Scilab Manual for DIGITAL SIGNAL PROCESSING & PROCESSORS

by Prof Leena Govekar
Electronics Engineering
Pvppcoe/mumbai University[1]

Solutions provided by
Prof Rajiv Suhas Tawde
Others
Mumbai University/pvpp College Of Engineering

July 1, 2025

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

Contents

List of Scilab Solutions 4

1 Compute Four Point DFT Using Matrix Approach Only. 5

2 Derive The [W4*] Matrix Useful To Compute IDFT 7

3 IDFT Computation Using Matrix Method 9

4 N=8; DIT-FFT Without Using Inbuilt Scilab FFT Function 10

5 N=8; IDIT-FFT Without Using Inbuilt Scilab FFT Function 15

6 N=8; DIF-FFT Without Using Inbuilt Scilab FFT Function 21

7 N=8;IDIF-FFT Without Using Inbuilt Scilab FFT Function 26

8 Compute Kaiser Window Parameter Beta & Its Minimum Length 31

9 Design High Pass Butterworth Filter Using Bilinear Transformation 33

10 Overlap Add Method To Filter Long Sequences Using Linear Convolution 35

11 Overlap Save Method For Sectioned Convolution Using Matrix Approach **38**

List of Experiments

Solution 1.0	Experiment Number 1	5
Solution 2.0	Experiment Number 2	7
Solution 3.0	Experiment Number 3	9
Solution 4.0	Experiment Number 4	10
Solution 5.0	Experiment Number 5	15
Solution 6.0	Experiment Number 6	21
Solution 7.0	Experiment Number 7	26
Solution 8.0	Experiment Number 8	31
Solution 9.0	Experiment Number 9	33
Solution 10.0	Experiment Number 10	35
Solution 11.0	Experiment Number 11	38

Experiment: 1

Compute Four Point DFT Using Matrix Approach Only.

Scilab code Solution 1.0 Experiment Number 1

```
1  // AIM:Compute four point DFT using matrix approach
       only.
2  //Software version Scilab 5.5.2
3  //OS windows 10
4  clc;
5  clear;
6
7  //Let x(n)={1,2,3,4}
8  //Let us first define the W4 matrix
9  W4=[1 1 1 1 ;1 -sqrt(-1) -1 sqrt(-1);1 -1 1 -1;1
       sqrt(-1) -1 -sqrt(-1)];
10 disp(W4,'W4=')
11 //Now let us define the input sequence
12 xn=[1;2;3;4];//The input sequence x(n)has been
       arranged as a column matrix
13 //DFT is obtained by multiplying the twiddle matrix
       W4 and the input sequence
14 Xk=W4*xn;
15 disp(Xk,'DFT : X(k)=')
```

Experiment: 2

Derive The [W4*] Matrix Useful To Compute IDFT

Scilab code Solution 2.0 Experiment Number 2

```
1 //AIM: Derive the [W4*] matrix useful to compute
    IDFT.
2 //Software version Scilab 5.5.2
3 //OS windows 10
4 clc;
5 clear;
6 W40_star=int(cos(0))+(sqrt(-1)*int(sin(0)));
7 W41_star=int(cos(%pi/2))+(sqrt(-1))*int((sin(%pi/2))
    );
8 W42_star=int(cos(%pi))+(sqrt(-1))*int((sin(%pi)));
9 W43_star=int(cos((3*%pi)/2))+(sqrt(-1))*int(sin((3*
    %pi)/2));
10
11 disp(W40_star,'W40_star=')
12 disp(W41_star,'W41_star=')
13 disp(W42_star,'W42_star=')
14 disp(W43_star,'W43_star=')
15
16 W44_star=W40_star;
```

```
17 W49_star=W41_star;
18 W46_star=W42_star;
19
20 W4_star= [W40_star W40_star W40_star W40_star;
21           W40_star W41_star W42_star W43_star;
22           W40_star W42_star W44_star W46_star;
23           W40_star W43_star W46_star W49_star];
24 disp(W4_star,'W4_star=')
```

Experiment: 3

IDFT Computation Using Matrix Method

Scilab code Solution 3.0 Experiment Number 3

```
1  //AIM:IDFT computation using matrix method.
2  //Software version Scilab 5.5.2
3  //OS windows 10
4  clc;
5  clear;
6
7  //Let Y(k)={1,0,1,0}
8  //Computation for Inverse Discrete Fourier Transform
       (IDFT)
9  //Let us first define the W4* matrix
10 W4_star=[1 1 1 1 ;1 sqrt(-1) -1 -sqrt(-1);1 -1 1
       -1;1 -sqrt(-1) -1 sqrt(-1)];
11 disp(W4_star,'W4*=')
12 Yk=[1;0;1;0];//The input sequence Y(k) has been
       arranged as a column matrix
13 yn=(1/4)*W4_star*Yk;
14 disp(yn,'IDFT : y(n)=')
```

