

Scilab Manual for
Discrete Time Signal Processing
by Prof Mr. Rajiv Suhas Tawde
Others
Mumbai University/padmabhushan
Vasantdada Patil Pratishthan'S College Of
Engineering (Pvppcoe)¹

Solutions provided by
Prof Mr. Rajiv Suhas Tawde
Others
Mumbai University/padmabhushan Vasantdada Patil Pratishthan'S College Of E

June 10, 2026

¹Funded 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 Linear Convolution Without Using Inbuilt Scilab Convolution Function	5
2 Derive The Four Point Twiddle Factor Matrix	7
3 Four Point Dit-Fft Without Using Inbuilt Scilab Fft Function	9
4 Four Point Idit-Fft Without Using Inbuilt Scilab Fft Function	11
5 Four Point Dif-Fft Without Using Inbuilt Scilab Fft Function	16
6 Four Point Idif-Fft Without Using Inbuilt Scilab Fft Function	18
7 Derive The Six Point Twiddle Factor Matrix [w6] Useful For Dft Computation	23
8 Derive The Eight Point Twiddle Factor Matrix For Computing Inverse Dft	26
9 Filtering Of Long Data Sequences	30
10 Implement Impulse Invariant Method	40

11 To Design Butterworth Filter With Minimum Readymade Scilab Functions	43
12 To Design Chebyshev Filter With Minimum Readymade Scilab Functions.	46
13 Designing Two Stage Decimator	50
14 Compute Dft Using Matrix Approach And Then Using Dft Properties.	54

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	11
Solution 4.1	Experiment Number 4 extra solution	13
Solution 5.0	Experiment Number 5	16
Solution 6.0	Experiment Number 6	18
Solution 6.1	Experiment Number 6 extra solution	20
Solution 7.0	Experiment Number 7	23
Solution 8.0	Experiment Number 8	26
Solution 9.0	Experiment Number 9	30
Solution 10.0	Experiment Number 10	40
Solution 11.0	Experiment Number 11	43
Solution 12.0	Experiment Number 12	46
Solution 13.0	Experiment Number 13	50
Solution 14.0	Experiment Number 14	54

Experiment: 1

Linear Convolution Without Using Inbuilt Scilab Convolution Function

Scilab code Solution 1.0 Experiment Number 1

```
1 //AIM:Linear convolution without using inbuilt
   Scilab convolution function.
2 //Software version Scilab 5.5.2
3 //OS windows 10
4 clc;
5 clear;
6 //Given that  $x(n) = \{1, 2, 3, 4, 5, 6, 7, 8\}$  and  $h(n) = \{1, 2\}$ 
7 //Soln:
8 x0=1;
9 x1=2;
10 x2=3;
11 x3=4;
12 x4=5;
13 x5=6;
14 x6=7;
15 x7=8;
16 h0=1;
```

```
17 h1=2;
18 xhn0_a=x0*h0;
19 xhn1_a=x1*h0;
20 xhn2_a=x2*h0;
21 xhn3_a=x3*h0;
22 xhn4_a=x4*h0;
23 xhn5_a=x5*h0;
24 xhn6_a=x6*h0;
25 xhn7_a=x7*h0;
26
27 xhn0_b=x0*h1;
28 xhn1_b=x1*h1;
29 xhn2_b=x2*h1;
30 xhn3_b=x3*h1;
31 xhn4_b=x4*h1;
32 xhn5_b=x5*h1;
33 xhn6_b=x6*h1;
34 xhn7_b=x7*h1;
35
36 y0=xhn0_a;
37 y1=xhn0_b+xhn1_a;
38 y2=xhn1_b+xhn2_a;
39 y3=xhn2_b+xhn3_a;
40 y4=xhn3_b+xhn4_a;
41 y5=xhn4_b+xhn5_a;
42 y6=xhn5_b+xhn6_a;
43 y7=xhn6_b+xhn7_a;
44 y8=xhn7_b;
45 disp({,y0,y1,y2,y3,y4,y5,y6,y7,y8,},'Output of
      linear convolution i.e y(n)=')
```

Experiment: 2

Derive The Four Point Twiddle Factor Matrix

Scilab code Solution 2.0 Experiment Number 2

```
1 //AIM: Derive the 4 point twiddle factor matrix.
2 //Software version Scilab 5.5.2
3 //OS windows 10
4 clc;
5 clear;
6 W40=cos(0)-(sqrt(-1)*sin(0));
7 W41=cos(%pi/2)-(sqrt(-1))*(sin(%pi/2));
8 W42=cos(%pi)-(sqrt(-1))*(sin(%pi));
9 W43=cos((3*%pi)/2)-(sqrt(-1))*sin((3*%pi)/2);
10
11 disp(W40, 'W40=')
12 disp(W41, 'W41=')
13 disp(W42, 'W42=')
14 disp(W43, 'W43=')
15
16 W44=W40;
17 W49=W41;
18 W46=W42;
19
```

```

20 W4_raw_matrix= [W40 W40 W40 W40;
21                 W40 W41 W42 W43;
22                 W40 W42 W44 W46;
23                 W40 W43 W46 W49]
24 disp(W4_raw_matrix, 'W4_raw_matrix=')
25 disp('Type resume in console and press enter')
26 pause
27 a=ceil(- 1.225D-16);
28 disp(a, 'Imaginary part of W42 & Imaginary part of
        W46 i.e. ceil(- 1.225D-16)=')
29 b=ceil(- 1.837D-16);
30 disp(b, 'Real part of W43 i.e. ceil(- 1.837D-16)=')
31 c=int(6.123D-17);
32 disp(c, 'Real part of W41 & Real part of W49 i.e. int
        (6.123D-17)=')
33
34 //So W4 can be modified as follows :
35 d=real(W42); //Imaginary part is ignored since it is
        zero
36 e=imag(W43)*sqrt(-1); //Real part is ignored since it
        is zero
37 f=imag(W41)*(sqrt(-1)); //Real part is ignored since
        it is zero
38
39 W4=[W40 W40 W40 W40;
40     W40 f d e;
41     W40 d W44 d;
42     W40 e d f]
43 disp(W4, 'Final W4 matrix =')

```

Experiment: 3

Four Point Dit-Fft Without Using Inbuilt Scilab Fft Function

Scilab code Solution 3.0 Experiment Number 3

```
1 //AIM:Four point DIT-FFT without using inbuilt
   Scilab FFT function
2
3 //Computing four point DFT for x(n)={1,2,3,4} using
   Decimation in Time-Fast
4 //Fourier transform (i.e. DIT-FFT )
5 //without using readymade inbuilt Scilab functions
   for DFT/FFT.
6
7 //Software version Scilab 5.5.2
8 //OS windows 10
9 clc;
10 clear;
11 //Let us begin with the programming.For
   understanding,let us write the given
12 //data as
13 //x(0)=1;x(1)=2,x(2)=3,x(3)=4
```

```

14 x0=1;
15 x2=3;
16 x1=2;
17 x3=4;
18 //Stage I computation
19 x0a=x2+x0;//Computing Stage-I output at position 1
20 disp(x0a,'Stage-I output at position 1')
21 x2b=(x2-x0)*(-1);//Computing Stage-I output at
    position 2
22 disp(x2b,'Stage-I output at position 2')
23 x1c=x3+x1;//Computing Stage-I output at position 3
24 disp(x1c,'Stage-I output at position 3')
25 x3d=(x3-x1)*(-1);//Computing Stage-I output at
    position 4
26 disp(x3d,'Stage-I output at position 4')
27 //Stage-II computation
28 x3d1=x3d*(-sqrt(-1));// Multiply by (-j) in the last
    line
29 disp(x3d1,'Stage-II input at the fourth line ')
30 X0=x1c+x0a;//Computing final stage output value X(0)
31 disp(X0,'The final stage output X(0)=')
32 X1=x3d1+x2b;//Computing final stage output value X
    (1)
33 disp(X1,'The final stage output X(1)=')
34 X2=(x1c-x0a)*(-1);//Computing final stage output
    value X(2)
35 disp(X2,'The final stage output X(2)=')
36 X3=(x3d1-x2b)*(-1);//Computing final stage output
    value X(3)
37 disp(X3,'The final stage output X(3)=')
38 disp({,X0,X1,X2,X3,},'So,the DFT of x(n) using
    Decimation-in-Time Fast Fourier Transform(DIT-FFT
    ) is X(k)=')

