1)
116 plot(y)
117 subplot(6,1,4)
118 title('R')
119 plot(r1)
```

```
120 plot(y)
121 subplot(6,1,5)
122 title('S')
123 plot(s1)
124 plot(y)
125 subplot(6,1,6)
126 title('T')
127 plot(t11)
128 plot(y)
```

Scilab code Exa 9.4 54164 shift register

```
1  //example 9.4
2  clc;
3  clear;
4  //b= input('Enter the number of bits :');
5  //c= input('Enter the clock frequency in Mhz :');
6  b= 8; // given values
7  c=10;
8  t= 1000/c;
9  printf('One clock period takes %d ns\n',t); //
      displying the results
10 tt=t*b;
11 printf(' Time required by total bits required is %d
      ns',tt);
```

Scilab code Exa 9.5 54164 shift register

```
1  //example 9.5
2  clc;
3  clear;
4  close;
5  //c= input('Enter the clock frequency in Mhz :');
```

```
6 c=10; //given clock frequency
7 t= 1000/c;
8 printf('The data must be stable for 30 ns\n');  //
    displaying results
9 tc = t-30;
10 printf(' The data may be changing in %d ns',tc);
```

Scilab code Exa 9.8 74ls174

```
1 //exaple 9.8
2 clc;
3 clear;
4 //s=input("Enter the setup time in ns :");
5 //h=input("Enter the hold time in ns :");
6 s=20;   //given input values
7 h=5;
8 printf('The data input levels must be held steady
    foor a minimum of %d ns',(s+h));  // displayin
    the results
```

Scilab code Exa 9.9 7495A

```
1 //example 9.9
2 clc;
3 clear;
4 disp('The mode control line must be high. The data
    lines must be stable for more than 10 ns prior to
     the clock NTs . If the clock is stopped after
    the transition time T, the levels n the input
    data lines may be changed. However , if the clock
     is not stopped, the input data levels must be
    mainted.')
```

Chapter 10

Counters

Scilab code Exa 10.1 ripple counter clock frequency

```
1 //example 10.1
2 clc;
3 clear;
4 //c= input('Enter the period of the waveform at C in
      micro seconds : ');
5 c=24;// given period of waveform
6 clk= c/8;
7 clkf = 1/(clk*10^-3);
8 printf('The clock period is %f micro seconds \n',clk
    );//displaying the results
9 printf('The clock frequenc must be %f  KHz ', clkf);
```

Scilab code Exa 10.2 number of flip flops required to construct a counter

```
1 //example 10.2
2 clc;
3 clc
4 c=128; // given counters
```

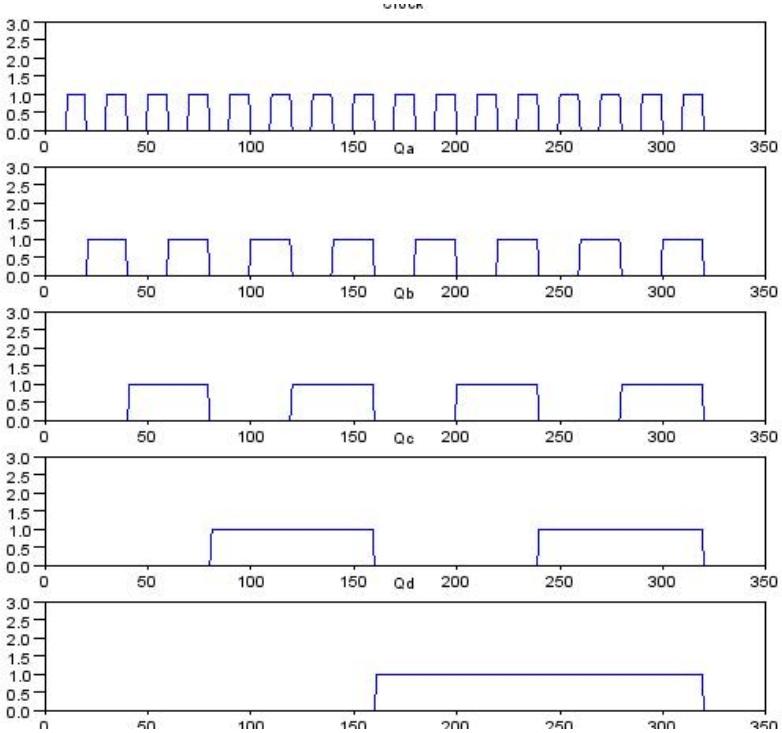

Figure 10.1: Output waveforms for a 7493A connected as a mod 16 counter

```
d=32;
e=64;
fc=log2(c);//making necessar calculations
fd=log2(d);
printf('A mod-128 conter should have %d flipflops\n'
   , fc);
printf(' A mod-32 conter should have %d flipflops\n'
   , fd); //displaying the results
fe=log2(e);
n=2^fe - 1 ;
printf(' The largest decimal no that can be stored
   in a mod-64 counter is %d',n);
```

Scilab code Exa 10.3 Output waveforms for a 7493A connected as a mod 16 counter

```
clc;
clear;
close;
t=320;
p=1;
while p<t*1 //making arrays for ploting
    if p==1 | modulo(p,t)==0 then
        for k=1:t/2
            qd(p+k)=0;
        end
         p=p+t/2;
        else
            qd(p)=1;
            p=p+1;
        end
end
t=160;
p=1;
while p<t*2
    if p==1 | modulo(p,t)==0 then
        for k=1:t/2
            qc(p+k)=0;
        end
         p=p+t/2;
        else
          qc(p)=1;
            p=p+1;
        end
end
t=80;
p=1;
```

```
32 while p<t*4
33     if p==1 | modulo(p,t)==0 then
34         for k=1:t/2
35             qb(p+k)=0;
36         end
37          p=p+t/2;
38         else
39           qb(p)=1;
40             p=p+1;
41         end
42 end
43 t=40;
44 p=1;
45 while p<t*8
46     if p==1 | modulo(p,t)==0 then
47         for k=1:t/2
48             qa(p+k)=0;
49         end
50          p=p+t/2;
51         else
52           qa(p)=1;
53             p=p+1;
54         end
55 end
56 t=20;
57 p=1;
58 while p<t*16
59     if p==1 | modulo(p,t)==0 then
60         for k=1:t/2
61             clk(p+k)=0;
62         end
63          p=p+t/2;
64         else
65           clk(p)=1;
66             p=p+1;
67         end
68 end
69 for i=320:350
```

```
70      clk(i)=0;
71      qa(i)=0;
72      qb(i)=0;
73      qc(i)=0;
74      qd(i)=0;
75  end;
76  y=[3 3]; //ploting the graphs
77  subplot(5,1,1)
78  title('Clock')
79  plot(clk)
80  plot(y)
81  subplot(5,1,2)
82  title('Qa')
83  plot(qa)
84  plot(y)
85  subplot(5,1,3)
86  title('Qb')
87  plot(qb)
88  plot(y)
89  subplot(5,1,4)
90  title('Qc')
91  plot(qc)
92  plot(y)
93  subplot(5,1,5)
94  title('Qd')
95  plot(qd)
96  plot(y)
```

Scilab code Exa 10.5 Expression for AND gate connected to the leg of OR gate that drives clock input to flip flop Qd in 74193

```
1  //example 10.5
2  clc;
3  clear;
4  printf('The correct expression is : (count-up clock)
```

```
    ''(Qa)(Qb)(Qc)');
```

Scilab code Exa 10.6 Expression for 4 input AND gate connected to the leg of OR gate that conditions the J and K inputs to the Qd flip flop in a 74191

```
1 //example 10.6
2
3 clc;
4 clear;
5 printf('The correct logic expression is : (down-up)'
    '(Qa)(Qb)(Qc)(enable)''');
```

Scilab code Exa 10.7 number of flip flops required to construct a counter

```
1 //example 10.7
2 clc;
3 clear;
4 mod = input("Enter the n value in your desired mod-n
    counter:");//taking the input
5 m=mod;
6 while 1
7  n= log2(mod); //checking whether the given number
    is a power of 2
8  k=modulo(n,1);
9  if k==0  then
10     printf('The number of flip flops used in mod-%d
           counter are:',m); // if yes the print th
          outpu.
11     printf('%d',n);
12     return;
13  end
14  mod =mod+1;
```

```
15  end
```

Scilab code Exa 10.8 what modulus counters can be constructed with given number of flip flops e

```
1  //example 10.8
2  clc;
3  clear;
4  //ff = input('Enter the no of flip-flops :');
5  ff=4; //given input
6  k=2^ff;
7  if(k==2) then  //output display
8      printf('With given flipflop we can only count 2,
           we can have a modulus 2 counter');
9      else
10 printf('With given number of flip-flops the counter
       will have a natural count of %d\n',k);
11 printf('We can thus construct any counter that has a
       modulus between %d and 2',k )
12 end;
```

Scilab code Exa 10.9 mod 6 counter

```
1  //example 10.9
2
3  clc;
4  clear;
5  close;
6  c = [0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1
       0]; //taking the values for a mod -6 counter
```

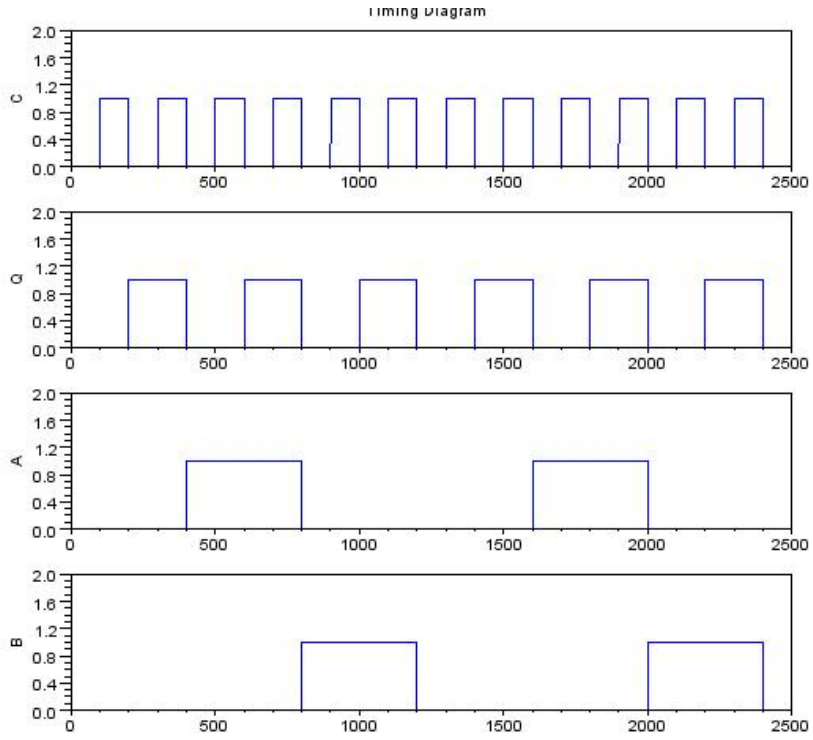

Figure 10.2: mod 6 counter

```
q = [0 0 1 1 0 0 1 1 0 0 1 1 0 0 1 1 0 0 1 1 0 0 1 1
    0];
a = [0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 1 1 1 1 0 0 0 0
    0];
b = [0 0 0 0 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 1 1 1 1
    0];
y1=q;
y2=a;
y3=b;
y11p=1;
y22p=1;
y33p=1;
y44p=1;
cp=1;
yf1p=1;
for i=1:25     // making arrays to draw the output
    if y1(i)==1 then
        for o=1:100
        y11(y11p)=1;
        y11p=y11p+1;
        end
    else
        for o=1:100
        y11(y11p)=0;
        y11p=y11p+1;
        end

end
if y2(i)==1 then
        for o=1:100
        y21(y22p)=1;
        y22p=y22p+1;
        end
    else
        for o=1:100
        y21(y22p)=0;
        y22p=y22p+1;
        end
```