Experiment: 4

N=8; DIT-FFT Without Using Inbuilt Scilab FFT Function

Scilab code Solution 4.0 Experiment Number 4

```
1  //AIM: N=8; DIT-FFT without using inbuilt Scilab FFT
       function
2  //Software version Scilab 5.5.2
3  //OS windows 10
4  clc;
5  clear;
6  //Let x(n)={1,2,1,2,0,2,1,2}
7  //Let us begin with the programming.For
       understanding,let us write the given data as
8  //x(0)=1;x(1)=2,x(2)=1,x(3)=2,x(4)=0,x(5)=2,x(6)=1,x
       (7)=2
9  x0=1;//DIT-FFT,so arranging the input in bit-
       reversed order
10 x4=0;//DIT-FFT,so arranging the input in bit-
       reversed order
11 x2=1;//DIT-FFT,so arranging the input in bit-
       reversed order
12 x6=1;//DIT-FFT,so arranging the input in bit-
       reversed order
```

```
13 x1=2;//DIT-FFT,so arranging the input in bit-
     reversed order
14 x5=2;//DIT-FFT,so arranging the input in bit-
     reversed order
15 x3=2;//DIT-FFT,so arranging the input in bit-
     reversed order
16 x7=2;//DIT-FFT,so arranging the input in bit-
     reversed order
17 //Stage I computation
18 x0a=x4+x0;//Computing Stage-I output at line 1
19 disp(x0a,'Stage-I output at line 1=')
20 x4b=(x4-x0)*(-1);//Computing Stage-I output at line
     2
21 disp(x4b,'Stage-I output at line 2=')
22 x2c=x6+x2;//Computing Stage-I output at line 3
23 disp(x2c,'Stage-I output at line 3=')
24 x6d=(x6-x2)*(-1);//Computing Stage-I output at line
     4
25 disp(x6d,'Stage-I output at line 4=')
26 x1e=x5+x1;//Computing Stage-I output at line 5
27 disp(x1e,'Stage-I output at line 5=')
28 x5f=(x5-x1)*(-1);//Computing Stage-I output at line
     6
29 disp(x5f,'Stage-I output at line 6=')
30 x3g=x7+x3;//Computing Stage-I output at line 7
31 disp(x3g,'Stage-I output at line 7')
32 x7h=(x7-x3)*(-1);//Computing Stage-I output at line
     8
33 disp(x7h,'Stage-I output at line 8=')
34
35 //Stage-I output at line 4 and line 8 is to be
     multiplied by twiddle factor having value (-j)
36 x6d1=(x6d)*(-sqrt(-1));
37 x7h1=(x7h)*(-sqrt(-1));
38 disp(x6d1,'Stage-I output(i.e. input to stage-II)
     after multiplication by twiddle factor value of
     (-j) at line 4 =')
39 disp(x7h1,'Stage-I output(i.e. input to stage-II)
```

```
    after multiplication by twiddle factor value of
    (-j) at line 8 =')
40
41 //Stage-II Computations
42 x0a_stageII_output=x2c+x0a;//Computing Stage-II
    output at line 1
43 disp(x0a_stageII_output,'Stage-II output at line 1='
    )
44 x4b_stageII_output=x6d1+x4b;//Computing Stage-II
    output at line 2
45 disp(x4b_stageII_output,'Stage-II output at line 2='
    )
46 x2c_stageII_output=(x2c-x0a)*(-1);//Computing Stage-
    II output at line 3
47 disp(x2c_stageII_output,'Stage-II output at line 3='
    )
48 x6d_stageII_output=(x6d1-x4b)*(-1);//Computing Stage
    -II output at line 4
49 disp(x6d_stageII_output,'Stage-II output at line 4='
    )
50 x1e_stageII_output=x3g+x1e;//Computing Stage-II
    output at line 5
51 disp(x1e_stageII_output,'Stage-II output at line 5='
    )
52 x5f_stageII_output=x7h1+x5f;//Computing Stage-II
    output at line 6
53 disp(x5f_stageII_output,'Stage-II output at line 6='
    )
54 x3g_stageII_output=(x3g-x1e)*(-1);//Computing Stage-
    II output at line 7
55 disp(x3g_stageII_output,'Stage-II output at line 7='
    )
56 x7h_stageII_output=(x7h1-x5f)*(-1);//Computing Stage
    -II output at line 8
57 disp(x7h_stageII_output,'Stage-II output at line 8='
    )
58
59 //Stage-II output at line 6,line 7 and line 8 are to
```

```
      be multiplied by twiddle factor having value
      (0.707-j0.707),(-j) and (-0.707-j0.707)
      respectively
60 x5f_stgII_op_multi_by_tw=(x5f_stageII_output)
      *(0.707-(sqrt(-1))*(0.707));
61 disp(x5f_stgII_op_multi_by_tw,'Stage-II output at
      line 6 after multiplication by twiddle factor=')
62 x3g_stgII_op_multi_by_tw=(x3g_stageII_output)*(-(
      sqrt(-1)));
63 disp(x3g_stgII_op_multi_by_tw,'Stage-II output at
      line 7 after multiplication by twiddle factor=')
64 x7h_stgII_op_multi_by_tw=(x7h_stageII_output)
      *(-0.707-(sqrt(-1))*(0.707));
65 disp(x7h_stgII_op_multi_by_tw,'Stage-II output at
      line 8 after multiplication by twiddle factor=')
66
67 //Stage-III Computations(i.e. Computations for the
      final stage)
68 X0=x1e_stageII_output+x0a_stageII_output;//Computing
       X(0) at last stage
69 X1=x5f_stgII_op_multi_by_tw+x4b_stageII_output;//
      Computing X(1) at last stage
70 X2=x3g_stgII_op_multi_by_tw+x2c_stageII_output;//
      Computing X(2) at last stage
71 X3=x7h_stgII_op_multi_by_tw+x6d_stageII_output;//
      Computing X(3) at last stage
72 X4=(x1e_stageII_output-x0a_stageII_output)*(-1);//
      Computing X(4) at last stage
73 X5=(x5f_stgII_op_multi_by_tw-x4b_stageII_output)
      *(-1);//Computing X(5) at last stage
74 X6=(x3g_stgII_op_multi_by_tw-x2c_stageII_output)
      *(-1);//Computing X(6) at last stage
75 X7=(x7h_stgII_op_multi_by_tw-x6d_stageII_output)
      *(-1);//Computing X(7) at last stage
76 disp(X0,'X(0)=')
77 disp(X1,'X(1)=')
78 disp(X2,'X(2)=')
79 disp(X3,'X(3)=')
```

```
80 disp(X4,'X(4)=')
81 disp(X5,'X(5)=')
82 disp(X6,'X(6)=')
83 disp(X7,'X(7)=')
84 disp({,X0,X1,X2,X3,X4,X5,X6,X7,},'So,the DFT of x(n)
       using Decimation-in-Time Fast Fourier Transform(
     DIT-FFT) is X(k)=')
```