```

Experiment: 4

Four Point Idit-Fft Without Using Inbuilt Scilab Fft Function

Scilab code Solution 4.0 Experiment Number 4

```
1 //AIM: Four point IDIT-FFT without using inbuilt
   Scilab FFT function
2
3 //Computing four point IDFT for X(k)={10,-2+2j
   ,-2,-2-2j} using
4 //Inverse Decimation in Time-Fast Fourier transform
   (i.e. IDIT-FFT )
5 //without using readymade inbuilt Scilab functions
   for IDFT/IFFT.
6
7 //Software version Scilab 5.5.2
8 //OS windows 10
9 clc;
10 clear;
11 //Let us begin with the programming.For
   understanding,let us write the given
12 //data as
```

```

13 //X(0)=10;X(1)=-2+2j ,X(2)=-2,X(3)=-2-2j
14 X0c=10; //X0c means complex conjugate of X0
15 X2c=-2; //X2c means complex conjugate of X2
16 X1c=(-2)+((-1)*(2)*(sqrt(-1))); //X1c means complex
    conjugate of X1
17 X3c=(-2)-((-1)*(2)*(sqrt(-1))); //X3c means complex
    conjugate of X3
18 disp(X0c, 'X*(0)=')
19 disp(X2c, 'X*(2)=')
20 disp(X1c, 'X*(1)=')
21 disp(X3c, 'X*(3)=')
22 x0_star=((X3c+X1c)*(1))+((X2c+X0c)*(1))*(1/4)
23 disp(x0_star, 'x*(0)=')
24 x1_star=((X3c-X1c)*(-1)*(-sqrt(-1)))+(X2c-X0c)*(-1)
    )*(1/4);
25 disp(x1_star, 'x*(1)=')
26 x2_star=((X3c+X1c)*(1)-(X2c+X0c))*(-1))*(1/4);
27 disp(x2_star, 'x*(2)=')
28 x3_star((((X3c-X1c)*(-1)*(-sqrt(-1)))-((X2c-X0c)
    *(-1)))*(-1))*(1/4);
29 disp(x3_star, 'x*(3)=')
30 disp({,x0_star,x1_star,x2_star,x3_star,},'x*(n)=')
31 //The computed value is x*(n). But we need x(n) as
    final output.
32 //We will separate real part of x*(n)
33 //We will separate imaginary part of x*(n) and take
    its complex conjugate by
34 //multiplying by a factor of (-1)
35 x0_star_real=real(x0_star);
36 x0_star_conj=(-1)*(imag(x0_star));
37 x1_star_real=real(x1_star);
38 x1_star_conj=(-1)*(imag(x1_star));
39 x2_star_real=real(x2_star);
40 x2_star_conj=(-1)*(imag(x2_star));
41 x3_star_real=real(x3_star);
42 x3_star_conj=(-1)*(imag(x3_star));
43 //Finally, we will add the real part and the
    imaginary part whose complex

```

```

44 //conjugate is taken to get x(0),(1),x(2) and x(3)
45 x0=x0_star_real+x0_star_conj
46 x1=x1_star_real+x1_star_conj
47 x2=x2_star_real+x2_star_conj
48 x3=x3_star_real+x3_star_conj
49 disp({,x0,x1,x2,x3,},'So,the IDFT of X(k) using
      Inverse Decimation-in-Time Fast Fourier Transform
      (IDIT-FFT) is x(n)=')

```

Scilab code Solution 4.1 Experiment Number 4 extra solution

```

1 //AIM:Four point IDIT-FFT without using inbuilt
  Scilab FFT function
2 // (This is an extra solution)
3
4 //Computing four point IDFT for X(k)={10,-2+2j
  ,-2,-2-2j} using
5 //Inverse Decimation in Time-Fast Fourier transform
  (i.e. IDIT-FFT )
6 //without using readymade inbuilt Scilab functions
  for IDFT/IFFT.
7
8 //Software version Scilab 5.5.2
9 //OS windows 10
10 clc;
11 clear;
12 //Let us begin with the programming.For
  understanding,let us write the given
13 //data as
14 //X(0)=10;X(1)=-2+2j ,X(2)=-2,X(3)=-2-2j
15 X0_conj=10;//X0_conj means complex conjugate of X0
16 X2_conj=-2;//X2_conj means complex conjugate of X2
17 X1_conj=(-2)+((-1)*(2)*(sqrt(-1)));//X1_conj means
  complex conjugate of X1
18 X3_conj=(-2)-((-1)*(2)*(sqrt(-1)));//X3_conj means

```

```

        complex conjugate of X3
19 disp(X0_conj, 'X*(0)=')
20 disp(X2_conj, 'X*(2)=')
21 disp(X1_conj, 'X*(1)=')
22 disp(X3_conj, 'X*(3)=')
23 //Stage I computation
24 X0a=X2_conj+X0_conj;//Computing Stage-I output at
    line 1
25 disp(X0a, 'Stage-I output at line 1')
26 X2b=(X2_conj-X0_conj)*(-1);//Computing Stage-I
    output at line 2
27 disp(X2b, 'Stage-I output at line 2')
28 X1c=X3_conj+X1_conj;//Computing Stage-I output at
    line 3
29 disp(X1c, 'Stage-I output at line 3')
30 X3d=(X3_conj-X1_conj)*(-1);//Computing Stage-I
    output at line 4
31 disp(X3d, 'Stage-I output at line 4')
32 //Stage II computation
33 X3d1=X3d*(-sqrt(-1));// Multiply by (-j) in the last
    line
34 disp(X3d1, 'Stage-II input at the fourth line ')
35 x0_star=X1c+X0a;//Computing stage-II output value at
    line 1
36 disp(x0_star, 'The stage-II output value at line 1=')
37 x1_star=X3d1+X2b;//Computing stage-II output value
    at line 2
38 disp(x1_star, 'The stage-II output value at line 2 =')
    )
39 x2_star=(X1c-X0a)*(-1);//Computing stage-II output
    value at line 3
40 disp(x2_star, 'The stage-II output value at line 3=')
41 x3_star=(X3d1-X2b)*(-1);//Computing stage-II output
    value at line 4
42 disp(x3_star, 'The stage-II output value at line 4=')
43 //Now we will multiply stage-II output values
    individually with a factor of
44 //(1/N). Here N=4, So we will multiply by (1/4)

```

```

45 x0_star_on_multiplication=(1/4)*(x0_star); // Multiply
    by(1/4)
46 disp(x0_star_on_multiplication, 'x*(0)=')
47 x1_star_on_multiplication=(1/4)*(x1_star); // Multiply
    by(1/4)
48 disp(x1_star_on_multiplication, 'x*(1)=')
49 x2_star_on_multiplication=(1/4)*(x2_star); // Multiply
    by(1/4)
50 disp(x2_star_on_multiplication, 'x*(2)=')
51 x3_star_on_multiplication=(1/4)*(x3_star); // Multiply
    by(1/4)
52 disp(x3_star_on_multiplication, 'x*(3)=')
53 disp({,x0_star_on_multiplication,
        x1_star_on_multiplication,
        x2_star_on_multiplication,
        x3_star_on_multiplication,}, 'x*(n)=')
54 x0_star_real=real(x0_star_on_multiplication);
55 x0_star_conj=(-1)*(imag(x0_star_on_multiplication));
56 x1_star_real=real(x1_star_on_multiplication);
57 x1_star_conj=(-1)*(imag(x1_star_on_multiplication));
58 x2_star_real=real(x2_star_on_multiplication);
59 x2_star_conj=(-1)*(imag(x2_star_on_multiplication));
60 x3_star_real=real(x3_star_on_multiplication);
61 x3_star_conj=(-1)*(imag(x3_star_on_multiplication));
62 x0=x0_star_real+x0_star_conj
63 x1=x1_star_real+x1_star_conj
64 x2=x2_star_real+x2_star_conj
65 x3=x3_star_real+x3_star_conj
66 disp({,x0,x1,x2,x3,}, 'So, the IDFT of X(k) using
    Inverse Decimation-in-Time Fast Fourier Transform
    (IDIT-FFT) is x(n)=')