```
42
43 end
44 if y3(i)==1 then
45          for o=1:100
46          y31(y33p)=1;
47          y33p=y33p+1;
48          end
49      else
50          for o=1:100
51          y31(y33p)=0;
52          y33p=y33p+1;
53          end
54
55 end
56 if c(i)==1 then
57          for o=1:100
58          c1(cp)=1;
59          cp=cp+1;
60          end
61      else
62          for o=1:100
63          c1(cp)=0;
64          cp=cp+1;
65          end
66 end
67
68 end
69 z=[2 2];
70 subplot(4,1,1); //ploting the out put
71 title('Timing Diagram');
72 plot(c1);
73 plot(z);
74 ylabel('C');
75 subplot(4,1,2);
76 plot(y11);
77 ylabel('Q');
78 plot(z);
79 subplot(4,1,3);
```

```
80 plot(y21);
81 ylabel('A');
82 plot(z);
83 subplot(4,1,4);
84 plot(z);
85 ylabel('B');
86 plot(y31);
```

Scilab code Exa 10.10 Expression for a gate to decode count 8 in a 7492A

```
1 //example 10.10
2 clc;
3 clear;
4 printf('The correct expresion is ""8"" = Qd Qc'' Qb
    Qa'');
```

Scilab code Exa 10.12 mod 12 counter

```
1 //example 10.12
2 clc
3 clear
4 //pro= ('Enter the value to whic counter should
    progress:');
5 pro =11; // given input
6 q=1;
7 aa=pro;
8 for i=1:4              //converting the given number
    in to binary
9     x=modulo(aa,2);
10    b(q)=x;
11    aa=aa/2;
12    aa=floor(aa);
13    q=q+1;
```

```
14 end
15
16 bi=' ';   // then printing the NAND gate inputs
17 for i=1:4
18     if i==1 & b(i)==1 then
19         bi=strcat([bi 'Qa']);
20     elseif i==1 & b(i)== 0 ;
21         bi=strcat([bi 'Qa'']);
22     end
23     if i==2 & b(i)==1 then
24         bi=strcat([bi 'Qb']);
25     elseif i==2 & b(i)== 0 ;
26         bi=strcat([bi 'Qb'']);
27     end
28     if i==3 & b(i)==1 then
29         bi=strcat([bi 'Qc']);
30     elseif i==3 & b(i)== 0 ;
31         bi=strcat([bi 'Qc'']);
32     end
33     if i==4 & b(i)==1 then
34         bi=strcat([bi 'Qd']);
35     elseif i==4 & b(i)== 0 ;
36         bi=strcat([bi 'Qd'']);
37     end
38
39 end
40 disp('The NAND gate inputs must be :');
41 disp(bi)
```

Scilab code Exa 10.13 4 bit binary counter presettable

```
1 //example 10.13
2 clc;
3 clear
4 //pre=input("Enter the number where the counter is
```

```
    preset");
pre = 1001; // given preset value
q=1;
b=0;
f=0;
a=pre;
while(a>0) //converting to decimal
    r=modulo(a,10);
    b(1,q)=r;
    a=a/10;
    a=floor(a);
    q=q+1;
end
for m=1:q-1
     c=m-1
    f = f + b(1,m)*(2^c);
end
disp("The counter will count down to 15 , Then
    preset back to %d, The resulting state diagram is
     shown below");
for k=1:3
for i=9:-1:0  // this will print the states
printf('%d  ',i);
end;
printf('15  ');

end;
```

---

check Appendix AP 8 for dependency:

`kmap3.sci`

check Appendix AP 2 for dependency:

`noof.sci`

check Appendix AP 3 for dependency:

`noof0.sci`

Scilab code Exa 10.14 self correcting modulo 6 counter

```
1  //example 10.14
2  //this program uses the following functions
3  //kmap3.sci
4  //noof.sci and noof0.sci
5  //the above programs should be executed before
      executing these programs
6  clc;
7  n= [ 0 0 0;
8       0 0 1;
9       0 1 0;
10      0 1 1;
11      1 0 0;
12      1 0 1;
13      1 1 0;
14      1 1 1];
15      for i= 1 : 5
16          n1(i,:)= n(i+1,:)
17      end
18      for i=6:8
19      n1(i,:)=[0 0 0]
20   end;
21   p=1;
22   for i= 1:3  //making the state table
23       for j = 1:8
24           if n(j,i)== 0
25               jf(j,p)= n1(j,i);
26               jf(j,p+1)= 2;
27           elseif n(j,i) == 1
28               jf(j,p)=2;
29               jf(j,p+1)=bitcmp(n1(j,i),1);
30       end
31   end
```

```
32    p=p+2
33  end;
34  disp('State tabel for mod 6 counter:'); //displaying
       the state table
35  di= [n n1 jf];
36  disp('   Cn    Bn    An   Cn1   Bn1    An1   Jc
       Kc    Jb    Kb    Ja    Ka');
37  disp(di);
38  disp('Here ''2'' represents a don''t care condition'
       );
39  disp('These below Karnaugh maps give the design
       equations');
40
41  jc=[0 0 1 0;2 2 2 2] //Krnaugh Maps for the design
       equations
42  JC=kmap3(jc);   //calling the 3-variable kmap
43  printf('\n\nJC = %s \n',JC); //displaying the result
44
45  kc=[2 2 2 2;0 1 1 1]
46  KC=kmap3(kc);//calling the 3-variable kmap
47  printf('\n\nKC = %s \n',KC); //displaying the result
48
49  jb=[0 1 2 2;0 0 2 2]
50  JB=kmap3(jb);//calling the 3-variable kmap
51  printf('\n\nJB = %s \n',JB); //displaying the result
52
53  kb=[2 2 1 0;2 2 1 1]
54  KB=kmap3(kb);//calling the 3-variable kmap
55  printf('\n\nKB = %s \n',KB); //displaying the result
56
57  ja=[1 2 2 1;1 2 2 0]
58  JA=kmap3(ja);//calling the 3-variable kmap
59  printf('\n\nJA = %s \n',JA); //displaying the result
60
61  ka=[2 1 1 2;2 1 1 2]
62  KA=kmap3(ka);//calling the 3-variable kmap
63  printf('\n\nKA = %s \n',KA); //displaying the result
```

check Appendix AP 7 for dependency:

kmap2.sci

Scilab code Exa 10.15 sequence generator

```
1 //example 10.15
2 //this program use kmap2.sci
3 //kmap2.sci should be executed before executing this
      program
4 clc;
5 a= [0 0 1 1]
6 b= [0 1 0 1]
7 y= [1 1 0 1]
8 k= [1 1 ; 0 1]
9 bi = kmap2(k); // calling 2-variable kmap
10 disp("   A     B     Y");
11 for i=1:3
12     Y(i,1) = a(i);
13     Y(i,2) = b(i);
14     Y(i,3) = y(i);
15 end
16 disp(Y);
17 disp('The minimised expression from karnaugh map is'
     );// displaying the result
18 disp(bi);
```

Chapter 11

Design of Sequential Circuit

check Appendix AP 6 for dependency:

`kmap3a.sci`

check Appendix AP 2 for dependency:

`noof.sci`

check Appendix AP 3 for dependency:

`noof0.sci`

Scilab code Exa 11.1 synchronous sequential logic circuit

```
1  //example 11.1
2  clc;
3  //this program requires
4  //kmap3a.sci  to find the kmap
5  //noof.sci function used inside kmap
6  //noof0.sci function used inside kmap
7  n= [ 0 0 0;
8       0 0 1;
9       0 1 0;
10      0 1 1;
```

```
11        1 0 0;
12        1 0 1;
13        1 1 0;
14        1 1 1];
15         for i= 1:8     //printing the state synthesis
              table
16         an1(i,1)=n(i,3);
17         dn(i,1)=n(i,3);
18         if n(i,1)==1 & n(i,2) ==1 & n(i,3)==0 then
19             z(i,1)=1;
20         else
21             z(i,1)=0;
22         end
23  end;
24  dis=[n an1 dn z];
25  disp('State Synthesis table :');
26  disp('   An    X     Y    An1    Dn    Z');
27  disp(dis);
28  printf('\n\n Design equations :\n');
29  Dn = [ 0 1 1 0;0 1 1 0];
30  Z= [ 0 0 0 0;0 0 0 1];
31  dn1= kmap3a(Dn);                          // finding
       the 3 varible kmap of Dn
32  printf('\n      Dn = %s \n\n',dn1);       //displaying
       the minimized expression
33  z1= kmap3a(Z);                            //finding
       the 3 variable kmap of Z
34  printf('\n      Z = %s \n\n',z1);         //displaying
       the minimized expression
```

---

check Appendix AP 4 for dependency:

`donkmapij.sci`

check Appendix AP 5 for dependency:

`noof1.sci`

Scilab code Exa 11.2 vending machine

```
// example 11.2
//this code needs
//donkmapij.sci // function to minimize given
   expression using a kmap
//noof1.sci
//above two shoulb be executed before executing this
    code
clc;
tt=[0 0 0 0 0 0 0 0 0 0;  // given state synthesis
   table
    0 0 0 1 0 0 0 0 0 0;
    0 0 1 0 0 1 0 0 0 1;
    0 0 1 1 1 0 0 0 1 0;
    0 1 0 0 0 1 0 0 0 1;
    0 1 0 1 0 1 0 0 0 1;
    0 1 1 0 1 0 0 0 1 0;
    0 1 1 1 0 0 1 0 0 0;
    1 0 0 0 1 0 0 0 1 0;
    1 0 0 1 1 0 0 0 1 0;
    1 0 1 0 0 0 1 0 0 0;
    1 0 1 1 0 0 1 1 0 0];
disp('State snthesis table for Vending machine
   problem'); //printing the staate synthesis table
disp('Present state   input     Next state    Output
        Db    Da');
disp('   Bn    An    I     J    Bn1   An1    X     Y
   ');
disp(tt);
printf('\n\n Design equations :\n');

printf('\n Design equation for DB\n');
db =[ 0 0 2 1 ; 0 0 2 1 ;1 0 2 0 ;0 1 2 0];
DB =donkmapij(db);// minimizing the expresion using
   4 variable kmap
printf('\n     DB = %s \n\n',DB);//displaing result

```

```
30 printf('\n Design equation for DA\n');
31 da =[ 0 1 2 0;0 1 2 0 ;0 0 2 0;1 0 2 0];
32 DA =donkmapij(da);// minimizing the expresion using
      4 variable kmap
33 printf('\n      DA = %s \n\n',DA);//displaing result
34
35 printf('\n Design equation for X\n');
36 x =[0 0 2 0;0 0 2 0;0 1 2 1; 0 0 2 1];
37 X =donkmapij(x);// minimizing the expresion using 4
      variable kmap
38 printf('\n      X = %s \n\n',X);//displaing result
39
40 printf('\n Design equation for Y\n');
41 y=[0 0 2 0;0 0 2 0;0 0 2 1;0 0 2 0];
42 Y =donkmapij(y);// minimizing the expresion using 4
      variable kmap
43 printf('\n      Y = %s \n\n',Y);//displaing result
```

Scilab code Exa 11.5 Reducing state transition diagrams

```
1  //example 11.5
2  clc;
3  clear;
4  disp('Original table :'); //displaying original
      table
5  disp('Present State    Next State    Present Output');
6  disp('                 X=0    X=1     ');
7  disp('       a          a       b            0     ');
8  disp('         b          c       d            0     ');
9  disp('       c          d       e            1     ');
10 disp('         d          c       b            0     ');
11 disp('       e          b       c            1     ');
12 disp('For states b and d except for next state X=1
      rest are same. NOw b and d would have been
      equivalent if these next states are equivalent.
```

```
    For b next state is d and d, next state is b.
    Thus bd are equivalent if next states db are
    equivalent which can always be true. Thus b and d
     are equivlent and state b is retained.')
disp('Table after first row elimination :'); //after
     first row elimination
disp('Present State   Next State   Present Output');
disp('                X=0    X=1     ');
disp('       a          a      b           0     ');
disp('       b          c      b           0     ');
disp('         c          b      e           1     ');
disp('         e          b      c           1     ');
disp('Now repeating the same above step for  c and e
    . Retaining c and replacing arll c''s with e we
    get the below table ');
disp('Table after second row elimination :');//after
     second row elimination
disp('Present State   Next State   Present Output');
disp('                X=0    X=1     ');
disp('       a          a      b           0     ');
disp('       b          c      b           0     ');
disp('       c          b      c           1     ');

disp('Implication table method'); // by implication
    method
printf('d:d\nc:d(ce)\nb:d(Ce)(bd)\na:(ce)(bd)a\nP=(
    ce)(bd)(a)');
```

Scilab code Exa 11.6 asynchronous sequential circuit