Experiment: 5

N=8; IDIT-FFT Without Using Inbuilt Scilab FFT Function

Scilab code Solution 5.0 Experiment Number 5

```
1 //AIM:N=8; IDIT-FFT without using inbuilt Scilab FFT
    function
2 //Software version Scilab 5.5.2
3 //OS windows 10
4 clc;
5 clear;
6 //Let X(k)={11,1-1,1,-5,1,-1,1}
7 //Let us begin with the programming.For
    understanding,let us write the given data as
8 //X(0)=11;X(1)=1,X(2)=-1,X(3)=1,X(4)=-5,X(5)=1,X(6)
    =-1,X(7)=1
9 X0_conj=11;//IDIT-FFT,so arranging the input in bit-
    reversed order
10 X4_conj=-5;//IDIT-FFT,so arranging the input in bit-
    reversed order
11 X2_conj=-1;//IDIT-FFT,so arranging the input in bit-
    reversed order
12 X6_conj=-1;//IDIT-FFT,so arranging the input in bit-
    reversed order
```

```
13 X1_conj=1;//IDIT-FFT,so arranging the input in bit-
     reversed order
14 X5_conj=1;//IDIT-FFT,so arranging the input in bit-
     reversed order
15 X3_conj=1;//IDIT-FFT,so arranging the input in bit-
     reversed order
16 X7_conj=1;//IDIT-FFT,so arranging the input in bit-
     reversed order
17 disp(X0_conj,'X*(0)=')
18 disp(X4_conj,'X*(4)=')
19 disp(X2_conj,'X*(2)=')
20 disp(X6_conj,'X*(6)=')
21 disp(X1_conj,'X*(1)=')
22 disp(X5_conj,'X*(5)=')
23 disp(X3_conj,'X*(3)=')
24 disp(X7_conj,'X*(7)=')
25 //Stage I computation
26 X0a=X4_conj+X0_conj;//Computing Stage-I output at
     line 1
27 disp(X0a,'Stage-I output at line 1=')
28 X4b=(X4_conj-X0_conj)*(-1);//Computing Stage-I
     output at line 2
29 disp(X4b,'Stage-I output at line 2=')
30 X2c=X6_conj+X2_conj;//Computing Stage-I output at
     line 3
31 disp(X2c,'Stage-I output at line 3=')
32 X6d=(X6_conj-X2_conj)*(-1);//Computing Stage-I
     output at line 4
33 disp(X6d,'Stage-I output at line 4=')
34 X1e=X5_conj+X1_conj;//Computing Stage-I output at
     line 5
35 disp(X1e,'Stage-I output at line 5=')
36 X5f=(X5_conj-X1_conj)*(-1);//Computing Stage-I
     output at line 6
37 disp(X5f,'Stage-I output at line 6=')
38 X3g=X7_conj+X3_conj;//Computing Stage-I output at
     line 7
39 disp(X3g,'Stage-I output at line 7')
```

```
40 X7h=(X7_conj-X3_conj)*(-1);//Computing Stage-I
     output at line 8
41 disp(X7h,'Stage-I output at line 8=')
42
43 //Stage-I output at line 4 and line 8 is to be
     multiplied by twiddle factor having value (-j)
44 X6d'=(X6d)*(-sqrt(-1));
45 X7h'=(X7h)*(-sqrt(-1));
46 disp(X6d','Stage-I output(i.e. input to stage-II)
     after multiplication by twiddle factor value of
     (-j) at line 4 =')
47 disp(X7h','Stage-I output(i.e. input to stage-II)
     after multiplication by twiddle factor value of
     (-j) at line 8 =')
48
49 //Stage-II Computations
50 X0a_stageII_output=X2c+X0a;//Computing Stage-II
     output at line 1
51 disp(X0a_stageII_output,'Stage-II output at line 1='
     )
52 X4b_stageII_output=X6d'+X4b;//Computing Stage-II
     output at line 2
53 disp(X4b_stageII_output,'Stage-II output at line 2='
     )
54 X2c_stageII_output=(X2c-X0a)*(-1);//Computing Stage-
     II output at line 3
55 disp(X2c_stageII_output,'Stage-II output at line 3='
     )
56 X6d_stageII_output=(X6d'-X4b)*(-1);//Computing Stage
     -II output at line 4
57 disp(X6d_stageII_output,'Stage-II output at line 4='
     )
58 X1e_stageII_output=X3g+X1e;//Computing Stage-II
     output at line 5
59 disp(X1e_stageII_output,'Stage-II output at line 5='
     )
60 X5f_stageII_output=X7h'+X5f;//Computing Stage-II
     output at line 6
```

```