```

Experiment: 5

Four Point Dif-Fft Without Using Inbuilt Scilab Fft Function

Scilab code Solution 5.0 Experiment Number 5

```
1 //AIM:Four point DIF-FFT without using inbuilt
   Scilab FFT function
2
3 //Computing four point DFT for x(n)={1,2,3,4} using
4 //Decimation in Frequency-Fast Fourier transform (i.
   e. DIF-FFT )without using
5 //readymade inbuilt Scilab functions for DFT/FFT.
6
7 //Software version Scilab 5.5.2
8 //OS windows 10
9 clc;
10 clear;
11 x0=1;
12 x1=2;
13 x2=3;
14 x3=4;
15 //Stage I computation
```

```

16 x0a=x2+x0;//Computing Stage-I output at position 1
17 disp(x0a,'Stage-I output at position 1')
18 x1b=(x3+x1);//Computing Stage-I output at position 2
19 disp(x1b,'Stage-I output at position 2')
20 x2c=(x2-x0)*(-1);//Computing Stage-I output at
    position 3
21 disp(x2c,'Stage-I output at position 3')
22 x3d=(x3-x1)*(-1);//Computing Stage-I output at
    position 4
23 disp(x3d,'Stage-I output at position 4')
24 //Stage-II computation
25 x3d1=x3d*(-sqrt(-1));// Multiply by (-j) in the last
    line
26 disp(x3d1,'Stage-II input at the fourth line ')
27 X0=x1b+x0a;//Computing final stage output value X(0)
28 disp(X0,'The final stage output X(0)=')
29 X2=(x1b-x0a)*(-1);//Computing final stage output
    value X(1)
30 disp(X2,'The final stage output X(2)=')
31 X1=(x3d1+x2c);//Computing final stage output value X
    (2)
32 disp(X1,'The final stage output X(1)=')
33 X3=(x3d1-x2c)*(-1);//Computing final stage output
    value X(3)
34 disp(X3,'The final stage output X(3)=')
35 disp({,X0,X1,X2,X3,},'So,the DFT of x(n) using
    Decimation-in-Frequency Fast Fourier Transform (
    DIF-FFT) is X(k)=')

```

Experiment: 6

Four Point Idif-Fft Without Using Inbuilt Scilab Fft Function

Scilab code Solution 6.0 Experiment Number 6

```
1 //AIM:Four point IDIF-FFT without using inbuilt
   Scilab FFT function
2
3 //Computing four point IDFT for X(k)={10,-2+2j
   ,-2,-2-2j} using
4 //Inverse Decimation in Frequency-Fast Fourier
   transform (i.e. IDIF-FFT )
5 //without using readymade inbuilt Scilab functions
   for IDFT/IFFT.
6
7 //Software version Scilab 5.5.2
8 //OS windows 10
9 clc;
10 clear;
11 //Let us begin with the programming.For
   understanding,let us write the given
12 //data as
```

```

13 //X(0)=10;X(1)=-2+2j ,X(2)=-2,X(3)=-2-2j
14 X0c=10; //X0c means complex conjugate of X0
15 X1c=(-2)+((-1)*(2)*(sqrt(-1))); //X1c means complex
    conjugate of X1
16 X2c=-2; //X2c means complex conjugate of X2
17 X3c=(-2)-((-1)*(2)*(sqrt(-1))); //X3c means complex
    conjugate of X3
18 disp(X0c, 'X*(0)=')
19 disp(X1c, 'X*(1)=')
20 disp(X2c, 'X*(2)=')
21 disp(X3c, 'X*(3)=')
22 x0_star=((X3c+X1c)*(1)+(X2c+X0c)*(1))*(1/4); //
    Computing x*(0)
23 disp(x0_star, 'x*(0)=')
24 x2_star=(((X3c+X1c)*(1))-((X2c+X0c)*(1)))*(-1))
    *(1/4); //Computing x*(2)
25 disp(x2_star, 'x*(2)=')
26 x1_star=((X3c-X1c)*(-1)*(-sqrt(-1))+(X2c-X0c)*(-1))
    *(1/4); //Computing x*(1)
27 disp(x1_star, 'x*(1)=')
28 //Computing x*(3)
29 x3_star=(((X3c-X1c)*(-1)*(-sqrt(-1))-(X2c-X0c)*(-1)
    ))*(-1))*(1/4);
30 disp(x3_star, 'x*(3)=')
31 disp({,x0_star,x1_star,x2_star,x3_star,},'x*(n)=')
32 //The computed value is x*(n). But we need x(n) as
    final output.
33 //We will separate real part of x*(n)
34 //We will separate imaginary part of x*(n) and take
    its complex conjugate by
35 //multiplying by a factor of (-1)
36 x0_star_real=real(x0_star);
37 x0_star_conj=(-1)*(imag(x0_star));
38 x1_star_real=real(x1_star);
39 x1_star_conj=(-1)*(imag(x1_star));
40 x2_star_real=real(x2_star);
41 x2_star_conj=(-1)*(imag(x2_star));
42 x3_star_real=real(x3_star);

```

```

43 x3_star_conj=(-1)*(imag(x3_star));
44 //Finally , we will add the real part and the
    imaginary part whose complex
45 //conjugate is taken to get xx(0),(1),x(2) and x(3)
46 x0=x0_star_real+x0_star_conj;//Computing x(0)
47 x1=x1_star_real+x1_star_conj;//Computing x(1)
48 x2=x2_star_real+x2_star_conj;//Computing x(2)
49 x3=x3_star_real+x3_star_conj;//Computing x(3)
50 disp({,x0,x1,x2,x3,},'So,the IDFT of X(k) using
    Inverse Decimation-in-Frequency Fast Fourier
    Transform(IDIF-FFT) is x(n)=')

```

Scilab code Solution 6.1 Experiment Number 6 extra solution

```

1 //AIM:Four point IDIF-FFT without using inbuilt
    Scilab FFT function
2 // (This is an extra solution)
3
4 //Computing four point IDFT for X(k)={10,-2+2j
    ,-2,-2-2j} using Inverse
5 //Decimation in Frequency-Fast Fourier transform (i.
    e. IDIF-FFT )
6 //without using readymade inbuilt Scilab functions
    for IDFT/IFFT.
7
8 //Software version Scilab 5.5.2
9 //OS windows 10
10 clc;
11 clear;
12 //Let us begin with the programming.For
    understanding ,let us write the given
13 //data as
14 //X(0)=10;X(1)=-2+2j ,X(2)=-2,X(3)=-2-2j
15 X0_conj=10;//X0_conj means complex conjugate of X(O)
16 X1_conj=(-2)+((-1)*(2)*(sqrt(-1)));//X1_conj means