```
//example 11.6
clc;
clear;
disp('To analye the circuit we consider x = X(t-  )
    where    is the cummulative propagatin delay from
```

```
    input side up to X.For all  possible
    combbinations of xAB we get X and Y following the
     logic relation as shown in the circuit and
    prepare the following Karnaugh map');
disp('Karnaugh map'); // displaying the kmap
disp('  AB')
disp('x    00      01      11      10');
disp('0    0''/0    0''/0    1/0     0''/0');
disp('1    0/0     0/1     1''/1    1''/0');
disp('State where X = x are stable and primed.
    Outputs corresponding to ech state and inpt
    combination are shown beside.');
```

Scilab code Exa 11.7 asynchronous sequential circuit problem in operation

```
//example 11.7
clc;
clear;
disp('Given karnaugh map '); //given kmap
disp('     00      01      11      10');
disp('00   11      00''     11      00''');
disp('01   01''     11      11      01''');
disp('11   10      11      11''     10');
disp('10   10''     10''     11      11');
disp('Yes, the circuit may face problem in its
    operation. When the circuit is at stable state
    xyAB = 1111 and input AB changes from 11 --> 10
    the circuit oscillates between xyAB = 1110 and xy
     AB = 1010. Also there can be a criticl race
    problem if at stable state xyAB = 0001, input AB
    chnge from 01 to 00. The circuit may settle at
    xyAB = 0100 or xyAB = 1000 depending on which of
    x and y changes first at the feedbck path. Non-
    critical race situatuion occurs if at stable
```

```
state xyAB = 0010 the input AB change from 10 to
00. ');
```

check Appendix AP 1 for dependency:

`kmap3abx.sci`

check Appendix AP 2 for dependency:

`noof.sci`

check Appendix AP 3 for dependency:

`noof0.sci`

Scilab code Exa 11.8 asynchronous sequential circuit

```
1  //example 11.8
2  // this program requires
3  //kmp3abx.sci
4  //noof.sci
5  //noof0.sci
6  //above three functions are first execute before
      executing this program
7  clc;
8  disp('State table through karnaugh map'); // state
      table through kmap
9  disp('      00       01       11       10');
10 disp('a     a''       a''       b        b');
11 disp('b     a        b''       b''       b''');
12 disp('If we represent current state a as x = 0 and b
       as x =1 the noutput X can be expressed as ');
13 j=[0 0  1 1 ; 0 1 1 1];
14 J= kmap3abx(j); // finding the minimized expresion
      using 3-variable kmap
15 disp('The minimised expression J');
16 disp(J); // displaying the minimized expression
```

Chapter 12

D to A Conversion and A to D conversion

Scilab code Exa 12.1 binary equivalent weight of each bit in a 4bit system

```
1 //chapter 12
2 //Example 12.1
3 //Q.Find the binary equivalent of each bit in a 4-
     bit system
4 //solution:
5 clc;
6 clear;
7 LSB = 1/(2^4-1); // calculating binary weights
8 LSB2 = 2*1/(2^4-1);
9 LSB3 = 4*1/(2^4-1);
10 MSB = 8*1/(2^4-1);
11 disp("Binary weight of each bit in a 4-bit system');
12 disp("LSB ="); // displaing the result
13 disp(LSB);
14 disp("LSB2 =");
15 disp(LSB2)
16 disp("LSB3 =");
17 disp(LSB3)
18 disp("MSB =");
```

```
19 disp(MSB) ;
```

Scilab code Exa 12.2 5 bit resistive divider

```
1  //Example 12.2
2  clc;
3  clear;
4  LSB = 1/(2^5-1);  // calculating weights
5  LSB2 = 2*1/(2^5-1);
6  LSB3 = 4*1/(2^5-1);
7  change_LSB = 10 *LSB;
8  change_LSB2 = 10 *LSB2;
9  change_LSB3 = 10*LSB3;
10 op_vol= (10*2^0 + 0*2^1 + 10*2^2 +0*2^3 +10*2^4)
     /(2^5-1); // calculating output voltage
11 disp("(a) LSB =");
12 disp(LSB);
13 disp("(b)Second LSB =");
14 disp(LSB2)
15 disp("  Third LSB3 =");
16 disp(LSB3)
17 disp('(c) change in output voltage caused by ');
18 disp("change in LSB =");
19 disp(change_LSB);
20 disp("change in second LSB =");
21 disp(change_LSB2)
22 disp("change in third LSB =");
23 disp(change_LSB3)
24 disp("(d)output voltage for a digital input of 10101
     =");
25 disp(op_vol) ;
```

Scilab code Exa 12.3 5 bit ladder

```
1 //Example 12.3
2 clc;
3 clear;
4 for i=1:5
5     op_v(1,i)= 10/2^i; // calculating otput voltages
          corresponding to each bit
6 end
7 disp("output voltages corresponding to each bit are
     ") //displaying result
8 disp(op_v);
```

Scilab code Exa 12.4 5 bit ladder

```
1 //Example 12.4
2 clc
3 clear
4 V_A=0
5 //a=input("Enter the binary digit(5 bits) :" );
6 a=11010
7 for i=1:5
8     r=modulo(a,10);
9     b(1,i)=r;
10    a=a/10;
11    a=floor(a);
12 end
13 for j=1:5
14 V_A = V_A + 10*b(1,j)*2^(j-1);
15 end;
16 V_A=V_A/2^5;
17 disp("The output voltage in volts is ');
18 disp(V_A); // displaying the value
```

Scilab code Exa 12.5 5 bit ladder

```
1 //Example 12.5
2 clc;
3 clear;
4 ful_scale_voltage = 0 ;
5 for i=1:5
6     op_v(1,i)= 10/2^i;
7     ful_scale_voltage = ful_scale_voltage + op_v(1,i
        ); // calculating the full scale voltage
8 end
9 disp("full scale output voltage in volts is =");
10 disp(ful_scale_voltage)
```

Scilab code Exa 12.6 5 bit ladder

```
1 //Example 12.6
2 clc;
3 clear;
4 I=10/(3*10^3);
5 printf("Current each input digital voltage must be
    capable of supplying is =%f mA\n",I*1000)
6 ful_scale_voltage = 0 ;
7 for i=1:5
8     op_v(1,i)= 10/2^i;
9     ful_scale_voltage = ful_scale_voltage + op_v(1,i
        );
10 end
11 V_A=ful_scale_voltage * (2*1000)/(1000+(2*1000));
12 printf("\n Output voltage Va = %f V",V_A);
```

Scilab code Exa 12.8 DAC0808

```
1 //Example 12.8
2 clc;
```

```
clear;
V0= 10*((1/2)+(1/4)+(1/32)+(1/128)); // calculating
    voltage when 1,2,5,7 re high
printf("Output voltage = %f V",V0)//displayin result
```

Scilab code Exa 12.9 resolution of 9 bit D to A

```
//Example 12.9
clc;
clear
resol = 1/512 * 100 ; // calculating resol
vol_resol = 1/512 *5 *1000;
printf("Resoluition in percentage = %f",resol);

printf("\n\n Voltage resolution = %f mV",vol_resol);
```

Scilab code Exa 12.10 resolution

```
//Example 12.10
clc;
clear;
disp("The LSB of an 11-bit system has a resolution
    of 1/2048");
re =ceil(10000/2048); // calculting the resolution
printf("\n\n 1/2048 x 10 = %d mV",re);
```

Scilab code Exa 12.11 counter type A to D converter

```
//Example 12.11
clc;
```

```
3 clear;
4 //bit = input("Specify the converter bit length :")
5 //fre = input("specify the clock frequency in kHz
    :")
6 bit =8;
7 fre = 500
8 max_conv_time = 2^bit * (1/(fre*1000));
9 avg_conv_time = 0.5 *max_conv_time;
10 max_conv_rate = 1/max_conv_time;
11 disp("Maximum Conversion Time = ");
12 disp(max_conv_time);
13 disp("Average Conversion Time =");
14 disp(avg_conv_time);
15 disp("Maximum Conversion Rate =");
16 disp(max_conv_rate);
```

Scilab code Exa 12.13 10 bit A to D converter

```
1 //Example 12.13
2 clc
3 clear
4 quat_err = 1/1024 *100 ;
5 disp("If the analog portion to be constructed ti an
    accuracy of 0.1")
6 printf("\nThe overall accuracy is in percentage = %f
    ",0.1 + quat_err)
```

Chapter 13

Memory

Scilab code Exa 13.2 structure of binary address

```
1 //example 13.2
2 clc;
3 clear;
4 close;
5 //cp = input('enter the capacity of the memory
     system in bits :');
6 cp=1024; // given capacity
7 n= log2(cp);
8 printf('The no of bits in the address word are : %d\
     n',n);
9 printf('The number of required rows are : %d\n',2^(n
     /2));
10 printf('The number of required columns are : %d',2^(
     n/2));
```

Scilab code Exa 13.3 decimal and hexadecimal address for the given binary address

```
1  //example 13.3
2  clc
3  clear
4  //bin(1,1) = input('Enter the first half string of
       binary number :');
5  //bin(1,2) = input('Enter the second half string of
       binary number :');
6  bin=['10110' '01101']; // given binry address
7  dec=bin2dec(bin); // finding decimal equivlent
8  hex=dec2hex(dec); //findin hexdecimal equivalent
9  disp('The decimal address is :');
10 disp(dec);
11 disp('The hexadecimal address is :');
12 disp(hex);
```

Chapter 14

Digital Integrated circuits

Scilab code Exa 14.1 diode forward or reverse

```
1 //example 14.1
2 clc;
3 clear;
4 close;
5 vdc = input('Enter the value of DC voltage Vdc in
     volts :');
6 r = input('Enter the value of resistace in K ohms :'
     );
7 v = input(' Enter the value of voltage across diode
     in volts :');
8
9 i = (vdc-v)/r ;
10 format('v',4);
11 if(i>0)  // checking whether the diode is forward or
      reverse biased by checking current
12     disp('The diode is in forward bias');
13     disp('The diode current in mA is :');
14     disp(i);
15 else
16     disp('The diode is in Reverse bias');
17     disp('The diode current in mA is : 0.0');
```

```
18 end;
```

Scilab code Exa 14.2 Diode current

```
1 //example 14.2
2 clc;
3 clear;
4 close;
5 vdc = input('Enter the value of DC voltage Vdc in
    volts :');
6 r = input('Enter the value of resistace in K ohms :'
    );
7 //v = input(' Enter the value of voltage across
    diode in volts:');
8 v= 1.6;
9 i = (vdc-v)/r ; /// calculating the current
10     disp('The diode current in mA is :');
11     disp(i);
```

Scilab code Exa 14.3 current in the given circuit

```
1 //example 14.3
2 clc;
3 clear;
4 close;
5 v1 = input('Enter the value of V1 in volts :'); //
    taking the inpt voltage
6 disp('CASE - a');// case a
7 if (v1==0) then
8     disp('V2 = 5 V');
9     disp('I = 0 mA');
10    else
11        disp('V2 = 0 V')
```

```
12          disp('I = 5 mA ')
13  end
14  disp('CASE - b'); // case b
15  if (v1==0) then
16     disp('V2 = 5 V')
17          disp('I = 5 mA' )
18  else
19        disp('V2 = 0 V');
20       disp('I = 0 mA');
21
22  end
```

Scilab code Exa 14.4 n channel MOSFET inverter

```
1  //example 14.4
2  clc;
3  clear;
4  v1 = input('Enter the value of V1 in volts :'); //
       part a : v1 =0 ; part b : v1 =5v
5  if (v1==0) then // checking for V1
6       disp('V2 = 5 V');
7       disp('I = 0 mA');
8      else
9          disp('V2 = 0 V');
10         disp('I = 0.5 mA ');
11 end
```

Chapter 15

Applications

Scilab code Exa 15.1 Timing of a six digit display