61 disp(X5f_stageII_output,'Stage-II output at line 6=')
62 X3g_stageII_output=(X3g-X1e)*(-1);//Computing Stage-II output at line 7
63 disp(X3g_stageII_output,'Stage-II output at line 7=')
64 X7h_stageII_output=(X7h'-X5f)*(-1);//Computing Stage-II output at line 8
65 disp(X7h_stageII_output,'Stage-II output at line 8=')
66
67 //Stage-II output at line 6,line 7 and line 8 are to be multiplied by twiddle factor having value (0.707-j0.707),(-j) and (-0.707-j0.707) respectively
68 X5f_stageII_output_multiplied_by_twiddle=(X5f_stageII_output)*(0.707-(sqrt(-1))*(0.707));
69 disp(X5f_stageII_output_multiplied_by_twiddle,'Stage-II output at line 6 after multiplication by twiddle factor=')
70 X3g_stageII_output_multiplied_by_twiddle=(X3g_stageII_output)*(-(sqrt(-1)));
71 disp(X3g_stageII_output_multiplied_by_twiddle,'Stage-II output at line 7 after multiplication by twiddle factor=')
72 X7h_stageII_output_multiplied_by_twiddle=(X7h_stageII_output)*(-0.707-(sqrt(-1))*(0.707));
73 disp(X7h_stageII_output_multiplied_by_twiddle,'Stage-II output at line 8 after multiplication by twiddle factor=')
74
75 //Stage-III Computations(i.e. Computations for the final stage)
76 x0_star=(1/8)*(X1e_stageII_output+X0a_stageII_output);//Computing x*(0) at last stage
77 x1_star=(1/8)*(X5f_stageII_output_multiplied_by_twiddle+X4b_stageII_output);//Computing x*(1) at last
```

```
    stage
78  x2_star=(1/8)*(
    X3g_stageII_output_multiplied_by_twiddle+
    X2c_stageII_output);//Computing x*(2) at last
    stage
79  x3_star=(1/8)*(
    X7h_stageII_output_multiplied_by_twiddle+
    X6d_stageII_output);//Computing x*(3) at last
    stage
80  x4_star=(1/8)*((X1e_stageII_output-
    X0a_stageII_output)*(-1));//Computing x*(4) at
    last stage
81  x5_star=(1/8)*((
    X5f_stageII_output_multiplied_by_twiddle-
    X4b_stageII_output)*(-1));//Computing x*(5) at
    last stage
82  x6_star=(1/8)*((
    X3g_stageII_output_multiplied_by_twiddle-
    X2c_stageII_output)*(-1));//Computing x*(6) at
    last stage
83  x7_star=(1/8)*((
    X7h_stageII_output_multiplied_by_twiddle-
    X6d_stageII_output)*(-1));//Computing x*(7) at
    last stage
84  disp(x0_star,'x*(0)=')
85  disp(x1_star,'x*(1)=')
86  disp(x2_star,'x*(2)=')
87  disp(x3_star,'x*(3)=')
88  disp(x4_star,'x*(4)=')
89  disp(x5_star,'x*(5)=')
90  disp(x6_star,'x*(6)=')
91  disp(x7_star,'x*(7)=')
92  disp({,x0_star,x1_star,x2_star,x3_star,x4_star,
    x5_star,x6_star,x7_star,},'x*(n)=')
93  x0_star_real=real(x0_star);
94  x0_star_imag_conj=(-1)*(imag(x0_star));
95  x1_star_real=real(x1_star);
96  x1_star_imag_conj=(-1)*(imag(x1_star));
```

```
x2_star_real=real(x2_star);
x2_star_imag_conj=(-1)*(imag(x2_star));
x3_star_real=real(x3_star);
x3_star_imag_conj=(-1)*(imag(x3_star));
x4_star_real=real(x4_star);
x4_star_imag_conj=(-1)*(imag(x4_star));
x5_star_real=real(x5_star);
x5_star_imag_conj=(-1)*(imag(x5_star));
x6_star_real=real(x6_star);
x6_star_imag_conj=(-1)*(imag(x6_star));
x7_star_real=real(x7_star);
x7_star_imag_conj=(-1)*(imag(x7_star));
x0=x0_star_real+x0_star_imag_conj;
x1=x1_star_real+x1_star_imag_conj;
x2=x2_star_real+x2_star_imag_conj;
x3=x3_star_real+x3_star_imag_conj;
x4=x4_star_real+x4_star_imag_conj;
x5=x5_star_real+x5_star_imag_conj;
x6=x6_star_real+x6_star_imag_conj;
x7=x7_star_real+x7_star_imag_conj;
disp({,x0,x1,x2,x3,x4,x5,x6,x7,},'So,the IDFT of X(k
   ) using Inverse Decimation-in-Time Fast Fourier
   Transform(IDIT-FFT) is x(n)=')
```