```

```

        complex conjugate of X(1)
17 X2_conj=-2; //X2_conj means complex conjugate of X(2)
18 X3_conj=(-2)-((-1)*(2)*(sqrt(-1))); //X3_conj means
        complex conjugate of X(3)
19 disp(X0_conj, 'X*(0)=')
20 disp(X1_conj, 'X*(1)=')
21 disp(X2_conj, 'X*(2)=')
22 disp(X3_conj, 'X*(3)=')
23 //Stage I computation
24 X0a=X2_conj+X0_conj; //Computing Stage-I output at
        line 1
25 disp(X0a, 'Stage-I output at line 1')
26 X1b=(X3_conj+X1_conj); //Computing Stage-I output at
        line 2
27 disp(X1b, 'Stage-I output at line 2')
28 X2c=(X2_conj-X0_conj)*(-1); //Computing Stage-I
        output at line 3
29 disp(X2c, 'Stage-I output at line 3')
30 X3d=(X3_conj-X1_conj)*(-1); //Computing Stage-I
        output at line 4
31 disp(X3d, 'Stage-I output at line 4')
32 //Stage II computation
33 X3d1=X3d*(-sqrt(-1)); // Multiply by (-j) in the last
        line
34 disp(X3d1, 'Stage-II input at the fourth line ')
35 x0_conj=X1b+X0a; //Computing stage-II output value at
        line 1
36 disp(x0_conj, 'The stage-II output value at line 1=')
37 x2_conj=(X1b-X0a)*(-1); //Computing stage-II output
        value at line 2
38 disp(x2_conj, 'The stage-II output value at line 2=')
39 x1_conj=X3d1+X2c; //Computing stage-II output value
        at line 3
40 disp(x1_conj, 'The stage-II output value at line 3=')
41 x3_conj=(X3d1-X2c)*(-1); //Computing stage-II output
        value at line 4
42 disp(x3_conj, 'The stage-II output value at line 4=')
43 //Now we will multiply stage-II output values

```

```

        individually with a factor of
44 // (1/N). Here N=4,So we will multiply by (1/4)
45 x0_conj_final=(1/4)*(x0_conj)
46 disp(x0_conj_final,'x*(0)=')
47 x2_conj_final=(1/4)*(x2_conj)
48 disp(x2_conj_final,'x*(2)=')
49 x1_conj_final=(1/4)*(x1_conj)
50 disp(x1_conj_final,'x*(1)=')
51 x3_conj_final=(1/4)*(x3_conj)
52 disp(x3_conj_final,'x*(3)=')
53 disp({,x0_conj_final,x1_conj_final,x2_conj_final,
        x3_conj_final,},'So,the IDFT of X(k) using
        Inverse Decimation-in-Frequency Fast Fourier
        Transform(IDIF-FFT) is x(n)=')

```

Experiment: 7

Derive The Six Point Twiddle Factor Matrix [w6] Useful For Dft Computation

Scilab code Solution 7.0 Experiment Number 7

```
1 //AIM:Derive the six point twiddle factor matrix [W6
  ] useful for DFT computation
2 //Software version Scilab 5.5.2
3 //OS windows 10
4 clc;
5 clear;
6 //Computing the twiddle factor values for W60,W61,
  W62, W63, W64, W65 :
7 W60=int(cos(0))-(sqrt(-1)*int(sin(0)));
8 W61=cos((2*%pi*1)/6)-(sqrt(-1))*sin((2*%pi*1)/6);
9 W62=(cos((2*%pi*2)/6))-(sqrt(-1))*sin((2*%pi*2)/6);
10 W63=cos((2*%pi*3)/6)-int((sqrt(-1))*sin((2*%pi*3)/6)
  );
11 W64=cos((2*%pi*4)/6)-(sqrt(-1))*(sin((2*%pi*4)/6));
12 W65=cos((2*%pi*5)/6)-(sqrt(-1))*sin((2*%pi*5)/6);
13
14 disp(W60, 'W60=')
```

```

15 disp(W61, 'W61=')
16 disp(W62, 'W62=')
17 disp(W63, 'W63=')
18 disp(W64, 'W64=')
19 disp(W65, 'W65=')
20
21 //W60=W612=W618=W624=W630=W636;// Cyclic property of
    twiddle factor
22 W66=W60;
23 W612=W66;
24 W618=W612;
25 W624=W618;
26 W630=W624;
27 W636=W630;
28
29 //W61=W67=W613=W619=W625 //Cyclic property of
    twiddle factor
30 W67=W61;
31 W613=W67;
32 W619=W613;
33 W625=W619;
34
35 //W62=W68=W614=W620 //Cyclic property of twiddle
    factor
36 W68=W62;
37 W614=W68;
38 W620=W614;
39
40 //W63=W69=W615=W621 //Cyclic property of twiddle
    factor
41 W69=W63;
42 W615=W69;
43 W621=W615;
44
45 //W64=W610=W616=W622 //Cyclic property of twiddle
    factor
46 W610=W64;
47 W616=W610;

```

```
48 W622=W616;
49
50 //W65=W613=W621=W629 //Cyclic property of twiddle
    factor
51 W613=W65;
52 W621=W613;
53 W629=W621;
54
55 W6= [W60 W60 W60 W60 W60 W60;W60 W61 W62 W63 W64 W65
      ;W60 W62 W64 W66 W68 W610;W60 W63 W66 W69 W612
      W615;W60 W64 W68 W612 W616 W620;W60 W65 W610 W615
      W620 W625];
56 //Displaying the W6 matrix :
57 disp(W6, '[W6]=')
```

Experiment: 8

Derive The Eight Point Twiddle Factor Matrix For Computing Inverse Dft

Scilab code Solution 8.0 Experiment Number 8

```
1 //AIM: Derive the 8 point twiddle factor matrix for
   computing inverse DFT
2
3 // i.e. W8* matrix derivation
4
5 //Software version Scilab 5.5.2
6 //OS windows 10
7 clc;
8 clear;
9 //Computing the twiddle factor values for W80,W81,
   W82, W83, W84, W85, W86, W87 :
10 W80=int(cos(0))+(sqrt(-1)*int(sin(0)));
11 W81=cos((2*%pi*1)/8)+(sqrt(-1))*sin((2*%pi*1)/8);
12 W82=int(cos((2*%pi*2)/8))+(sqrt(-1))*sin((2*%pi*2)
   /8);
13 W83=cos((2*%pi*3)/8)+(sqrt(-1))*sin((2*%pi*3)/8);
14 W84=cos((2*%pi*4)/8)+(sqrt(-1))*int(sin((2*%pi*4)/8))
```

```

    );
15 W85=cos((2*%pi*5)/8)+(sqrt(-1))*sin((2*%pi*5)/8);
16 W86=int(cos((2*%pi*6)/8)+(sqrt(-1))*sin((2*%pi*6)
    /8);
17 W87=cos((2*%pi*7)/8)+(sqrt(-1))*sin((2*%pi*7)/8);
18
19 disp(W80, 'W80=')
20 disp(W81, 'W81=')
21 disp(W82, 'W82=')
22 disp(W83, 'W83=')
23 disp(W84, 'W84=')
24 disp(W85, 'W85=')
25 disp(W86, 'W86=')
26 disp(W87, 'W87=')
27
28 //W80=W88=W816=W824=W832=W840=W848;// Cyclic property
    of twiddle factor
29 W88=W80;
30 W816=W88;
31 W824=W816;
32 W832=W824;
33 W840=W832;
34 W848=W840;
35
36 //W81=W89=W817=W825=W833=W841=W849;// Cyclic property
    of twiddle factor
37 W89=W81;
38 W817=W89;
39 W825=W817;
40 W833=W825;
41 W841=W833;
42 W849=W841;
43
44 //W82=W810=W818=W826=W834=W842;// Cyclic property of
    twiddle factor
45 W810=W82;
46 W818=W810;
47 W826=W818;

```

```

48 W834=W826;
49 W842=W834;
50
51 //W83=W811=W819=W827=W835=W843;// Cyclic property of
    twiddle factor
52 W811=W83;
53 W819=W811;
54 W827=W819;
55 W835=W827;
56 W843=W835;
57
58 //W84=W812=W820=W828=W836=W844;// Cyclic property of
    twiddle factor
59 W812=W84;
60 W820=W812;
61 W828=W820;
62 W836=W828;
63 W844=W836;
64
65 //W85=W813=W821=W829=W837=W845;// Cyclic property of
    twiddle factor
66 W813=W85;
67 W821=W813;
68 W829=W821;
69 W837=W829;
70 W845=W837;
71
72 //W86=W814=W822=W830=W838=W846;// Cyclic property of
    twiddle factor
73 W814=W86;
74 W822=W814;
75 W830=W822;
76 W838=W830;
77 W846=W838;
78
79 //W87=W815=W823=W831=W839=W847;// Cyclic property of
    twiddle factor
80 W815=W87;