```
1 //example 15.1
2 //timing for a six digit display
3 clc;
4 clear;
5 //f=input('Enter the repetition rate in Hz :');
6 //d= input('Enter the length of display :');
7 f=125; // given inputs
8 d=6;
9 format('v',5); //changing the precision of the
    calculation
10 k=1000/f;
11 l=1000/(f*d);//making neccesary calculations
12 m=k-l;
13 printf('All digits must be serviced once every %f
    milliseconds \n',k);
14 printf('Each digit will be ON for : %f milliseconds\
    n',l) ;
15 printf('and OFF for : %f milliseconds',m); //
    displaying results
```

Scilab code Exa 15.4 Basic frequency counter

```
1 //example 15.4
2 clc;
3 clear;
4 //f=input('Enter the input square wave signal
     frequency in kHz:');
5 //t=input('Enter the gate enble time in seconds ' );
6 //first part :
7 f=7.50;
8 t=0.1;
9 format('v',18);
10 m=t*f*1000; //making neccesary calculations
11 printf('For t = %f seconds\n',t);  // displaying
     results
12 printf('The counter will count up to : %f\n',m);
13 //part2
14 t=1;
15 printf('\n\nFor t = %f seconds\n',t);
16 m=t*f*1000;
17 printf('The counter will count up to : %f\n',m);
18 //part3
19 t=10;
20 m=t*f*1000;
21 printf('\n\nFor t = %f seconds\n',t);
22 printf('The counter will count up to : %f\n',m);
```

Scilab code Exa 15.5 4 decimal digit frequency counter

```
1 //example 15.5
2 clc;
```

```
3 disp('Assuming the counter began at 0000, the
    display would read 200 at the end of the first
    measurment period.It will read 400,then 600 and
    so on at the end of succeeding periods. This is
    because the counter capacity is exceeded each
    time, and it simply recycles through 0000.');
```

Scilab code Exa 15.6 instrument to measure time period

```
1 //example 15.6
2 clc;
3 clear;
4 //s= input('Enter the clk freqency in kHz : ');
5 //f=input('Enter the frequency of the unknown input
    in Hz :');
6 s=100;// taking the inputs
7 f=200;
8 g=1000000/f;  // making neccesary calculations
9 c=g*s/1000;
10 c=round(c);
11 p=c*1000/s;
12 disp('Assuming that the conter and the display are
    initially at 00000');//displaying results
13 printf('Enable gate time in micro secnds will be :
    %d\n',g);
14 printf('During the gate time the counter will be
    advced by (number of counts ) %d \n',c);
15 printf('The time period of the unknown input in
    micro-seconds is : %d',p);
```

Scilab code Exa 15.9 ADC0804

```
1 //example 15.9
```

```
clc ;
clear;
//part (a)
//an=input('Enter the analog input in volts :');
format('v',12);// changing the precision of
   calculation
an=2.5;
k=an*1000/19.53;
k= round(k);
m=dec2bin(k); // converting from decmal to binary
printf('The digital output is :%s\n',m);
//part(b)
//dg=input('Enter the digital output as a string:');
dg='00100010';
f=bin2dec(dg); // converting binary to decimal
y=f*19.53*10^-3;
printf(' The analog input in volts is :%f',y);
```

Scilab code Exa 15.10 ADC3511

```
//example 15.10
clc;
clear;
//v = input('Enter the reference voltage in volts
   :');
//an = input('Enter the analog input voltage in
   volts :');
v=2;  // taking given input
an=1.25;
count = 2000*an/v ;
count = round(count);
printf('The ccount held in the counter for given
   analog input will be : %f',count);
d= an/v;
printf('\nThe duty cycle is : %f',d);
```

Scilab code Exa 15.11 ADC3511

```
1 // example 15.11
2 clc;
3 clear;
4 disp('The full scale count for ADC3511 is 1999 and
    for the ADC3711 is 3999. So, the largest value
    possible for the MSD in either case is 3 = 0011.
    clearly the MSB is not needed for th magnitue of
    the MSD. It is thus convenient to specif
    positive number when this bit is a 0 and a
    negtive number when this bit is a 1 .');
```

Scilab code Exa 15.12 ADD3501

```
1 //exmple 15.12
2 clc ;
3 clear;
4 disp('These two components establish the internal
    oscillator frequency used as the clock frequency
    in the cnverter according to the relationship fi
    =0.6/RC. In this case fi=320 kHz.');
```

Chapter 16

A Simple Computer Design

Scilab code Exa 16.1 size of PC IR ACC MAR MDR

```
1 //example 16.1
2 clc
3 clear
4 //len = input('Enter the length of each memory
     location in bits :');
5 //op = input('Enter the length of Opcode:');
6 len =16;
7 op=4;
8 nop= 2^4;    // calculating
9 nab = len-op;
10 memloc = 2^nab;
11 memsize = memloc*16;
12 mem=memsize/1024;
13 printf('(a)Maximum Number of Opcodes = %d \n',nop);
     // displaying
14 printf(' (b)Size of memory in Kilo bits = %d \n',mem
     );
15 printf(' (c)Size of PC and MAR = %d \n',nab );
16 printf('    Size of IR = %d\n',op);
17 printf('    Size of ACC and MDR = %d \n',len);
```

Scilab code Exa 16.6 Number of clock cycles needed to execute a program

```
1 //example 16.6
2 lda= input('Enter the number of LDA instructions :')
    ; // accepting the input from the user
3 add= input('Enter the number of ADD instructions :')
    ;
4 sub= input('Enter the number of SUB instructions :')
    ;
5 sta= input('Enter the number of STA instructions :')
    ;
6 shl= input('Enter the number of SHL instructions :')
    ;
7 hlt= input('Enter the number of HLT instructions :')
    ;
8 k= lda+add+sub+sta;
9 l=shl+hlt;
10 c= k*5 + l*4; // calculating the total no.of clck
    cycles required
11 printf('Total clock cycles required to execute are =
    %d ',c); //displaying result.
```

Appendix

Scilab code AP 1 3-variable kmap(abx)

```
1  //3-VARIABLE KMAP
2  //uses noof.sci and noof0.sci
3  //above two functions should be executed before
      executing this function .
4  function bi = kmap3abx(k)
5      n=4;
6      m=2
7
8  //k=[0  0  0  1;
9    // 0  1  1  1];
10 k(:,:,2)=zeros(m,n);
11     var=['x' 'A' 'B'];
12     //var=['w' 'x' 'y' 'z'];
13     p1=['x''' 'x'];
14     p2=['A''B''';'A''B';'AB';'AB'''];
15     cmn4=4;
16     cmn2=2;
17     temp=1;
18    // printf('The minimal ecpression of the given
        Kmap ');
19     disp(k(:,:,1));
20     //disp("is :");
21     //printf('f');
22    // printf("=");
23
24  bi = ' ';
```

```
25      //8 cells
26      for i=1:m
27          for j=1:n
28              if(k(i,j)~=1 & k(i,j)~=2)
29                  temp=0;
30                  break;
31               end
32          end
33      end
34      if(temp==1)
35          bi = strcat([bi "1"]);
36          return;
37      end
38      //4 cells
39      z1=ones(1,4);
40      z2=ones(4,1);
41      z3=ones(2,2);
42      temp1=['0' '1'];
43      temp2=['00';'01';'11';'10'];
44      for t=1:m
45              z=k(t,:,1);
46              no=noof(k(t,:,2));
47              if(noof0(z)==0 & no<cmn4 & noof(z)>0)
48                  k(t,:,2)=z1;
49                  a=strsplit(temp1(1,t));
50                  for in=1:max(size(a))
51                      if(a(in)=='0')
52                          bi = strcat([bi var(in) ''''
                                ]);
53                       end
54                       if(a(in)=='1')
55                           bi = strcat([bi var(in)]);
56                       end
57                   end
58                   bi = strcat([bi " + "]);
59                end
60      end
61      for i=1:m-1
```

```
62          for j=1:n
63              t1=i+1;
64              if(j==n)
65                   t2=1;
66               else
67                   t2=j+1;
68               end
69               z4=[k(i,j,1) k(i,t2,1);k(t1,j,1) k(t1,t2
                     ,1)];
70               z5=[k(i,j,2) k(i,t2,2);k(t1,j,2) k(t1,t2
                     ,2)];
71               no=noof(z5);
72               if(noof0(z4)==0 & no<cmn4 & noof(z4)>0)
73                   k(i,j,2)=1;
74                   k(i,t2,2)=1;
75                   k(t1,j,2)=1;
76                   k(t1,t2,2)=1;
77                   a=strsplit(temp2(j,1));
78                   b=strsplit(temp2(t2,1));
79                   c=strcmp(a,b);
80                   for in=1:max(size(c))
81                       if(c(in)==0 & a(in)=='0')
82                           bi = strcat([bi var(1+in) ''
                                 '' ]);
83                        end
84                        if(c(in)==0 & a(in)=='1')
85                            bi = strcat([bi var(1+in)])
                                  ;
86                        end
87                    end
88                    bi = strcat([bi " + "]);
89
90               end
91          end
92      end
93      //2 cells
94      z6=[1 1];
95      z7=z6';
```

```
96      for i=1:m
97          for j=1:n
98                  t1=i+1;
99                  if(j==n)
100                     t2=1;
101                 else
102                     t2=j+1;
103                  end
104             z8=[k(i,j,1) k(i,t2,1)];
105             z9=[k(i,j,2) k(i,t2,2)];
106             no1=noof(z9);
107             if(noof0(z8)==0 & no1<cmn2 & noof(z8)>0)
108               k(i,j,2)=1;
109               k(i,t2,2)=1;
110               bi = strcat([bi p1(1,i)]);
111               a=strsplit(temp2(j,1));
112               b=strsplit(temp2(t2,1));
113               c=strcmp(a,b);
114                 for in=1:max(size(c))
115                     if(c(in)==0 & a(in)=='0')
116                         bi = strcat([bi var(1+in) ''
                              '']);
117                         bi = strcat([bi '' + '']);
118                      end
119                      if(c(in)==0 & a(in)=='1')
120                          bi = strcat([bi var(1+in)])
                                ;
121                           bi = strcat([bi '' + '']);
122                      end
123                  end
124             end
125         end
126     end
127     for i=1:m-1
128         for j=1:n
129            t1=i+1;
130            if(j==n)
131                 t2=1;
```

```
132                 else
133                     t2=j+1;
134                 end
135                 z10=[k(i,j,1);k(t1,j,1)];
136                 z11=[k(i,j,2);k(t1,j,2)];
137                 no2=noof(z11);
138                 if(noof0(z10)==0 & no2<cmn2 & noof(z10)
                       >0)
139                   k(i,j,2)=1;
140                   k(t1,j,2)=1;
141                   bi = strcat([bi p2(j,1)]);
142                   bi = strcat([bi " + "]);
143                 end
144             end
145         end
146         //single cell
147         for i=1:m
148             for j=1:n
149                 if(k(i,j,2)==0 & k(i,j,1)==1)
150                     bi = strcat([bi p1(1,i)]);
151                     bi = strcat([bi p2(j,1)]);
152                     bi = strcat([bi " + "]);
153                 end
154             end
155         end
156        bi = strcat([bi " 0 "]);
157         //disp(" ")
158
159 endfunction
```

Scilab code AP 2 returns number of 1s in a matrix

```
1 function res=noof(a)  // this function returns the
     no of 1's in the given matrrix
2     res=0;
3     for i=1:max(size(a(:,1)))
4         for j=1:max(size(a(1,:)))
5             if(a(i,j)==1)
```

```
6                   res=res+1;
7               end
8           end
9       end
10  endfunction
```

Scilab code AP 3 returns number of 0s in a matrix

```
1  function res=noof0(a) // to find the no of zeros in
       given matrix
2      res=0;
3      for i=1:max(size(a(:,1)))
4          for j=1:max(size(a(1,:)))
5              if(a(i,j)==0)
6                  res=res+1;
7              end
8          end
9      end
10 endfunction
```

Scilab code AP 4 4-variable kmap with don't cares