Experiment: 6

N=8; DIF-FFT Without Using Inbuilt Scilab FFT Function

Scilab code Solution 6.0 Experiment Number 6

```
1  //AIM :N=8; DIF–FFT without using inbuilt Scilab FFT
       function
2  //Software version Scilab 5.5.2
3  //OS windows 10
4  clc;
5  clear;
6  //Let x(n)={1,2,1,2,0,2,1,2}
7  //Let us begin with the programming.For
       understanding,let us write the given data as
8  //x(0)=1;x(1)=2,x(2)=1,x(3)=2,x(4)=0,x(5)=2,x(6)=1,x
       (7)=2
9  x0=1;//DIF–FFT,so arranging the input in natural
       order
10 x1=2;//DIF–FFT,so arranging the input in natural
       order
11 x2=1;//DIF–FFT,so arranging the input in natural
       order
12 x3=2;//DIF–FFT,so arranging the input in natural
       order
```

```
13 x4=0;//DIF-FFT,so arranging the input in natural
      order
14 x5=2;//DIF-FFT,so arranging the input in natural
      order
15 x6=1;//DIF-FFT,so arranging the input in natural
      order
16 x7=2;//DIF-FFT,so arranging the input in natural
      order
17 //Stage I computation
18 x0a=x4+x0;//Computing Stage-I output at line 1
19 disp(x0a,'Stage-I output at line 1=')
20 x1b=x5+x1;//Computing Stage-I output at line 2
21 disp(x1b,'Stage-I output at line 2=')
22 x2c=x6+x2;//Computing Stage-I output at line 3
23 disp(x2c,'Stage-I output at line 3=')
24 x3d=x7+x3;//Computing Stage-I output at line 4
25 disp(x3d,'Stage-I output at line 4=')
26 x4e=(x4-x0)*(-1);//Computing Stage-I output at line
      5
27 disp(x4e,'Stage-I output at line 5=')
28 x5f=(x5-x1)*(-1);//Computing Stage-I output at line
      6
29 disp(x5f,'Stage-I output at line 6=')
30 x6g=(x6-x2)*(-1);//Computing Stage-I output at line
      7
31 disp(x6g,'Stage-I output at line 7')
32 x7h=(x7-x3)*(-1);//Computing Stage-I output at line
      8
33 disp(x7h,'Stage-I output at line 8=')
34
35 //Stage-I output at line 6,line 7 and line 8 are to
      be multiplied by twiddle factor having value
      (0.707-j0.707),(-j) and (-0.707-j0.707)
      respectively
36 x5f_stageI_output_multiplied_by_twiddle=(x5f)
      *(0.707-(sqrt(-1))*(0.707));
37 disp(x5f_stageI_output_multiplied_by_twiddle,'Stage-
      I output at line 6 after multiplication by
```

```
    twiddle factor=')
38 x6g_stageI_output_multiplied_by_twiddle=(x6g)*(-(
    sqrt(-1)));
39 disp(x6g_stageI_output_multiplied_by_twiddle,'Stage-
    I output at line 7 after multiplication by
    twiddle factor=')
40 x7h_stageI_output_multiplied_by_twiddle=(x7h)
    *(-0.707-(sqrt(-1))*(0.707));
41 disp(x7h_stageI_output_multiplied_by_twiddle,'Stage-
    I output at line 8 after multiplication by
    twiddle factor=')
42
43 //Stage-II Computations
44 x0a_stageII_output=x2c+x0a;//Computing Stage-II
    output at line 1
45 disp(x0a_stageII_output,'Stage-II output at line 1='
    )
46 x1b_stageII_output=x3d+x1b;//Computing Stage-II
    output at line 2
47 disp(x1b_stageII_output,'Stage-II output at line 2='
    )
48 x2c_stageII_output=(x2c-x0a)*(-1);//Computing Stage-
    II output at line 3
49 disp(x2c_stageII_output,'Stage-II output at line 3='
    )
50 x3d_stageII_output=(x3d-x1b)*(-1);//Computing Stage-
    II output at line 4
51 disp(x3d_stageII_output,'Stage-II output at line 4='
    )
52 x4e_stageII_output=x6g+x4e;//Computing Stage-II
    output at line 5
53 disp(x4e_stageII_output,'Stage-II output at line 5='
    )
54 x5f_stageII_output=
    x7h_stageI_output_multiplied_by_twiddle+
    x5f_stageI_output_multiplied_by_twiddle;//
    Computing Stage-II output at line 6
55 disp(x5f_stageII_output,'Stage-II output at line 6='
```

```
    )
x6g_stageII_output=(
    x6g_stageI_output_multiplied_by_twiddle-x4e)*(-1)
    ;//Computing Stage-II output at line 7
disp(x6g_stageII_output,'Stage-II output at line 7='
    )
x7h_stageII_output=(x7h'-x5f)*(-1);//Computing Stage
    -II output at line 8
disp(x7h_stageII_output,'Stage-II output at line 8='
    )

//Stage-II output at line 4 and line 8 are to be
    multiplied by twiddle factor having value (-j)
x3d_stageII_output_multiplied_by_twiddle=(
    x3d_stageII_output)*(-(sqrt(-1)));
disp(x3d_stageII_output_multiplied_by_twiddle,'Stage
    -II output at line 4 after multiplication by
    twiddle factor=')
x7h_stageII_output_multiplied_by_twiddle=(
    x7h_stageII_output)*(-(sqrt(-1)));
disp(x7h_stageII_output_multiplied_by_twiddle,'Stage
    -II output at line 8 after multiplication by
    twiddle factor=')

//Stage-III Computations(i.e. Computations for the
    final stage)
X0=x1b_stageII_output+x0a_stageII_output;//Computing
    X(0) at last stage
X4=(x1b_stageII_output-x0a_stageII_output)*(-1);//
    Computing X(4) at last stage
X2=x3d_stageII_output_multiplied_by_twiddle+
    x2c_stageII_output;//Computing X(2) at last stage
X6=(x3d_stageII_output_multiplied_by_twiddle-
    x2c_stageII_output)*(-1);//Computing X(6) at last
    stage
X1=(x5f_stageII_output+x4e_stageII_output);//
    Computing X(1) at last stage
X5=(x5f_stageII_output-x4e_stageII_output)*(-1);//
```

```
    Computing X(5) at last stage
X3=x7h_stageII_output_multiplied_by_twiddle+
    x6g_stageII_output;//Computing X(3) at last stage
X7=(x7h_stageII_output_multiplid_by_twiddle-
    x6g_stageII_output)*(-1);//Computing X(7) at last
     stage
disp(X0,'X(0)=')
disp(X4,'X(4)=')
disp(X2,'X(2)=')
disp(X6,'X(6)=')
disp(X1,'X(1)=')
disp(X5,'X(5)=')
disp(X3,'X(3)=')
disp(X7,'X(7)=')
disp({,X0,X1,X2,X3,X4,X5,X6,X7,},'So,the DFT of x(n)
     using Decimation-in-Frequency Fast Fourier
    Transform(DIF-FFT) is X(k)=')
```