```

```
81 W823=W815;
82 W831=W823;
83 W839=W831;
84 W847=W839;
85
86 W8_star= [W80 W80 W80 W80 W80 W80 W80 W80;W80 W81
            W82 W83 W84 W85 W86 W87;W80 W82 W84 W86 W88 W810
            W812 W814;W80 W83 W86 W89 W812 W815 W818 W821;W80
            W84 W88 W812 W816 W820 W824 W828;W80 W85 W810
            W815 W820 W825 W830 W835;W80 W86 W812 W818 W824
            W830 W836 W842;W80 W87 W814 W821 W828 W835 W842
            W849];
87
88 disp(W8_star, '[W8*]=')
```

Experiment: 9

Filtering Of Long Data Sequences

Scilab code Solution 9.0 Experiment Number 9

```
1 //AIM: Filtering of long data sequences
2
3 //Overlap-add method using FFT-IFFT technique(
  without using inbuilt Scilab
4 //functions for DFT/IDFT or FFT/IFFT)
5
6 //Software version Scilab 5.5.2
7 //OS windows 10
8 clc;
9 clear;
10 //Given that  $x(n)=\{1,2,3,4,5,6,7,8\}$  and  $h(n)=\{1,2\}$ 
11 //Soln:
12 xn =[1 2 3 4 5 6 7 8]; //Nx=8
13 hn =[1 2];
14 //Since  $N_x=8, N_h=2$  and we know  $N_x=m*N_h$ (so  $8=m*2$ )
  giving  $m=4$ ;and so  $x(n)$  has been
15 //partitioned into 4 blocks of length  $N_h=2$ 
16 x0n =[1 2];
17 x1n =[3 4];
```

```

18 x2n =[5 6];
19 x3n =[7 8];
20 //Length of each partitioned input i.e x0n,x1n,x2n
    and x3n is 2(i.e. L=2)
21 //Here length of impulse response array h(n) is 2 (i
    .e. M=2) or Nh=2
22 //Hence,we pad the partitioned sequence and h(n)
    with zeros such that the length
23 // of each one becomes 'atleast' L+M-1 i.e. 3
24 //But since we know 4 point DFT matrix,we can pad an
    additional zero & make the
25 //length of each sequence =4
26 x0n_z=[1 2 0 0];//x0n_z represents zero pad is done
    to x0n
27 x1n_z=[3 4 0 0];//x1n_z represents zero pad is done
    to x1n
28 x2n_z=[5 6 0 0];//x2n_z represents zero pad is done
    to x2n
29 x3n_z=[7 8 0 0];//x3n_z represents zero pad is done
    to x3n
30 hn_z=[1 2 0 0];//hn_z represents zero pad is done to
    hn
31
32 //Computing FFT for x0n_z
33 x0n_z_0=1;//x0n_z_0 represents the 0th sample of
    x0n_z
34 x0n_z_1=2;//x0n_z_1 represents the 1st sample of
    x0n_z
35 x0n_z_2=0;//x0n_z_2 represents the 2nd sample of
    x0n_z
36 x0n_z_3=0;//x0n_z_3 represents the 3rd sample of
    x0n_z
37 X0_0=(x0n_z_2+x0n_z_0)*(1)+(x0n_z_3+x0n_z_1)*(1)
38 X0_1=(x0n_z_3-x0n_z_1)*(-1)*(-sqrt(-1))+(x0n_z_2-
    x0n_z_0)*(-1);
39 X0_2=((x0n_z_3+x0n_z_1)*(1)-(x0n_z_2+x0n_z_0)*(1))
    *(-1);
40 X0_3=((x0n_z_3-x0n_z_1)*(-1)*(-sqrt(-1))-(x0n_z_2-

```

```

    x0n_z_0)*(-1))*(-1);
41 disp({'X0_0,X0_1,X0_2,X0_3'}, 'So, the DFT of x0(n)
    using Decimation-in-Time Fast Fourier Transform (
    DIT-FFT) is X0(k)=')
42
43 //Computing FFT for x1n_z
44 x1n_z_0=3; //x1n_z_0 represents the 0th sample of
    x1n_z
45 x1n_z_1=4; //x1n_z_1 represents the 1st sample of
    x1n_z
46 x1n_z_2=0; //x1n_z_2 represents the 2nd sample of
    x1n_z
47 x1n_z_3=0; //x1n_z_3 represents the 3rd sample of
    x1n_z
48 X1_0=(x1n_z_2+x1n_z_0)*(1)+(x1n_z_3+x1n_z_1)*(1)
49 X1_1=(x1n_z_3-x1n_z_1)*(-1)*(-sqrt(-1))+(x1n_z_2-
    x1n_z_0)*(-1);
50 X1_2=((x1n_z_3+x1n_z_1)*(1)-(x1n_z_2+x1n_z_0)*(1))
    *(-1);
51 X1_3=((x1n_z_3-x1n_z_1)*(-1)*(-sqrt(-1))-(x1n_z_2-
    x1n_z_0)*(-1))*(-1);
52 disp({'X1_0,X1_1,X1_2,X1_3'}, 'So, the DFT of x1(n)
    using Decimation-in-Time Fast Fourier Transform (
    DIT-FFT) is X1(k)=')
53
54 //Computing FFT for x2n_z
55 x2n_z_0=5; //x2n_z_0 represents the 0th sample of
    x2n_z
56 x2n_z_1=6; //x2n_z_1 represents the 1st sample of
    x2n_z
57 x2n_z_2=0; //x2n_z_2 represents the 2nd sample of
    x2n_z
58 x2n_z_3=0; //x2n_z_3 represents the 3rd sample of
    x2n_z
59 X2_0=(x2n_z_2+x2n_z_0)*(1)+(x2n_z_3+x2n_z_1)*(1)
60 X2_1=(x2n_z_3-x2n_z_1)*(-1)*(-sqrt(-1))+(x2n_z_2-
    x2n_z_0)*(-1);
61 X2_2=((x2n_z_3+x2n_z_1)*(1)-(x2n_z_2+x2n_z_0)*(1))

```

```

        *(-1);
62 X2_3=((x2n_z_3-x2n_z_1)*(-1)*(-sqrt(-1))-(x2n_z_2-
        x2n_z_0)*(-1))*(-1);
63 disp({' ,X2_0,X2_1,X2_2,X2_3,},'So,the DFT of x2(n)
        using Decimation-in-Time Fast Fourier Transform(
        DIT-FFT) is X2(k)=')
64
65 //Computing FFT for x3n_z
66 x3n_z_0=7;//x3n_z_0 represents the 0th sample of
        x3n_z
67 x3n_z_1=8;//x3n_z_1 represents the 1st sample of
        x3n_z
68 x3n_z_2=0;//x3n_z_2 represents the 2nd sample of
        x3n_z
69 x3n_z_3=0;//x3n_z_3 represents the 3rd sample of
        x3n_z
70 X3_0=(x3n_z_2+x3n_z_0)*(1)+(x3n_z_3+x3n_z_1)*(1)
71 X3_1=(x3n_z_3-x3n_z_1)*(-1)*(-sqrt(-1))+(x3n_z_2-
        x3n_z_0)*(-1);
72 X3_2=((x3n_z_3+x3n_z_1)*(1)-(x3n_z_2+x3n_z_0)*(1))
        *(-1);
73 X3_3=((x3n_z_3-x3n_z_1)*(-1)*(-sqrt(-1))-(x3n_z_2-
        x3n_z_0)*(-1))*(-1);
74 disp({' ,X3_0,X3_1,X3_2,X3_3,},'So,the DFT of x3(n)
        using Decimation-in-Time Fast Fourier Transform(
        DIT-FFT) is X3(k)=')
75
76 //Computing FFT for hn_z
77 hn_z_0=1;//hn_z_0 represents the 0th sample of hn_z
78 hn_z_1=2;//hn_z_1 represents the 1st sample of hn_z
79 hn_z_2=0;//hn_z_2 represents the 2nd sample of hn_z
80 hn_z_3=0;//hn_z_3 represents the 3rd sample of hn_z
81 Hk_0=(hn_z_2+hn_z_0)*(1)+(hn_z_3+hn_z_1)*(1)
82 Hk_1=(hn_z_3-hn_z_1)*(-1)*(-sqrt(-1))+(hn_z_2-hn_z_0
        )*(-1);
83 Hk_2=((hn_z_3+hn_z_1)*(1)-(hn_z_2+hn_z_0)*(1))*(-1);
84 Hk_3=((hn_z_3-hn_z_1)*(-1)*(-sqrt(-1))-(hn_z_2-
        hn_z_0)*(-1))*(-1);