```
1  //4-Variable KMAP
2  //returns a string of the minimized expression
3  //requires noof1.sci
4  //noof1.sci should be executed before executing this
       function
5  function bi = donkmapij(k)
6      n=4;
7      k(:,:,2)=zeros(n,n);
8      var=['I' 'J' 'Bn' 'An'];
9      p1=['I''J''' 'I''J' 'IJ' 'IJ''''];
10     p2=['Bn''An''';'Bn''An';'BnAn';'BnAn''''];
11     cmn4=4;
12     cmn2=2;
13     temp=1;
14     bi= ' ';
15    disp(k(:,:,1));
```

```
16      for i=1:n
17          for j=1:n
18              if(k(i,j)~=1 | k(i,j)~=2)
19                  temp=0;
20                  break;
21               end
22          end
23      end
24      if(temp==1)
25          printf("1");
26          abort;
27      end
28      //checking the 8 cells cases
29      z1=ones(2,4);
30      z2=ones(4,2);
31      temp1=['00' '01' '11' '10'];
32      temp2=temp1';
33      for i=1:n
34              if(i==4)
35                  t=1;
36              else
37                  t=i+1;
38              end
39              z=[k(i,:,1);k(t,:,1)];
40              if(noof1(z,0)==0 & noof1(z,1)>1)
41                  k(i,:,2)=[1 1 1 1];
42                  k(t,:,2)=[1 1 1 1];
43                  a=strsplit(temp2(i,1));
44                  b=strsplit(temp2(t,1));
45                  c=strcmp(a,b);
46                  for in=1:max(size(c))
47                      if(c(in)==0 & a(in)=='0')
48                          bi = strcat([bi var(in) ''''
                               ]);
49                          bi = strcat([bi " + "]);
50                          break;
51                       else
52                           if(c(in)==0 & a(in)=='1')
```

```
53                                  bi = strcat([bi var(in)])
                                       ;
54                                   bi = strcat([bi " + "]);
55                                   break;
56                                 end
57                     end
58                 end
59     end
60 end
61     for j=1:n
62         if(j==4)
63             t=1;
64         else
65             t=j+1;
66         end
67         z=[k(:,j,1) k(:,t,1)];
68         if(noof1(z,0)==0 & noof1(z,1)>0)
69             k(:,j,2)=[1;1;1;1];
70             k(:,t,2)=[1;1;1;1];
71             a=strsplit(temp1(1,j));
72             b=strsplit(temp1(1,t));
73             c=strcmp(a,b);
74             for in=1:max(size(c))
75                 if(c(in)==0 & a(in)=='0')
76                     bi = strcat([bi var(2+in) ''''])
                           ;
77                     bi = strcat([bi " + "]);
78                     break;
79                  else
80                      if(c(in)==0 & a(in)=='1')
81                          bi = strcat([bi var(2+in)])
                               ;
82                          bi = strcat([bi " + "]);
83                          break;
84                      end
85                  end
86             end
87         end
```

```
88      end
89      //checking the 4 cells cases
90      z1=ones(1,4);
91      z2=ones(4,1);
92      z3=ones(2,2);
93      temp1=['00' '01' '11' '10'];
94      temp2=temp1';
95      for t=1:n
96              z=k(t,:,1);
97              no=noof1(k(t,:,2),1);
98              if(noof1(z,0)==0 & no<cmn4 & noof1(z,1)
                   >0)
99                  k(t,:,2)=z1;
100                 a=strsplit(temp1(1,t));
101                 for in=1:max(size(a))
102                     if(a(in)=='0')
103                         bi = strcat([bi var(in) ''''
                               ]);
104                     end
105                     if(a(in)=='1')
106                         bi = strcat([bi var(in)]);
107                     end
108                 end
109                 bi = strcat([bi '' + '']);
110             end
111     end
112     for t=1:n
113         z=k(:,t,1);
114         no=noof1(k(:,t,2),1);
115         if(noof1(z,0)==0 & no<cmn4 & noof1(z,1)>0)
116             k(:,t,2)=z2;
117             a=strsplit(temp2(t,1));
118             for in=1:max(size(a))
119                 if(a(in)=='0')
120                     bi = strcat([bi var(2+in) ''''])
                           ;
121                 end
122                 if(a(in)=='1')
```

```
123                     bi = strcat([bi var(2+in)]);
124                 end
125             end
126                 bi = strcat([bi " + "]);
127         end
128     end
129     for i=1:n
130         for j=1:n
131            if(i==n)
132                 t1=1;
133             else
134                 t1=i+1;
135             end
136            if(j==n)
137                 t2=1;
138             else
139                 t2=j+1;
140             end
141             z4=[k(i,j,1) k(i,t2,1);k(t1,j,1) k(t1,t2
                   ,1)];
142             z5=[k(i,j,2) k(i,t2,2);k(t1,j,2) k(t1,t2
                   ,2)];
143             no=noof1(z5,1);
144             if(noof1(z4,0)==0 & no<cmn4 & noof1(z4
                   ,1)>0)
145                 k(i,j,2)=1;
146                 k(i,t2,2)=1;
147                 k(t1,j,2)=1;
148                 k(t1,t2,2)=1;
149                 a=strsplit(temp2(i,1));
150                 b=strsplit(temp2(t1,1));
151                 c=strcmp(a,b);
152                 for in=1:max(size(c))
153                     if(c(in)==0 & a(in)=='0')
154                         bi = strcat([bi ,var(in) '''
                               ']);
155                     end
156                     if(c(in)==0 & a(in)=='1')
```

```
157                         bi = strcat([bi var(in)]);
158                     end
159                  end
160                 a=strsplit(temp1(1,j));
161                 b=strsplit(temp1(1,t2));
162                 c=strcmp(a,b);
163                 for in=1:max(size(c))
164                     if(c(in)==0 & a(in)=='0')
165                         bi = strcat([bi ,var(2+in) '
                                ''']);
166                     end
167                     if(c(in)==0 & a(in)=='1')
168                         bi = strcat([bi var(2+in)])
                                ;
169                     end
170                  end
171                  bi = strcat([bi " + "]);
172             end
173         end
174     end
175     //2 cells
176     z6=[1 1];
177     z7=z6';
178     for i=1:n
179         for j=1:n
180             if(i==n)
181                 t1=1;
182             else
183                 t1=i+1;
184             end
185            if(j==n)
186                 t2=1;
187             else
188                 t2=j+1;
189             end
190             z8=[k(i,j,1) k(i,t2,1)];
191             z9=[k(i,j,2) k(i,t2,2)];
192             no1=noof1(z9,1);
```

```
193             if(noof1(z8,0)==0 & no1<cmn2 & noof1(z8
                   ,1)>0)
194               k(i,j,2)=1;
195               k(i,t2,2)=1;
196               a=strsplit(temp1(1,j));
197               b=strsplit(temp1(1,t2));
198               c=strcmp(a,b);
199                 for in=1:max(size(c))
200                     if(c(in)==0 & a(in)=='0')
201                         bi = strcat([bi p1(1,i)]);
202                         bi = strcat([bi ,var(2+in) '
                               ''']);
203                         bi = strcat([bi '' + '']);
204                      end
205                      if(c(in)==0 & a(in)=='1')
206                          bi = strcat([bi p1(1,i)]);
207                          bi = strcat([bi var(2+in)])
                                ;
208                          bi = strcat([bi '' + '']);
209                      end
210                  end
211             end
212         end
213     end
214     for i=1:n
215         for j=1:n
216             if(i==n)
217                 t1=1;
218             else
219                 t1=i+1;
220             end
221            if(j==n)
222                 t2=1;
223             else
224                 t2=j+1;
225             end
226             z10=[k(i,j,1);k(t1,j,1)];
227             z11=[k(i,j,2);k(t1,j,2)];
```

```
228             no2=noof1(z11,1);
229             if(noof1(z10,0)==0 & no2<cmn2 & noof1(
                   z10,1)>0)
230               k(i,j,2)=1;
231               k(t1,j,2)=1;
232               a=strsplit(temp2(i,1));
233               b=strsplit(temp2(t1,1));
234               c=strcmp(a,b);
235                 for in=1:max(size(c))
236                     if(c(in)==0 & a(in)=='0')
237                         bi = strcat([bi p2(j,1)]);
238                         bi = strcat([bi var(in) ''''
                               ]);
239                         bi = strcat([bi " + "]);
240                      end
241                      if(c(in)==0 & a(in)=='1')
242                          bi = strcat([bi p2(j,1)]);
243                          bi = strcat([bi var(in)]);
244                          bi = strcat([bi " + "]);
245                      end
246                  end
247             end
248         end
249     end
250     //checking the single cell cases
251     for i=1:n
252         for j=1:n
253             if(k(i,j,2)==0 & k(i,j,1)==1)
254                 a=strsplit(temp1(1,j));
255                 b=strsplit(temp2(i,1));
256                 for in=1:max(size(a(:,1)))
257                     if(a(in,1)=='1')
258                         bi = strcat([bi var(in+2)]);
259                     else
260                         if(a(in,1)=='0')
261                             bi = strcat([bi var(2+in
                                   ) ''''']);
262                         end
```

```
263                         end
264                     end
265                     for in=1:max(size(b(:,1)))
266                         if(b(in,1)=='1')
267                             bi = strcat([bi var(in)]);
268                         else
269                             if(b(in,1)=='0')
270                                 bi = strcat([bi var(in)
                                        ''''']);
271                             end
272                         end
273                     end
274                         bi = strcat([bi " + "]);
275                 end
276             end
277         end
278         bi = strcat([bi "0 "]);
279 endfunction
```

Scilab code AP 5 number of zeros and ones

```
1  function res=noof1(a,z) //this function returns both
       the no of zeros and ones in  given matrix
2      res=0;
3      for i=1:max(size(a(:,1)))
4          for j=1:max(size(a(1,:)))
5              if(a(i,j)==z)
6                  res=res+1;
7              end
8          end
9      end
10 endfunction
```

Scilab code AP 6 3-variable kmap(a)

```
1
2      //3-VARIABLE KMAP
```

```
3  //this function returns the a string containing the
       minimized expression for the given 3 variable
       kmap
4  //this function requires
5  //noof.sci
6  //noof0.sci
7  function bi = kmap3a(k)
8      n=4;
9      m=2
10 k(:,:,2)=zeros(m,n);
11     var=['An' 'X' 'Y'];
12      p1=['An''' 'An'];
13     p2=['X''Y''';'X''Y';'XY';'XY'''];
14
15     cmn4=4;
16     cmn2=2;
17     temp=1;
18     disp(k(:,:,1));
19 bi = ' ';
20 //checking all the 8 1's cases
21     for i=1:m
22         for j=1:n
23             if(k(i,j)~=1 & k(i,j)~=2)
24                 temp=0;
25                 break;
26              end
27         end
28     end
29     if(temp==1)
30         bi = strcat([bi "1"]);
31         return;
32     end
33 //checking all the 4 1's cases
34     z1=ones(1,4);
35     z2=ones(4,1);
36     z3=ones(2,2);
37     temp1=['0' '1'];
38     temp2=['00';'01';'11';'10'];
```

```
39      for t=1:m
40              z=k(t,:,1);
41              no=noof(k(t,:,2));
42              if(noof0(z)==0 & no<cmn4 & noof(z)>0)
43                  k(t,:,2)=z1;
44                  a=strsplit(temp1(1,t));
45                  for in=1:max(size(a))
46                      if(a(in)=='0')
47                          bi = strcat([bi var(in) '''' ]);
48                       end
49                       if(a(in)=='1')
50                           bi = strcat([bi var(in)]);
51                       end
52                   end
53                   bi = strcat([bi '' + '']);
54                end
55      end
56      for i=1:m-1
57          for j=1:n
58             t1=i+1;
59             if(j==n)
60                  t2=1;
61              else
62                  t2=j+1;
63              end
64              z4=[k(i,j,1) k(i,t2,1);k(t1,j,1) k(t1,t2
                   ,1)];
65              z5=[k(i,j,2) k(i,t2,2);k(t1,j,2) k(t1,t2
                   ,2)];
66              no=noof(z5);
67              if(noof0(z4)==0 & no<cmn4 & noof(z4)>0)
68                  k(i,j,2)=1;
69                  k(i,t2,2)=1;
70                  k(t1,j,2)=1;
71                  k(t1,t2,2)=1;
72                  a=strsplit(temp2(j,1));
73                  b=strsplit(temp2(t2,1));
```