Experiment: 7

N=8;IDIF-FFT Without Using Inbuilt Scilab FFT Function

Scilab code Solution 7.0 Experiment Number 7

```
1  //AIM:N=8;IDIF-FFT without using inbuilt Scilab FFT
       function
2  //Software version Scilab 5.5.2
3  //OS windows 10
4  clc;
5  clear;
6  //Let X(k)={11,1,-1,1,-5,1,-1,1}
7  //Let us begin with the programming.For
       understanding,let us write the given data as
8  //X(0)=11;X(1)=1,X(2)=-1,X(3)=1,X(4)=-5,X(5)=1,X(6)
       =-1,X(7)=1
9  X0_conj=11;//IDIF-FFT,so arranging the input in
       natural order
10 X1_conj=1;//IDIF-FFT,so arranging the input in
       natural order
11 X2_conj=-1;//IDIF-FFT,so arranging the input in
       natural order
12 X3_conj=1;//IDIF-FFT,so arranging the input in
       natural order
```

```
13 X4_conj=-5;//IDIF-FFT,so arranging the input in
      natural order
14 X5_conj=1;//IDIF-FFT,so arranging the input in
      natural order
15 X6_conj=-1;//IDIF-FFT,so arranging the input in
      natural order
16 X7_conj=1;//IDIF-FFT,so arranging the input in
      natural order
17 disp(X0_conj,'X*(0)=')
18 disp(X1_conj,'X*(1)=')
19 disp(X2_conj,'X*(2)=')
20 disp(X3_conj,'X*(3)=')
21 disp(X4_conj,'X*(4)=')
22 disp(X5_conj,'X*(5)=')
23 disp(X6_conj,'X*(6)=')
24 disp(X7_conj,'X*(7)=')
25
26 // Twiddle factor
27 W0=cos(((2*%pi)/8)*0)-(sqrt(-1))*sin(((2*%pi)/8)*0)
28 W1=cos(((2*%pi)/8)*1)-sqrt(-1)*sin(((2*%pi)/8)*1)
29 W2=cos(((2*%pi)/8)*2)-sqrt(-1)*sin(((2*%pi)/8)*2)
30 W3=cos(((2*%pi)/8)*3)-sqrt(-1)*sin(((2*%pi)/8)*3)
31
32 //Stage I computation
33 x0a=X0_conj+X4_conj
34 x1b=X1_conj+X5_conj
35 x2c=X2_conj+X6_conj
36 x3d=X3_conj+X7_conj
37 x4e=X0_conj+(-1)*X4_conj
38 x5f=X1_conj+(-1)*X5_conj
39 x6g=X2_conj+(-1)*X6_conj
40 x7h=X3_conj+(-1)*X7_conj
41 disp('Stage-I values are')
42 disp(x0a)
43 disp(x1b)
44 disp(x2c)
45 disp(x3d)
46 disp(x4e)
```

```
47 disp(x5f)
48 disp(x6g)
49 disp(x7h)
50 //Stage I output at line 4,5,6 & 7 are to be
      multiplied by factors W0, W1, W2, and W3
      respectively
51 x4e1=x4e*W0
52 x5f1=x5f*W1
53 x6g1=x6g*W2
54 x7h1=x7h*W3
55
56 //Stage II computation
57 x0a_stageII_output=x2c+x0a;//Computing Stage-II
      output at line 1
58 disp(x0a_stageII_output,'Stage-II output at line 1='
      )
59 x1b_stageII_output=x3d+x1b;//Computing Stage-I
      output at line 2
60 disp(x1b_stageII_output,'Stage-II output at line 2='
      )
61 x2c_stageII_output=x0a-x2c;//Computing Stage-I
      output at line 3
62 disp(x2c_stageII_output,'Stage-II output at line 3='
      )
63 x3d_stageII_output=x1b-x3d;//Computing Stage-I
      output at line 4
64 disp(x3d_stageII_output,'Stage-II output at line 4='
      )
65 x4e_stageII_output=x6g+x4e1;//Computing Stage-II
      output at line 5
66 disp(x4e_stageII_output,'Stage-II output at line 5='
      )
67 x5f_stageII_output=x7h+x5f1//Computing Stage-II
      output at line 6
68 disp(x5f_stageII_output,'Stage-II output at line 6='
      )
69 x6g_stageII_output=x4e1+(x6g1*(-1));//Computing
      Stage-II output at line 7
```

```
70 disp(x6g_stageII_output,'Stage-II output at line 7=')
71 x7h_stageII_output=x5f1+(x7h1*(-1));//Computing Stage-II output at line 8
72 disp(x7h_stageII_output,'Stage-II output at line 8=')
73
74 //Stage III computation
75 x0=x0a_stageII_output+x1b_stageII_output;//
76 x4=x0a_stageII_output+(-1)*x1b_stageII_output
77 x2=x3d_stageII_output*((-1)*sqrt(-1))+x2c_stageII_output;//at line 2 x3d_stageII_output is to be multiplied by factor -j
78 x6=x3d_stageII_output*((-1)*sqrt(-1))*(-1)+x2c_stageII_output;//at line 3 x3d_stageII_output is to be multioplied by factor -j*(-1)
79 x1=x4e_stageII_output+x5f_stageII_output
80 x5=x4e_stageII_output-x5f_stageII_output
81 x3=x7h_stageII_output*((-1)*sqrt(-1))+x6g_stageII_output;//at line 7 x7h_stageII_output is to b e multiplied by factor -j
82 x7=x7h_stageII_output*((-1)*sqrt(-1))*(-1)+x6g_stageII_output;// at line 8 x7h_stageII_output is to be multiplied by factor (-j)*(-1)
83 //final computation
84 x0_star=(1/8)*(x0)
85 disp(x0_star,'x*(0)=')
86 x4_star=(1/8)*(x4)
87 disp(x4_star,'x*(4)=')
88 x2_star=(1/8)*(x2)
89 disp(x2_star,'x*(2)=')
90 x6_star=(1/8)*(x6)
91 disp(x6_star,'x*(6)=')
92 x1_star=(1/8)*(x1)
93 disp(x1_star,'x*(1)=')
94 x5_star=(1/8)*(x5)
95 disp(x5_star,'x*(5)=')
```

```
96  x3_star=(1/8)*(x3)
97  disp(x3_star,'x*(3)=')
98  x7_star=(1/8)*(x7)
99  disp(x7_star,'x*(7)=')
100
101 disp({,x0_star,x1_star,x2_star,x3_star,x4_star,
       x5_star,x6_star,x7_star,},'x*(n)=')
102 x0_star_real=real(x0_star);
103 x0_star_imag_conj=(-1)*(imag(x0_star));
104 x1_star_real=real(x1_star);
105 x1_star_imag_conj=(-1)*(imag(x1_star));
106 x2_star_real=real(x2_star);
107 x2_star_imag_conj=(-1)*(imag(x2_star));
108 x3_star_real=real(x3_star);
109 x3_star_imag_conj=(-1)*(imag(x3_star));
110 x4_star_real=real(x4_star);
111 x4_star_imag_conj=(-1)*(imag(x4_star));
112 x5_star_real=real(x5_star);
113 x5_star_imag_conj=(-1)*(imag(x5_star));
114 x6_star_real=real(x6_star);
115 x6_star_imag_conj=(-1)*(imag(x6_star));
116 x7_star_real=real(x7_star);
117 x7_star_imag_conj=(-1)*(imag(x7_star));
118 x0=x0_star_real+x0_star_imag_conj;
119 x1=x1_star_real+x1_star_imag_conj;
120 x2=x2_star_real+x2_star_imag_conj;
121 x3=x3_star_real+x3_star_imag_conj;
122 x4=x4_star_real+x4_star_imag_conj;
123 x5=x5_star_real+x5_star_imag_conj;
124 x6=x6_star_real+x6_star_imag_conj;
125 x7=x7_star_real+x7_star_imag_conj;
126 disp({,x0,x1,x2,x3,x4,x5,x6,x7,},'So,the IDFT of X(k
       ) using Inverse Decimation-in-Frequency Fast
       Fourier Transform(IDIF-FFT) is x(n)=')
```