```

```

85 disp({,Hk_0,Hk_1,Hk_2,Hk_3,},'So,the DFT of h(n)
      using Decimation-in-Time Fast Fourier Transform(
      DIT-FFT) is H(k)=')
86
87 Y0k0=(X0_0).*(Hk_0);
88 Y0k1=(X0_1).*(Hk_1);
89 Y0k2=(X0_2).*(Hk_2);
90 Y0k3=(X0_3).*(Hk_3);
91 Y0k=[Y0k0 Y0k1 Y0k2 Y0k3];
92 disp(Y0k,'Y0(k)=')
93
94 //Computing IDFT of Y0k using IDIT-FFT :
95
96 Y0k0_0c=real(Y0k0)-(sqrt(-1))*imag(Y0k0); //Y0K0_0c
      means complex conjugate of Y0k0
97 Y0k0_1c=real(Y0k1)-(sqrt(-1))*imag(Y0k1); //Y0K0_1c
      means complex conjugate of Y0k1
98 Y0k0_2c=real(Y0k2)-(sqrt(-1))*imag(Y0k2); //Y0K0_2c
      means complex conjugate of Y0k2
99 Y0k0_3c=real(Y0k3)-(sqrt(-1))*imag(Y0k3); //Y0K0_3c
      means complex conjugate of Y0k3
100
101 a0=(((Y0k0_3c+Y0k0_1c)*(1))+((Y0k0_2c+Y0k0_0c)*(1)))
      *(1/4);
102 a1=(((Y0k0_3c-Y0k0_1c)*(-1)*(-sqrt(-1)))+(Y0k0_2c-
      Y0k0_0c)*(-1))*(1/4);
103 a2=(((Y0k0_3c+Y0k0_1c)*(1)-(Y0k0_2c+Y0k0_0c))*(-1))
      *(1/4);
104 a3=((((Y0k0_3c-Y0k0_1c)*(-1)*(-sqrt(-1)))-((Y0k0_2c-
      Y0k0_0c)*(-1)))*(-1))*(1/4);
105
106 a0_real=real(a0);
107 a0_conj=(-1)*(imag(a0));
108 a1_real=real(a1);
109 a1_conj=(-1)*(imag(a1));
110 a2_real=real(a2);
111 a2_conj=(-1)*(imag(a2));
112 a3_real=real(a3);

```

```

113 a3_conj=(-1)*(imag(a3));
114 //Finally, we will add the real part and the
    imaginary part whose complex
115 //conjugate is taken
116 a0'=a0_real+a0_conj
117 a1'=a1_real+a1_conj
118 a2'=a2_real+a2_conj
119 a3'=a3_real+a3_conj
120 a=[a0',a1',a2',a3']
121 disp(a,'So, the IDFT of Y0(k) using Inverse
    Decimation-in-Time Fast Fourier Transform (IDIT-
    FFT) is y0(n)=')
122
123 Y1k0=(X1_0).*(Hk_0);
124 Y1k1=(X1_1).*(Hk_1);
125 Y1k2=(X1_2).*(Hk_2);
126 Y1k3=(X1_3).*(Hk_3);
127 Y1k=[Y1k0 Y1k1 Y1k2 Y1k3];
128 disp(Y1k,'Y1(k)=')
129
130 //Computing IDFT of Y1k using IDIT-FFT :
131 Y1k0_0c=real(Y1k0)-(sqrt(-1))*imag(Y1k0); //Y1K0_0c
    means complex conjugate of Y1k0
132 Y1k0_1c=real(Y1k1)-(sqrt(-1))*imag(Y1k1); //Y1K0_1c
    means complex conjugate of Y1k1
133 Y1k0_2c=real(Y1k2)-(sqrt(-1))*imag(Y1k2); //Y1K0_2c
    means complex conjugate of Y1k2
134 Y1k0_3c=real(Y1k3)-(sqrt(-1))*imag(Y1k3); //Y1K0_3c
    means complex conjugate of Y1k3
135
136 b0=(((Y1k0_3c+Y1k0_1c)*(1))+((Y1k0_2c+Y1k0_0c)*(1)))
    *(1/4);
137 b1=(((Y1k0_3c-Y1k0_1c)*(-1)*(-sqrt(-1)))+(Y1k0_2c-
    Y1k0_0c)*(-1))*(1/4);
138 b2=(((Y1k0_3c+Y1k0_1c)*(1)-(Y1k0_2c+Y1k0_0c))*(-1))
    *(1/4);
139 b3=(((Y1k0_3c-Y1k0_1c)*(-1)*(-sqrt(-1)))-((Y1k0_2c-
    Y1k0_0c)*(-1)))*(-1))*(1/4);

```

```

140
141 b0_real=real(b0);
142 b0_conj=(-1)*(imag(b0));
143 b1_real=real(b1);
144 b1_conj=(-1)*(imag(b1));
145 b2_real=real(b2);
146 b2_conj=(-1)*(imag(b2));
147 b3_real=real(b3);
148 b3_conj=(-1)*(imag(b3));
149 //Finally, we will add the real part and the
      imaginary part whose complex
150 //conjugate is taken
151 b0'=b0_real+b0_conj
152 b1'=b1_real+b1_conj
153 b2'=b2_real+b2_conj
154 b=[b0',b1',b2',b3']
155 disp(b,'So, the IDFT of Y1(k) using Inverse
      Decimation-in-Time Fast Fourier Transform (IDIT-
      FFT) is y1(n)=')
156
157 Y2k0=(X2_0).*(Hk_0);
158 Y2k1=(X2_1).*(Hk_1);
159 Y2k2=(X2_2).*(Hk_2);
160 Y2k3=(X2_3).*(Hk_3);
161 Y2k=[Y2k0 Y2k1 Y2k2 Y2k3];
162 disp(Y2k,'Y2(k)=')
163
164 //Computing IDFT of Y2k using IDIT-FFT :
165 Y2k0_0c=real(Y2k0)-(sqrt(-1))*imag(Y2k0); //Y2K0_0c
      means complex conjugate of Y2k0
166 Y2k0_1c=real(Y2k1)-(sqrt(-1))*imag(Y2k1); //Y2K0_1c
      means complex conjugate of Y2k1
167 Y2k0_2c=real(Y2k2)-(sqrt(-1))*imag(Y2k2); //Y2K0_2c
      means complex conjugate of Y2k2
168 Y2k0_3c=real(Y2k3)-(sqrt(-1))*imag(Y2k3); //Y2K0_3c
      means complex conjugate of Y2k3
169
170 c0=(((Y2k0_3c+Y2k0_1c)*(1))+((Y2k0_2c+Y2k0_0c)*(1)))