```
74                  c=strcmp(a,b);
75                  for in=1:max(size(c))
76                      if(c(in)==0 & a(in)=='0')
77                          bi = strcat([bi var(1+in) ''
                                '' ]);
78                       end
79                       if(c(in)==0 & a(in)=='1')
80                           bi = strcat([bi var(1+in)])
                                 ;
81                       end
82                   end
83                   bi = strcat([bi " + "]);
84
85              end
86          end
87      end
88      //checking all the 2 1's cases
89      z6=[1 1];
90      z7=z6';
91      for i=1:m
92          for j=1:n
93                  t1=i+1;
94                  if(j==n)
95                      t2=1;
96                  else
97                      t2=j+1;
98                   end
99              z8=[k(i,j,1) k(i,t2,1)];
100             z9=[k(i,j,2) k(i,t2,2)];
101             no1=noof(z9);
102             if(noof0(z8)==0 & no1<cmn2 & noof(z8)>0)
103               k(i,j,2)=1;
104               k(i,t2,2)=1;
105               bi = strcat([bi p1(1,i)]);
106               a=strsplit(temp2(j,1));
107               b=strsplit(temp2(t2,1));
108               c=strcmp(a,b);
109                 for in=1:max(size(c))
```

```
110                     if(c(in)==0 & a(in)=='0')
111                         bi = strcat([bi var(1+in) ''
                                '']);
112                         bi = strcat([bi " + "]);
113                      end
114                      if(c(in)==0 & a(in)=='1')
115                          bi = strcat([bi var(1+in)])
                                 ;
116                            bi = strcat([bi " + "]);
117                      end
118                  end
119              end
120          end
121      end
122      for i=1:m-1
123          for j=1:n
124             t1=i+1;
125             if(j==n)
126                  t2=1;
127              else
128                  t2=j+1;
129              end
130              z10=[k(i,j,1);k(t1,j,1)];
131              z11=[k(i,j,2);k(t1,j,2)];
132              no2=noof(z11);
133              if(noof0(z10)==0 & no2<cmn2 & noof(z10)
                    >0)
134                k(i,j,2)=1;
135                k(t1,j,2)=1;
136                bi = strcat([bi p2(j,1)]);
137                bi = strcat([bi " + "]);
138              end
139          end
140      end
141      //checking if any single isolated 1's are left
142      for i=1:m
143          for j=1:n
144              if(k(i,j,2)==0 & k(i,j,1)==1)
```

```
145                     bi = strcat([bi p1(1,i)]);
146                     bi = strcat([bi p2(j,1)]);
147                     bi = strcat([bi " + "]);
148                 end
149             end
150         end
151        bi = strcat([bi " 0 "]);
152    endfunction
```

Scilab code AP 7 2-variable kmap

```
1  //this function minimizes a two vriable boolean
       expression using kmap
2  function bi =kmap2(k)
3  var=['A''B''' 'A''B' 'AB' 'AB''']
4  temp =1
5  for i=1:2  // intially checking for all 1's
6      for j=1:2
7          if k(i,j)==1 then
8              temp = temp + 1;
9          end
10     end
11 end
12 v=0;
13 bi = ' ' ;
14 if temp == 5 then
15      disp("The minimal expression is : 1');
16      v=1;
17 else
18 for i= 1 : 2 // considering all 2 1's cases
19      if k(i,1) == 1 & k(i,2) == 1 then
20           if i== 1 then
21                bi = strcat([ bi 'A''] );v=1;
22           else
23                bi = strcat([ bi 'A']);v=1;
24           end
25          bi = strcat([ bi " + " ]);
26          end
```

```
27      if k(1,i) == 1 & k(2,i) == 1 then
28              if i== 1 then
29                  bi = strcat([ bi 'B' ' '] );v=1;
30              else
31                  bi = strcat([ bi 'B']);v=1;
32              end
33          end
34  end
35  end;
36  one(1)=k(2,1);
37  f=2;m=2;i=1;
38      for j=1:2
39          one(f)=k(i,j)
40          f=f+1;
41      end
42      i=2;
43      for j=2:-1:1
44          one(f)=k(i,j)
45          f=f+1;
46      end
47  one(6)=k(1,1);
48  if v==0 then // for isolated 1's
49      for i =2:5
50          if one(i)==1 & one(i+1)== 0 & one(i-1) ==0
               then
51              if m>0
52                  bi = strcat([bi " + "]);
53                  end;
54              bi = strcat([bi var(i-1)]);
55              m=m+1;
56          end
57      end
58  end
59  endfunction // final result will be stored in bi
```

Scilab code AP 8 3-variable kmap

```
1  //3-VARIABLE KMAP
```

```
2  //this function returns the a string containing the
       minimized expression for the given 3 variable
       kmap
3  //this function requires
4  //noof.sci
5  //noof0.sci
6  function bi = kmap3(k)
7      n=4;
8      m=2
9  k(:,:,2)=zeros(m,n);
10     var=['Cn' 'Bn' 'An'];
11     p1=['Cn''' 'Cn'];
12     p2=['Bn''An''';'Bn''An';'BnAn';'BnAn'''];
13     cmn4=4;
14     cmn2=2;
15     temp=1;
16     disp(k(:,:,1));
17 bi = ' ';
18 //checking all the 8 1's cases
19     for i=1:m
20         for j=1:n
21             if(k(i,j)~=1 & k(i,j)~=2)
22                 temp=0;
23                 break;
24              end
25         end
26     end
27     if(temp==1)
28         bi = strcat([bi "1"]);
29         return;
30     end
31 //checking all the 4 1's cases
32     z1=ones(1,4);
33     z2=ones(4,1);
34     z3=ones(2,2);
35     temp1=['0' '1'];
36     temp2=['00';'01';'11';'10'];
37     for t=1:m
```

```
38              z=k(t,:,1);
39              no=noof(k(t,:,2));
40              if(noof0(z)==0 & no<cmn4 & noof(z)>0)
41                  k(t,:,2)=z1;
42                  a=strsplit(temp1(1,t));
43                  for in=1:max(size(a))
44                      if(a(in)=='0')
45                          bi = strcat([bi var(in) ''''
                                ]);
46                       end
47                       if(a(in)=='1')
48                           bi = strcat([bi var(in)]);
49                       end
50                   end
51                   bi = strcat([bi '' + '']);
52                end
53      end
54      for i=1:m-1
55          for j=1:n
56             t1=i+1;
57             if(j==n)
58                  t2=1;
59              else
60                  t2=j+1;
61              end
62              z4=[k(i,j,1) k(i,t2,1);k(t1,j,1) k(t1,t2
                   ,1)];
63              z5=[k(i,j,2) k(i,t2,2);k(t1,j,2) k(t1,t2
                   ,2)];
64              no=noof(z5);
65              if(noof0(z4)==0 & no<cmn4 & noof(z4)>0)
66                  k(i,j,2)=1;
67                  k(i,t2,2)=1;
68                  k(t1,j,2)=1;
69                  k(t1,t2,2)=1;
70                  a=strsplit(temp2(j,1));
71                  b=strsplit(temp2(t2,1));
72                  c=strcmp(a,b);
```

```
73                  for in=1:max(size(c))
74                      if(c(in)==0 & a(in)=='0')
75                          bi = strcat([bi var(1+in) ''
                                '' ]);
76                       end
77                       if(c(in)==0 & a(in)=='1')
78                           bi = strcat([bi var(1+in)])
                                 ;
79                       end
80                   end
81                   bi = strcat([bi " + "]);
82
83              end
84          end
85      end
86      //checking all the 2 1's cases
87      z6=[1 1];
88      z7=z6';
89      for i=1:m
90          for j=1:n
91                  t1=i+1;
92                  if(j==n)
93                      t2=1;
94                  else
95                      t2=j+1;
96                   end
97              z8=[k(i,j,1) k(i,t2,1)];
98              z9=[k(i,j,2) k(i,t2,2)];
99              no1=noof(z9);
100             if(noof0(z8)==0 & no1<cmn2 & noof(z8)>0)
101               k(i,j,2)=1;
102               k(i,t2,2)=1;
103               bi = strcat([bi p1(1,i)]);
104               a=strsplit(temp2(j,1));
105               b=strsplit(temp2(t2,1));
106               c=strcmp(a,b);
107                 for in=1:max(size(c))
108                     if(c(in)==0 & a(in)=='0')
```

```
109                         bi = strcat([bi var(1+in) ''
                               '']);
110                         bi = strcat([bi '' + '']);
111                     end
112                     if(c(in)==0 & a(in)=='1')
113                         bi = strcat([bi var(1+in)])
                                ;
114                           bi = strcat([bi '' + '']);
115                     end
116                 end
117             end
118         end
119     end
120     for i=1:m-1
121         for j=1:n
122            t1=i+1;
123            if(j==n)
124                 t2=1;
125             else
126                 t2=j+1;
127             end
128             z10=[k(i,j,1);k(t1,j,1)];
129             z11=[k(i,j,2);k(t1,j,2)];
130             no2=noof(z11);
131             if(noof0(z10)==0 & no2<cmn2 & noof(z10)
                   >0)
132               k(i,j,2)=1;
133               k(t1,j,2)=1;
134               bi = strcat([bi p2(j,1)]);
135               bi = strcat([bi '' + '']);
136             end
137         end
138     end
139     //checking if any single isolated 1's are left
140     for i=1:m
141         for j=1:n
142             if(k(i,j,2)==0 & k(i,j,1)==1)
143                 bi = strcat([bi p1(1,i)]);
```

```
144                     bi = strcat([bi p2(j,1)]);
145                     bi = strcat([bi " + "]);
146                 end
147             end
148         end
149         bi = strcat([bi " 0 "]);
150     endfunction
```

Scilab code AP 9 4-variable kmap(sx1x2)

```
1  function []=kmapsx(k) // this fnctions prints the
       minimied expression for the given kmap .
2  // it requires noof.sci
3  //so the above mentioned function shoub be execute
       before executing this function .
4
5       n=4;
6         k(:,:,2)=zeros(n,n);
7       var=['X2' 'X3' 'S' 'X1'];
8
9  p1=['X2''X3'''  'X2''X3'  'X2X3'  'X2X3'''];
10 p2=['S''X1''';'S''X1';'SX1';'SX1'''];
11      cmn4=4;
12      cmn2=2;
13      temp=1;
14      disp(k(:,:,1));
15      disp("is :");
16      disp(" ")
17      //checking the 16 cells case
18      for i=1:n
19          for j=1:n
20              if(k(i,j)~=1)
21                  temp=0;
22                  break;
23               end
24          end
25      end
26      printf('    ');
```

```
27      if(temp==1)
28          printf("1");
29          abort;
30      end
31      //checking the 8 cells cases
32      z1=ones(2,4);
33      z2=ones(4,2);
34      temp1=['00' '01' '11' '10'];
35      temp2=temp1';
36      for i=1:n
37              if(i==4)
38                  t=1;
39              else
40                  t=i+1;
41              end
42              z=[k(i,:,1);k(t,:,1)];
43              if(z==z1)
44                  k(i,:,2)=[1 1 1 1];
45                  k(t,:,2)=[1 1 1 1];
46                  a=strsplit(temp2(i,1));
47                  b=strsplit(temp2(t,1));
48                  c=strcmp(a,b);
49                  for in=1:max(size(c))
50                      if(c(in)==0 & a(in)=='0')
51                          printf('%s''',var(in));
52                          printf(' + ');
53                          break;
54                       else
55                           if(c(in)==0 & a(in)=='1')
56                              printf(var(in));
57                              printf(' + ');
58                              break;
59                            end
60                       end
61                  end
62              end
63      end
64      for j=1:n
```