Experiment: 8

Compute Kaiser Window Parameter Beta & Its Minimum Length

Scilab code Solution 8.0 Experiment Number 8

```
1 //AIM:Compute Kaiser window parameter Beta & its
     minimum length
2 //Software version Scilab 5.5.2
3 //OS windows 10
4 clc;
5 clear;
6 //Let us consider the following specifications :
7 // H ( ) 0 .01 0 0 .25
8 //0.95 H ( ) 1 .05 0.35
            0 .6
9 // H ( ) 0 .01 0.65
10 //The magnitude specifications of the FIR filter is
     given by
11 // 1- pH ( ) 1+ p for 0 p
12 // 0 H ( ) s for s
13 //On comparing,we get 1- p =0.95
14 del_p=0.05;
```

```
del_s=0.01;
omega_p=0.6*(%pi);
omega_s=0.65*(%pi);
del_omega=omega_s-omega_p;
//    ia minimum of  p  and minimum of  s
del=0.05;
//Attenuation A is given as
A=((-20)*(log10(del)));
disp("dB",A,"Attenuation(A)=")
//Calculating value of
beeta=(A-21)^(0.4)+0.07886+(A-21);
disp(beeta,"  =")
//The length of filter is (M+1)
//The value of M is calculated as follows
M=((A-8)/(2.285*(del_omega)));
disp(M,"M=")
```

Experiment: 9

Design High Pass Butterworth Filter Using Bilinear Transformation

Scilab code Solution 9.0 Experiment Number 9

```
1  //AIM:Design High pass Butterworth filter using
       Bilinear Transformation.
2  //Software version Scilab 5.5.2
3  //OS windows 10
4  clc;
5  clear;
6  s=poly(0,"s")
7  T=1;//Assume T=1 second
8  Ap=0.8;//Attenuation in pass band
9  As=0.2;//Attenuation in stop band
10 wp=0.2*(%pi)
11 ws=0.6*(%pi)
12 ohmp=2/T*(tan(wp/2))
13 ohms=2/T*(tan(ws/2))
14 //ORDER CALCULATION(N);
15 a=(1/As^2-1)
16 b=(1/Ap^2-1)
```

```
c=log(a/b)
N=(1/2)*(c/(log(ohms/ohmp)))
Nr=int (N)
x=N-int(N)
if(x>0)
 Nr=Nr+1
ohmc=(ohmp/(1/Ap^2-1)^(1/(2*Nr)))
//calculation of poles
i=0:1:Nr-1;
pi_plus=ohmc*exp(%i*(Nr+2*i+1)*(%pi)/(2*Nr))
pi_minus=-ohmc*exp(%i*(2+2.*i+1)*(%pi)/(2*Nr))
disp(wp,' p =')
disp(ws,' s =')
disp(ohmp,' p =')
disp(ohms,' s =')
disp(N','Order (N)=')
disp(Nr,'Integer value of the order:(Nr)=')
disp(ohmc,' c =')
disp(pi_plus,'Poles=')
disp(pi_minus,'Poles=')
h=ohmc/(s-(-0.53-0.53*%i))
h1=ohmc/(s-(-0.53+0.53*%i))
h2=h*h1;
disp(h,h1,'The analog transfer function will be the
   multiplication of the following two terms:');
disp(h2,'The analog transfer function H(s)=')
Z=poly(0,"Z")
s=(ohmc*ohmp)/((2/T)*((Z-1)/(Z+1)));
h3=0.56/(s^2+1.06*s+0.56);
disp(h3,"Transfer function of digital filter H(Z)=")
```