```

```

    *(1/4);
171 c1=(((Y2k0_3c-Y2k0_1c)*(-1)*(-sqrt(-1)))+(Y2k0_2c-
    Y2k0_0c)*(-1))*(1/4);
172 c2=(((Y2k0_3c+Y2k0_1c)*(1)-(Y2k0_2c+Y2k0_0c))*(-1))
    *(1/4);
173 c3=(((Y2k0_3c-Y2k0_1c)*(-1)*(-sqrt(-1)))-((Y2k0_2c-
    Y2k0_0c)*(-1)))*(-1))*(1/4);
174
175 c0_real=real(c0);
176 c0_conj=(-1)*(imag(c0));
177 c1_real=real(b1);
178 c1_conj=(-1)*(imag(c1));
179 c2_real=real(c2);
180 c2_conj=(-1)*(imag(c2));
181 c3_real=real(c3);
182 c3_conj=(-1)*(imag(c3));
183 //Finally, we will add the real part and the
    imaginary part whose complex
184 //conjugate is taken
185 c0'=c0_real+c0_conj
186 c1'=c1_real+c1_conj
187 c2'=c2_real+c2_conj
188 c3'=c3_real+c3_conj
189 c=[c0',c1',c2',c3']
190 disp(c,'So, the IDFT of Y2(k) using Inverse
    Decimation-in-Time Fast Fourier Transform (IDIT-
    FFT) is y2(n)=')
191
192 Y3k0=(X3_0).*(Hk_0);
193 Y3k1=(X3_1).*(Hk_1);
194 Y3k2=(X3_2).*(Hk_2);
195 Y3k3=(X3_3).*(Hk_3);
196 Y3k=[Y3k0 Y3k1 Y3k2 Y3k3];
197 disp(Y3k,'Y3(k)=')
198
199 //Computing IDFT of Y3k using IDIT-FFT :
200 Y3k0_0c=real(Y3k0)-(sqrt(-1))*imag(Y3k0); //Y3K0_0c
    means complex conjugate of Y3k0

```

```

201 Y3k0_1c=real(Y3k1)-(sqrt(-1))*imag(Y3k1); //Y3K0_1c
      means complex conjugate of Y3k1
202 Y3k0_2c=real(Y3k2)-(sqrt(-1))*imag(Y3k2); //Y3K0_2c
      means complex conjugate of Y3k2
203 Y3k0_3c=real(Y3k3)-(sqrt(-1))*imag(Y3k3); //Y3K0_3c
      means complex conjugate of Y3k3
204
205 d0=((((Y3k0_3c+Y3k0_1c)*(1))+((Y3k0_2c+Y3k0_0c)*(1)))
      *(1/4);
206 d1=((((Y3k0_3c-Y3k0_1c)*(-1)*(-sqrt(-1)))+(Y3k0_2c-
      Y3k0_0c)*(-1))*(1/4);
207 d2=((((Y3k0_3c+Y3k0_1c)*(1)-(Y3k0_2c+Y3k0_0c))*(-1))
      *(1/4);
208 d3((((Y3k0_3c-Y3k0_1c)*(-1)*(-sqrt(-1)))-((Y3k0_2c-
      Y3k0_0c)*(-1)))*(-1))*(1/4);
209
210 d0_real=real(d0);
211 d0_conj=(-1)*(imag(d0));
212 d1_real=real(d1);
213 d1_conj=(-1)*(imag(d1));
214 d2_real=real(d2);
215 d2_conj=(-1)*(imag(d2));
216 d3_real=real(d3);
217 d3_conj=(-1)*(imag(d3));
218 //Finally, we will add the real part and the
      imaginary part whose complex
219 //conjugate is taken
220 d0'=d0_real+d0_conj
221 d1'=d1_real+d1_conj
222 d2'=d2_real+d2_conj
223 d3'=d3_real+d3_conj
224 d=[d0',d1',d2',d3']
225 disp(d,'So, the IDFT of Y3(k) using Inverse
      Decimation-in-Time Fast Fourier Transform (IDIT-
      FFT) is y3(n)=')
226 w=[a 0 0 0 0 0 0];
227 x=[0 0 b 0 0 0 0];
228 y=[0 0 0 0 c 0 0];

```

```
229 z=[0 0 0 0 0 0 d];
230 disp(z,y,x,w,'After overlapping,the sequences will
    be seen as follows:')
231 yn=w+x+y+z;
232 disp(yn,'The output : y(n)=')
```

Experiment: 10

Implement Impulse Invariant Method

Scilab code Solution 10.0 Experiment Number 10

```
1 //AIM: Implement Impulse Invariant method
2
3 //Find out H(z) using impulse invariances method at
  5Hz sampling frequency
4 //from H(s) where  $H(s)=1/(s+1)(s+2)$ 
5
6 //Software version Scilab 5.5.2
7 //OS windows 10
8 clc;
9 clear;
10 s=%s;
11 s2=-2;
12 s1=-1;
13 d1=(s-s1);
14 p2=(s-s2);
15 if (s1) then // When pole=-1
16     s1=-1;
17     s2=-2;
18     s=s1;
```

```

19     d2=(s-s2);
20     num1=1/d2; // Value of A1
21 h1=syslin('c', num1/d1)
22 end
23 disp(h1)
24 disp(num1,'value of A1=')
25 if (s2) then // When pole=-2
26     s1=-1;
27     s2=-2;
28     s=s2;
29     p1=(s-s1);
30     num2=1/p1; // Value of A2
31 h2=syslin('c', num2/p2)
32 end
33 disp(h2)
34 disp(num2,'Value of A2=')
35 Hs=(h1)+(h2);
36 disp(Hs,'Transfer function of analog filter H(s)=')
37 //Obtain the Z-transform using impulse invariance
    transformation equation
38 //1/(s-pk)=1/[1-exp(pk*Ts)*Z^(-1)]
39 Fs=5;
40 Ts=1/Fs;
41 disp('sec',Ts,'Sampling time Ts=')
42 //we have poles at s1=-1 and s2=-2
43 Z=poly(0,"Z")
44 //1/(s+1)=a;We consider
45 a=num1/(1-exp(s1*(Ts))*Z^(-1));
46 //1/(s+2)=b;We consider
47 b=num2/(1-exp(s2*(Ts))*Z^(-1));
48 disp(a,'1/s+1=')
49 disp(b,'1/s+2=')
50 //The Transfer function of digital filter is given
    by,
51 //H(Z)= \sum_{k=1}^N(Ak/(1-e^(pk*Ts))*Z^(-1) )
52 //H(Z)=A1/1-exp(p1*Ts)*Z^(-1)+A2/1-exp(p1*Ts)*Z^(-1)
53 Hz=(a+b);
54 disp(Hz,'The required transfer function for digital

```

IIR filter $H(Z)=')$

Experiment: 11

To Design Butterworth Filter With Minimum Readymade Scilab Functions

Scilab code Solution 11.0 Experiment Number 11

```
1 //AIM:To design Butterworth filter with minimum
   readymade Scilab functions
2
3 //To compute the order and the poles of Butterworth
   low pass filter using
4 //Bilinear transformation(ASSUME T=1SEC);
5 //Attenuation in passband=1.93dB
6 //Attenuation in stopband=13.97dB
7 //Passband edge frequency=0.2
8 //Stopbandband edge frequency=0.6
9
10 //Software version Scilab 5.5.2
11 //OS windows 10
12 clc;
13 clear;
14 s=poly(0,"s")
15 T=1;
```

```

16 Ap=1.93; //in dB
17 As=13.97; //in dB
18 wp=0.2*(%pi)
19 ws=0.6*(%pi)
20 ohmp=2/T*(tan(wp/2))
21 ohms=2/T*(tan(ws/2))
22 //ORDER CALCULATION :
23 N=(0.5)*(log(((10^(0.1*As))-1)/((10^(0.1*Ap))-1))))
    /(log(ohms/ohmp))
24
25 Nr=int (N)
26 x=N-int(N)
27 if(x>0)
28   Nr=Nr+1
29 ohmc=(ohmp/(10^(0.1*Ap)-1)^(1/(2*Nr)))
30 //Calculation of poles
31 i=0:1:Nr-1;
32 pi_plus=ohmc*exp(%i*(Nr+2*i+1)*(%pi)/(2*Nr))
33 pi_minus=-ohmc*exp(%i*(2+2.*i+1)*(%pi)/(2*Nr))
34 disp(wp,'wp=')
35 disp(ws,'ws=')
36 disp(ohmp,'ohmp=')
37 disp(ohms,'ohms=')
38 disp(N,'N=')
39 disp(Nr,'Roundoff value of N now denoted as Nr =')
40 disp(ohmc,'Cutoff frequency : ohmc=')
41 disp('Displaying the poles')
42 disp(pi_plus,'pi_plus=')
43 disp(pi_minus,'pi_minus=')
44 h2=zeros(1,2)
45 h=ohmc/(s-(-0.53-0.53*i))
46 h1=ohmc/(s-(-0.53+0.53*i))
47 h2=h*h1;
48 disp(h,h1,'Now the analog transfer function H(s) is
    the multiplication of the following two terms :')
    ;
49 disp(h2,'After multiplication ,H(s)=')
50 g=numer(h2);

```

```
51 disp(g, 'Numerator of the analog transfer function=')
52 //Obtaining H(z) using Bilinear Transformation
    Method :
53 z=poly(0, "z")
54 s=(2/T)*((z-1)/(z+1)); //Bilinear Transformation
    Method
55 disp('Type resume in Console')
56 pause
57 a=0.5618 +1.06*s+s^2;
58 b=(1/a)
59 c=0.5645360*b;
60 disp(c, 'The digital transfer function H(z)=')
```

Experiment: 12

To Design Chebyshev Filter With Minimum Readymade Scilab Functions.