```
65          if(j==4)
66              t=1;
67          else
68              t=j+1;
69          end
70          z=[k(:,j,1) k(:,t,1)];
71          if(z==z2)
72              k(:,j,2)=[1;1;1;1];
73              k(:,t,2)=[1;1;1;1];
74              a=strsplit(temp1(1,j));
75              b=strsplit(temp1(1,t));
76              c=strcmp(a,b);
77              for in=1:max(size(c))
78                  if(c(in)==0 & a(in)=='0')
79                      printf('%s'',var(2+in));
80                      printf(' + ');
81                      break;
82                   else
83                       if(c(in)==0 & a(in)=='1')
84                           printf(var(2+in));
85                           printf(' + ');
86                           break;
87                       end
88                   end
89              end
90         end
91      end
92      //checking the 4 cells cases
93      z1=ones(1,4);
94      z2=ones(4,1);
95      z3=ones(2,2);
96      temp1=['00' '01' '11' '10'];
97      temp2=temp1';
98      for t=1:n
99              z=k(t,:,1);
100             no=noof(k(t,:,2));
101             if(z==z1 & no<cmn4)
102                 k(t,:,2)=z1;
```

```
103                 a=strsplit(temp1(1,t));
104                 for in=1:max(size(a))
105                     if(a(in)=='0')
106                         printf('%s''',var(in));
107                      end
108                      if(a(in)=='1')
109                          printf(var(in));
110                      end
111                  end
112                  printf(" + ");
113              end
114      end
115      for t=1:n
116          z=k(:,t,1);
117          no=noof(k(:,t,2));
118          if(z==z2 & no<cmn4)
119              k(:,t,2)=z2;
120              a=strsplit(temp2(t,1));
121              for in=1:max(size(a))
122                  if(a(in)=='0')
123                      printf('%s''',var(2+in));
124                  end
125                  if(a(in)=='1')
126                      printf(var(2+in));
127                  end
128              end
129                   printf(" + ");
130          end
131      end
132      for i=1:n
133          for j=1:n
134             if(i==n)
135                  t1=1;
136              else
137                  t1=i+1;
138              end
139             if(j==n)
140                  t2=1;
```

```
141                 else
142                     t2=j+1;
143                 end
144                 z4=[k(i,j,1) k(i,t2,1);k(t1,j,1) k(t1,t2
                        ,1)];
145                 z5=[k(i,j,2) k(i,t2,2);k(t1,j,2) k(t1,t2
                        ,2)];
146                 no=noof(z5);
147                 if(z4==z3 & no<cmn4)
148                     k(i,j,2)=1;
149                     k(i,t2,2)=1;
150                     k(t1,j,2)=1;
151                     k(t1,t2,2)=1;
152                     a=strsplit(temp2(i,1));
153                     b=strsplit(temp2(t1,1));
154                     c=strcmp(a,b);
155                     for in=1:max(size(c))
156                         if(c(in)==0 & a(in)=='0')
157                             printf('%s'',var(in));
158                          end
159                          if(c(in)==0 & a(in)=='1')
160                              printf(var(in));
161                          end
162                      end
163                     a=strsplit(temp1(1,j));
164                     b=strsplit(temp1(1,t2));
165                     c=strcmp(a,b);
166                     for in=1:max(size(c))
167                         if(c(in)==0 & a(in)=='0')
168                             printf('%s'',var(2+in));
169                          end
170                          if(c(in)==0 & a(in)=='1')
171                              printf(var(2+in));
172                          end
173                      end
174                      printf(" + ");
175                 end
176             end
```

```
177     end
178     //checking all the 2 cells cases
179     z6=[1 1];
180     z7=z6';
181     for i=1:n
182         for j=1:n
183             if(i==n)
184                 t1=1;
185             else
186                 t1=i+1;
187             end
188            if(j==n)
189                 t2=1;
190             else
191                 t2=j+1;
192             end
193             z8=[k(i,j,1) k(i,t2,1)];
194             z9=[k(i,j,2) k(i,t2,2)];
195             no1=noof(z9);
196             if(z8==z6 & no1<cmn2 )
197               k(i,j,2)=1;
198               k(i,t2,2)=1;
199               a=strsplit(temp1(1,j));
200               b=strsplit(temp1(1,t2));
201               c=strcmp(a,b);
202                 for in=1:max(size(c))
203                     if(c(in)==0 & a(in)=='0')
204                         printf(p1(1,i));
205                         printf('%s''',var(2+in));
206                         printf(" + ");
207                      end
208                      if(c(in)==0 & a(in)=='1')
209                          printf(p1(1,i));
210                          printf(var(2+in));
211                          printf(" + ");
212                      end
213                  end
214             end
```

```
215         end
216     end
217     for i=1:n
218         for j=1:n
219             if(i==n)
220                 t1=1;
221             else
222                 t1=i+1;
223             end
224            if(j==n)
225                 t2=1;
226             else
227                 t2=j+1;
228             end
229             z10=[k(i,j,1);k(t1,j,1)];
230             z11=[k(i,j,2);k(t1,j,2)];
231             no2=noof(z11);
232             if(z10==z7 & no2<cmn2)
233               k(i,j,2)=1;
234               k(t1,j,2)=1;
235               a=strsplit(temp2(i,1));
236               b=strsplit(temp2(t1,1));
237               c=strcmp(a,b);
238                 for in=1:max(size(c))
239                     if(c(in)==0 & a(in)=='0')
240                         printf(p2(j,1));
241                         printf('%s'',var(in));
242                         printf(" + ");
243                      end
244                      if(c(in)==0 & a(in)=='1')
245                          printf(p2(j,1));
246                          printf(var(in));
247                          printf(" + ");
248                      end
249                   end
250             end
251         end
252     end
```

```
253     // checking all the single cell cases
254     for i=1:n
255         for j=1:n
256             if(k(i,j,2)==0 & k(i,j,1)==1)
257                 a=strsplit(temp1(1,j));
258                 b=strsplit(temp2(i,1));
259                 for in=1:max(size(a(:,1)))
260                     if(a(in,1)=='1')
261                         printf(var(in+2));
262                     else
263                         if(a(in,1)=='0')
264                             printf('%s'',var(2+in))
                                    ;
265                         end
266                      end
267                 end
268                 for in=1:max(size(b(:,1)))
269                     if(b(in,1)=='1')
270                         printf(var(in));
271                     else
272                         if(b(in,1)=='0')
273                             printf('%s'',var(in));
274                         end
275                      end
276                 end
277                 if(i~=4 & j~=4)
278                     printf(" + ");
279                 end
280             end
281
282         end
283     end
284     printf("0");
285 endfunction
```

Scilab code AP 10 4-variable kmap

```
1
```

```
2  //this funtion prints the minimal expression of a
       given 4-vriable kmap
3  //this program requires noof.sci
4  function []=kmap(k)
5      n=4;
6      k(:,:,2)=zeros(n,n);
7      var=['A' 'B' 'C' 'D'];
8  p1=['A''B''' 'A''B' 'AB' 'AB''']
9  p2=['C''D''';'C''D';'CD';'CD''''];
10     cmn4=4;
11     cmn2=2;
12     temp=1;
13     disp(k(:,:,1));
14     disp("is :");
15     disp(" ")
16     //checking for 16 cells
17     for i=1:n
18         for j=1:n
19             if(k(i,j)~=1)
20                 temp=0;
21                 break;
22              end
23         end
24     end
25     printf('    ');
26     if(temp==1)
27         printf("1");
28         abort;
29     end
30     //checking 8 cells cases
31     z1=ones(2,4);
32     z2=ones(4,2);
33     temp1=['00' '01' '11' '10'];
34     temp2=temp1';
35     for i=1:n
36             if(i==4)
37                 t=1;
38             else
```

```
39                  t=i+1;
40              end
41              z=[k(i,:,1);k(t,:,1)];
42              if(z==z1)
43                  k(i,:,2)=[1 1 1 1];
44                  k(t,:,2)=[1 1 1 1];
45                  a=strsplit(temp2(i,1));
46                  b=strsplit(temp2(t,1));
47                  c=strcmp(a,b);
48                  for in=1:max(size(c))
49                      if(c(in)==0 & a(in)=='0')
50                          printf('%s'',var(in));
51                          printf(' + ');
52                          break;
53                       else
54                           if(c(in)==0 & a(in)=='1')
55                              printf(var(in));
56                              printf(' + ');
57                              break;
58                            end
59                       end
60                  end
61              end
62      end
63      for j=1:n
64          if(j==4)
65              t=1;
66          else
67              t=j+1;
68          end
69          z=[k(:,j,1) k(:,t,1)];
70          if(z==z2)
71              k(:,j,2)=[1;1;1;1];
72              k(:,t,2)=[1;1;1;1];
73              a=strsplit(temp1(1,j));
74              b=strsplit(temp1(1,t));
75              c=strcmp(a,b);
76              for in=1:max(size(c))
```

```
77                  if(c(in)==0 & a(in)=='0')
78                      printf('%s''',var(2+in));
79                      printf(' + ');
80                      break;
81                   else
82                       if(c(in)==0 & a(in)=='1')
83                           printf(var(2+in));
84                           printf(' + ');
85                           break;
86                       end
87                   end
88              end
89          end
90      end
91      //checking all 4 cells cases
92      z1=ones(1,4);
93      z2=ones(4,1);
94      z3=ones(2,2);
95      temp1=['00' '01' '11' '10'];
96      temp2=temp1';
97      for t=1:n
98              z=k(t,:,1);
99              no=noof(k(t,:,2));
100             if(z==z1 & no<cmn4)
101                 k(t,:,2)=z1;
102                 a=strsplit(temp1(1,t));
103                 for in=1:max(size(a))
104                     if(a(in)=='0')
105                         printf('%s''',var(in));
106                      end
107                      if(a(in)=='1')
108                          printf(var(in));
109                      end
110                  end
111                  printf(" + ");
112              end
113     end
114     for t=1:n
```

```
115         z=k(:,t,1);
116         no=noof(k(:,t,2));
117         if(z==z2 & no<cmn4)
118             k(:,t,2)=z2;
119             a=strsplit(temp2(t,1));
120             for in=1:max(size(a))
121                 if(a(in)=='0')
122                     printf('%s''',var(2+in));
123                  end
124                  if(a(in)=='1')
125                      printf(var(2+in));
126                  end
127             end
128                  printf(" + ");
129         end
130     end
131     for i=1:n
132         for j=1:n
133            if(i==n)
134                 t1=1;
135              else
136                 t1=i+1;
137              end
138            if(j==n)
139                 t2=1;
140              else
141                 t2=j+1;
142              end
143              z4=[k(i,j,1) k(i,t2,1);k(t1,j,1) k(t1,t2
                    ,1)];
144              z5=[k(i,j,2) k(i,t2,2);k(t1,j,2) k(t1,t2
                    ,2)];
145              no=noof(z5);
146              if(z4==z3 & no<cmn4)
147                 k(i,j,2)=1;
148                 k(i,t2,2)=1;
149                 k(t1,j,2)=1;
150                 k(t1,t2,2)=1;
```

```
151                 a=strsplit(temp2(i,1));
152                 b=strsplit(temp2(t1,1));
153                 c=strcmp(a,b);
154                 for in=1:max(size(c))
155                     if(c(in)==0 & a(in)=='0')
156                         printf('%s''',var(in));
157                      end
158                      if(c(in)==0 & a(in)=='1')
159                          printf(var(in));
160                      end
161                  end
162                 a=strsplit(temp1(1,j));
163                 b=strsplit(temp1(1,t2));
164                 c=strcmp(a,b);
165                 for in=1:max(size(c))
166                     if(c(in)==0 & a(in)=='0')
167                         printf('%s''',var(2+in));
168                      end
169                      if(c(in)==0 & a(in)=='1')
170                          printf(var(2+in));
171                      end
172                  end
173                  printf(" + ");
174             end
175         end
176     end
177     //checking all 2 cells cases
178     z6=[1 1];
179     z7=z6';
180     for i=1:n
181         for j=1:n
182             if(i==n)
183                 t1=1;
184             else
185                 t1=i+1;
186             end
187            if(j==n)
188                 t2=1;
```