Experiment: 10

Overlap Add Method To Filter Long Sequences Using Linear Convolution

Scilab code Solution 10.0 Experiment Number 10

```
1  //AIM: Overlap add method to filter long sequences
       using linear convolution
2  //Software version Scilab 5.5.2
3  //OS windows 10
4  clc;
5  clear;
6  //Let x(n)={1,2,3,4,5,6,7,8} and h(n)={1,2}
7  xn =[1 2 3 4 5 6 7 8]; //Nx=8
8  xon =[1 2];
9  xono=1;
10 xon1=2;
11 x1n =[3 4];
12 x1no=3;
13 x1n1=4;
14 x2n =[5 6];
15 x2no=5;
16 x2n1=6;
```

```
17 x3n =[7 8];
18 x3no=7;
19 x3n1=8;
20 hn =[1 2]; //Here length of impulse response array h
      (n) is 2 (i.e. M=2) or Nh=2
21 //Length of each partitioned input i.e x0n to x3n is
      2(i.e. L=2)
22 //Since Nx=8,Nh=2 and we know Nx=m*Nh(so 8=m*2)
      giving m=4;and so x(n) has been partitioned into
      4 blocks of length Nh=2
23 hno=1;
24 hn1=2;
25
26 a=xono*hno;
27 b=xon1*hno;
28 c=xono*hn1;
29 d=xon1*hn1;
30 yon=[a c+b d];
31 disp(yon,'yon=')
32
33 e=x1no*hno;
34 f=x1n1*hno;
35 g=x1no*hn1;
36 h=x1n1*hn1;
37 y1n=[e g+f h];
38 disp(y1n,'y1n=')
39
40 i=x2no*hno;
41 j=x2n1*hno;
42 k=x2no*hn1;
43 l=x2n1*hn1;
44 y2n=[i k+j l];
45 disp(y2n,'y2n=')
46
47 m=x3no*hno;
48 n=x3n1*hno;
49 o=x3no*hn1;
50 p=x3n1*hn1;
```

```
51 y3n=[m o+n p];
52 disp(y3n,'y3n=')
53
54 yon =[yon,0,0,0,0,0,0]
55 y1n =[0,0,y1n,0,0,0,0]
56 y2n =[0,0,0,0,y2n,0,0]
57 y3n =[0,0,0,0,0,0,y3n ]
58
59 yn=yon+ y1n+y2n+y3n
60 disp(yn,'So,the output using overlap add method(
      without using inbuilt functions) is y(n)= ')
```

Experiment: 11

Overlap Save Method For Sectioned Convolution Using Matrix Approach

Scilab code Solution 11.0 Experiment Number 11

```
1 //AIM: Overlap save method for sectioned convolution
      using matrix approach.
2 //Software version Scilab 5.5.2
3 //OS windows 10
4 clc;
5 clear;
6 xn =[1 2 -1 2 3 -2 -3 -1 1 1 2 -1]; //Nx=12
7 hn =[1 2 3];    //Nh=3
8 //L(approx.=)2*Nh,so L(approx.=)2*3
9 //So(approx=)6
10 //We consider the length as 5
11 //Nh-1=3-1=2
12 //So Nh-1 number of leading zeros to be added to x(n
     )
13 //So xn=[0 0 1 2 -1 2 3 -2 -3 -1 1 1 2 -1]
14 x0n =[0 0 1 2 -1]; //Partitioned input sequence
15 x1n =[2 -1 2 3 -2];//Partitioned input sequence
```

```
16 x2n =[3 -2 -3 -1 1];//Partitioned input sequence
17 x3n=[-1 1 1 2 -1];//Partitioned input sequence
18 x4n=[2 -1 0 0 0 ];//Partitioned input sequence
19 //Convolving each partitioned input sequence with hn
20 y0n =[0 -1 2 1 0; 0 0 -1 2 1; 1 0 0 -1 2; 2 1 0 0
      -1; -1 2 1 0 0]*[1;2;3;0;0];
21 disp(y0n,"y0n=")
22 y1n =[2 -2 3 2 -1; -1 2 -2 3 2; 2 -1 2 -2 3; 3 2 -1
      2 -2; -2 3 2 -1 2]*[1;2;3;0;0];
23 disp(y1n,"y1n=")
24 y2n =[3 1 -1 -3 -2; -2 3 1 -1 -3; -3 -2 3 1 -1;-1 -3
       -2 3 1; 1 -1 -3 -2 3]*[1;2;3;0;0];
25 disp(y2n,"y2n=")
26 y3n=[-1 -1 2 1 1;1 -1 -1 2 1; 1 1 -1 -1 2;2 1 1 -1
      -1; -1 2 1 1 -1]*[1;2;3;0;0];
27 disp(y3n,"y3n=")
28 y4n=[2 0 0 0 -1; -1 2 0 0 0; 0 -1 2 0 0; 0 0 -1 2 0;
       0 0 0 -1 2]*[1;2;3;0;0];
29 disp(y4n,"y4n=")
30 yn0 = y0n (3:5)
31 //(3:5) means that from yon,select the element from
      3rd to 5th
32 yn1 = y1n (3:5)
33 yn2 = y2n (3:5)
34 yn3 = y3n (3:5)
35 yn4 = y4n (3:5)
36 yn =[yn0;yn1;yn2;yn3;yn4] //Concatenating yno,yn1,
      yn2,yn3 and yn4
37 disp(yn,"y(n)=")
```