```
189                 else
190                     t2=j+1;
191                 end
192                 z8=[k(i,j,1) k(i,t2,1)];
193                 z9=[k(i,j,2) k(i,t2,2)];
194                 no1=noof(z9);
195                 if(z8==z6 & no1<cmn2 )
196                   k(i,j,2)=1;
197                   k(i,t2,2)=1;
198                   a=strsplit(temp1(1,j));
199                   b=strsplit(temp1(1,t2));
200                   c=strcmp(a,b);
201                     for in=1:max(size(c))
202                         if(c(in)==0 & a(in)=='0')
203                             printf(p1(1,i));
204                             printf('%s'',var(2+in));
205                             printf(" + ");
206                          end
207                          if(c(in)==0 & a(in)=='1')
208                              printf(p1(1,i));
209                              printf(var(2+in));
210                              printf(" + ");
211                          end
212                      end
213                 end
214             end
215         end
216         for i=1:n
217             for j=1:n
218                 if(i==n)
219                     t1=1;
220                 else
221                     t1=i+1;
222                 end
223                if(j==n)
224                     t2=1;
225                 else
226                     t2=j+1;
```

```
227                 end
228                 z10=[k(i,j,1);k(t1,j,1)];
229                 z11=[k(i,j,2);k(t1,j,2)];
230                 no2=noof(z11);
231                 if(z10==z7 & no2<cmn2)
232                   k(i,j,2)=1;
233                   k(t1,j,2)=1;
234                   a=strsplit(temp2(i,1));
235                   b=strsplit(temp2(t1,1));
236                   c=strcmp(a,b);
237                     for in=1:max(size(c))
238                         if(c(in)==0 & a(in)=='0')
239                             printf(p2(j,1));
240                             printf('%s'',var(in));
241                             printf(" + ");
242                          end
243                          if(c(in)==0 & a(in)=='1')
244                              printf(p2(j,1));
245                              printf(var(in));
246                              printf(" + ");
247                          end
248                      end
249                 end
250             end
251         end
252         //checking for isolated cell
253         for i=1:n
254             for j=1:n
255                 if(k(i,j,2)==0 & k(i,j,1)==1)
256                     a=strsplit(temp1(1,j));
257                     b=strsplit(temp2(i,1));
258                     for in=1:max(size(a(:,1)))
259                         if(a(in,1)=='1')
260                             printf(var(in+2));
261                         else
262                             if(a(in,1)=='0')
263                                 printf('%s'',var(2+in))
                                    ;
```

```
                        end
                    end
                end
                for in=1:max(size(b(:,1)))
                    if(b(in,1)=='1')
                        printf(var(in));
                    else
                        if(b(in,1)=='0')
                            printf('%s'',var(in));
                        end
                    end
                end
                if(i~=4 & j~=4)
                    printf(" + ");
                end
            end
        end
    end
    printf("0");
endfunction
```

Scilab code AP 11 4-variable kmap pos

```
//this funtion prints the minimal expression in the
   Pruduct of sums form for a given 4-vriable kmap
//this program requires noof.sci
function []=kmappos(k)
    n=4;
    k(:,:,2)=zeros(n,n);
    var=['A' 'B' 'C' 'D'];
p1=['A + B' 'A + B'' ' 'A'' + B'' ' 'A'' + B'];
p2=['C + D';'C + D'';'C'' + D'';'C'' + D'];
    cmn4=4;
    cmn2=2;
    temp=1;
    disp(k(:,:,1));
    disp("is :");
    disp(" ")
```

```
15      //checking for 16 cells
16      for i=1:n
17          for j=1:n
18              if(k(i,j)~=1)
19                  temp=0;
20                  break;
21               end
22          end
23      end
24      printf('    ');
25      if(temp==1)
26          printf("1");
27          abort;
28      end
29      for i=1:n
30          for j=1:n
31              if(k(i,j)~=0)
32                  temp=0;
33                  break;
34               end
35          end
36      end
37      printf('    ');
38      if(temp==1)
39          printf("0");
40          abort;
41      end
42
43      //checking for 8 cells cases
44      z1=zeros(2,4);
45      z2=zeros(4,2);
46      temp1=['00' '01' '11' '10'];
47      temp2=temp1';
48      for i=1:n
49              if(i==4)
50                  t=1;
51              else
52                  t=i+1;
```

```
53              end
54              z=[k(i,:,1);k(t,:,1)];
55              if(z==z1)
56                  printf('(');
57                  k(i,:,2)=[1 1 1 1];
58                  k(t,:,2)=[1 1 1 1];
59                  a=strsplit(temp2(i,1));
60                  b=strsplit(temp2(t,1));
61                  c=strcmp(a,b);
62                  for in=1:max(size(c))
63                      if(c(in)==0 & a(in)=='0')
64                              printf(var(in));
65                          break;
66                       else
67                           if(c(in)==0 & a(in)=='1')
68                          printf('%s'',var(in));
69                              break;
70                            end
71                       end
72                  end
73                  printf(')');
74              end
75      end
76      for j=1:n
77          if(j==4)
78              t=1;
79          else
80              t=j+1;
81          end
82          z=[k(:,j,1) k(:,t,1)];
83          if(z==z2)
84              printf('(');
85              k(:,j,2)=[1;1;1;1];
86              k(:,t,2)=[1;1;1;1];
87              a=strsplit(temp1(1,j));
88              b=strsplit(temp1(1,t));
89              c=strcmp(a,b);
90              for in=1:max(size(c))
```

```
                if(c(in)==0 & a(in)=='0')
                    printf(var(2+in));
                    break;
                 else
                     if(c(in)==0 & a(in)=='1')
                         printf('%s''',var(2+in));
                         break;
                     end
                 end
            end
            printf(')')
        end
    end
    //checking for 4 cells cases
    z1=zeros(1,4);
    z2=zeros(4,1);
    z3=zeros(2,2);
    temp1=['00' '01' '11' '10'];
    temp2=temp1';
    for t=1:n
            z=k(t,:,1);
            no=noof(k(t,:,2));
            if(z==z1 & no<cmn4)
                printf('(')
                k(t,:,2)=[1 1 1 1];
                a=strsplit(temp1(1,t));
                for in=1:max(size(a))
                    if(a(in)=='0')
                        if in ~= 1 then
                            printf(' + ');
                        end
                        printf(var(in));
                     end
                     if(a(in)=='1')
                         if in ~= 1 then
                            printf(' + ');
                        end
                        printf('%s''',var(in));
```

```
                    end
                end
                printf(")");
            end
    end
    for t=1:n
        z=k(:,t,1);
        no=noof(k(:,t,2));
        if(z==z2 & no<cmn4)
            printf('(');
            k(:,t,2)=[1;1;1;1];
            a=strsplit(temp2(t,1));
            for in=1:max(size(a))
                if(a(in)=='0')
                    if in ~= 1 then
                            printf(' + ');
                        end
                    printf(var(2+in));
                end
                if(a(in)=='1')
                    if in ~= 1 then
                            printf(' + ');
                        end
                        printf('%s''',var(2+in));
                end
            end
                printf(")");
        end
    end
    for i=1:n
        for j=1:n
           if(i==n)
                t1=1;
            else
                t1=i+1;
            end
           if(j==n)
                t2=1;
```

```
167                 else
168                     t2=j+1;
169                 end
170                 z4=[k(i,j,1) k(i,t2,1);k(t1,j,1) k(t1,t2
                        ,1)];
171                 z5=[k(i,j,2) k(i,t2,2);k(t1,j,2) k(t1,t2
                        ,2)];
172                 no=noof(z5);
173                 if(z4==z3 & no<cmn4)
174                     printf('(')
175                     k(i,j,2)=1;
176                     k(i,t2,2)=1;
177                     k(t1,j,2)=1;
178                     k(t1,t2,2)=1;
179                     a=strsplit(temp2(i,1));
180                     b=strsplit(temp2(t1,1));
181                     c=strcmp(a,b);
182                     for in=1:max(size(c))
183                         if(c(in)==0 & a(in)=='0')
184                             printf(var(in));
185                          end
186                          if(c(in)==0 & a(in)=='1')
187                              printf('%s''',var(in));
188                          end
189                      end
190                     a=strsplit(temp1(1,j));
191                     b=strsplit(temp1(1,t2));
192                     c=strcmp(a,b);
193                     for in=1:max(size(c))
194                         if(c(in)==0 & a(in)=='0')
195                                 printf(' + ');
196                             printf(var(2+in));
197                          end
198                          if(c(in)==0 & a(in)=='1')
199                                 printf(' + ');
200                              printf('%s''',var(2+in));
201
202                          end
```

```
                end
                printf(")");
            end
        end
    end
    //checking for 2 cells
    z6=[0 0];
    z7=z6';
    for i=1:n
        for j=1:n
            if(i==n)
                t1=1;
            else
                t1=i+1;
            end
           if(j==n)
                t2=1;
            else
                t2=j+1;
            end
            z8=[k(i,j,1) k(i,t2,1)];
            z9=[k(i,j,2) k(i,t2,2)];
            no1=noof(z9);
            if(z8==z6 & no1<cmn2 )

             printf('(');
              k(i,j,2)=1;
              k(i,t2,2)=1;
              a=strsplit(temp1(1,j));
              b=strsplit(temp1(1,t2));
              c=strcmp(a,b);
                for in=1:max(size(c))
                    if(c(in)==0 & a(in)=='0')
                        printf(p1(1,i));
                        printf(' + ');
                        printf(var(2+in));
                        printf(")");
                     end
```

```
241                         if(c(in)==0 & a(in)=='1')
242                             printf(p1(1,i));
243                             printf(" + ");
244                             printf('%s'',var(2+in));
245
246                             printf(")");
247                         end
248                     end
249                 end
250             end
251         end
252         for i=1:n
253             for j=1:n
254                 if(i==n)
255                     t1=1;
256                 else
257                     t1=i+1;
258                 end
259                if(j==n)
260                     t2=1;
261                 else
262                     t2=j+1;
263                 end
264                 z10=[k(i,j,1);k(t1,j,1)];
265                 z11=[k(i,j,2);k(t1,j,2)];
266                 no2=noof(z11);
267                 if(z10==z7 & no2<cmn2)
268                     printf('(');
269                   k(i,j,2)=1;
270                   k(t1,j,2)=1;
271                   a=strsplit(temp2(i,1));
272                   b=strsplit(temp2(t1,1));
273                   c=strcmp(a,b);
274                     for in=1:max(size(c))
275                         if(c(in)==0 & a(in)=='0')
276                             printf(p2(j,1));
277                             printf(" + ");
278                             printf(var(in));
```

```
279                         printf(")");
280                     end
281                     if(c(in)==0 & a(in)=='1')
282                         printf(p2(j,1));
283                         printf(" + ");
284                         printf('%s'',var(in));
285 
286                         printf(")");
287                     end
288                 end
289             end
290         end
291     end
292     //for single cell
293     for i=1:n
294         for j=1:n
295             if(k(i,j,2)==0 & k(i,j,1)==0)
296                 printf('(');
297                 a=strsplit(temp1(1,j));
298                 b=strsplit(temp2(i,1));
299                 for in=1:max(size(a(:,1)))
300                     if(a(in,1)=='1')
301                         printf('%s'',var(2+in));
302                         printf(' + ');
303                     else
304                         if(a(in,1)=='0')
305                             printf(var(in+2));
306 
307                             printf(' + ');
308                         end
309                     end
310                 end
311                 for in=1:max(size(b(:,1)))
312                     if(b(in,1)=='1')
313                         printf('%s'',var(in));
314                         if(in~=max(size(b(:,1))))
315                             printf(' + ');
316                         end
```

```
317                         else
318                             if(b(in,1)=='0')
319                                printf(var(in));
320
321                             if(in~=max(size(b(:,1))))
322                                 printf(' + ');
323                             end
324
325                             end
326                          end
327                     end
328                         printf(")");
329                 end
330             end
331     end
332 endfunction
```