Scilab code Solution 12.0 Experiment Number 12

```
1 //AIM:To design Chebyshev filter with minimum
   readymade Scilab functions
2
3 //Design of low pass 1 rad/sec bandwidth Chebyshev
   filter
4 //Acceptable passband ripple=2 db
5 //cut off radian frequency 1 radian/sec
6 //stop band attenuation of 20db or greater beyond
   1.3 radian/sec
7
8 //Software version Scilab 5.5.2
9 //OS windows 10
10 clc;
11 clear;
12 //Given cut-off frequency is 1 rad/sec. This means
   that it is a normalized low
13 //pass Chebyshev filter
```

```

14 fc=1; //from the above question
15 Ap=2; //from the above question
16 As=20; //from the above question
17 ohms=1.3; //from the above question
18 ohmp=1; //It is a normalized filter.Hence the value
    is 1 rad/sec
19
20 //Steps for calculation of
21 a=(0.1*2)
22 b=10^a
23 c=b-1
24 episelon=c^(1/2)
25 disp(episelon," =")
26
27 //Steps for calculation of order
28 d=(-20)*((log(episelon)/log(10)))
29 e=(20)*(log(ohms)/log(10))
30 f=6+e
31 g=26+d
32 N=g/f
33 Nr=int (N)
34 x=N-int(N)
35 if(x>0)
36   Nr=Nr+1
37 //N=((( -20)*log(episelon))+6+20)/(6+20*(log(ohms)))
38 D=-20; //given in db
39 //N=- (20*log10(episelon))-6(N-1)-(20*log(ohms))
40 h1=((episelon)^2)
41 h2=1+h1
42 h3=h2^(1/2)
43 h4=h3+1
44 g=(episelon)
45 h5=h4/g
46 beta=(h5)^(1/Nr)
47 disp(N,"N=")
48 disp(Nr,"The round-off value of N(now called as Nr)=
    ")
49 disp(beta," =")

```

```

50
51 //for the determination of poles we have
52 r=(ohmp)*(((beta^2)-1)/(2*beta))
53 disp(r,"The minor axis of the ellipse(r)=")
54 R=ohmp*((beta^2+1)/(2*beta))
55 disp(R,"The major axis of the ellipse(R)=");
56 // thetai=(%pi/2)+((2i+%pi)/2*N)// i=0123
57 // for i=0
58 theta0=((%pi/2)+((2*0*%pi+%pi)/(2*4)))
59 disp(theta0,"theta0=")
60 // for i=1
61 theta1=((%pi/2)+((2*1*%pi+%pi)/(2*4)))
62 disp(theta1,"theta1=")
63 // for i=2
64 theta2=((%pi/2)+((2*2*%pi+%pi)/(2*4)))
65 disp(theta2,"theta2=")
66 // for i=3
67 theta3=((%pi/2)+((2*3*%pi+%pi)/(2*4)))
68 disp(theta3,"theta3=")
69 //the pole position is given by
70 //sp=r*cos(thetai)+jsin(thetai)
71 i=0:1:Nr-1
72 //Computing real and imaginary part of s0,s1,s2,s3
73 h6=((r)*(cos(theta0))) //Computing real part of s0
74 h7=(%i)*(R)*(sin(theta0)) //Computing imaginary part
    of s0
75 s0=h6+h7; //Combining real and imaginary part of s0
76 disp(s0,"s0=")
77 h8=((r)*(cos(theta1))) //Computing real part of s1
78 h9=(%i)*(R)*(sin(theta1)) //Computing imaginary part
    of s1
79 s1=h8+h9; //Combining real and imaginary part of s1
80 disp(s1,"s1=")
81 h10=((r)*(cos(theta2))) //Computing real part of s2
82 h11=(%i)*(R)*(sin(theta2)) //Computing imaginary
    part of s2
83 s2=h10+h11; //Combining real and imaginary part of
    s2

```

```

84 disp(s2,"s2=")
85 h12=((r)*(cos(theta3))) //Computing real part of s3
86 h13=(%i)*(R)*(sin(theta3)) //Computing imaginary
    part of s3
87 s3=h12+h13; //Combining real and imaginary part of
    s13
88 disp(s3,"s3=")
89
90 //Calculation of transfer function:
91 s=poly(0,"s")
92 h=1/((s-(s0))*(s-(s1))*(s-(s2))*(s-(s3)))
93 disp(h,"h=")
94 disp('Now type resume and press enter in the Console
    window')
95 pause
96 //Now value of b0 is required which is nothing but
    the value of the constant
97 //term in the denominator of h (obtained by seeing
    the calculated value in the
98 //console window by inserting a 'pause' in the
    program)
99 b0=0.2057651;
100 //Also we see in the Console window that the rounded
    value of the order is 4
101 //and since 4 is an even number,so the formula for
    calculation of i will be
102 // i=b0/(sqrt(1+ ^2))
103 i=b0/(sqrt(1+(episelon)^2))
104 disp(i,'i=')
105 Hs=i*h//Calculated value of Ha(s)
106 disp(Hs,'The required transfer function Ha(s)=') //
    Displaying the calculated value of the transfer
    function

```

Experiment: 13

Designing Two Stage Decimator

Scilab code Solution 13.0 Experiment Number 13

```
1 //AIM: To implement a two stage decimator for the
   following specifications:
2 // Sampling rate of the input signal=20,000 Hz
3 //D=100,Passband=0 to 40Hz,Transition Band=40 to 50
   Hz,Passband ripple=0.02,Stopband ripple=0.002
4
5 //Software version Scilab 5.5.2
6 //OS windows 10
7 clc;
8 clear;
9
10 // Let us consider the combination 25*4
11 D1=25;
12 D2=4;
13 //such that D=D1*D2
14 F0=20000;//Fo is the sampling frequency(or sampling
   rate) of the input signal(given in the question)
15 Fp=40; //Fp is the passband edge frequency(given in
   the question)
```

```

16 Fstop=50; //Fstop is the stopband edge frequency(
    given in the question)
17 F1=F0/D1;
18 F2=F1/D2;
19 disp("Hertz",F0,"The given value of F0=")
20 disp("Hertz",F1,"The calculated value of F1=")
21 disp("Hertz",F2,"The calculated value of F2=")
22 Dp=0.02;
23 Ds=0.002;
24 // calculations for stage I...
25 //Step 1:Passband:0<=F<=Fp that means 0<= F<= 40
    Hertz
26 //Step 2:Stopband: Fi-Fstop<=F<=F(i-1)/2
27 //Here i=1 for Stage-I
28 LROS1=F1-Fstop; //Here, LROS1=Lowest limit of
    stopband for Stage-I
29 HROS1=F0/2; //Here, HROS1=Highest limit of stopband
    for Stage-I
30 disp("Hertz",LROS1,"The lowest limit of stopband(for
    Stage-I) =")
31 disp("Hertz",HROS1,"The highest limit of stopband(
    for Stage-I) =")
32 disp("Hertz",HROS1,"<=F<=", "Hertz",LROS1,"So the
    range of stopband for Stage I is:",)
33 Tmax1=LROS1;
34 Tmin1=Fp;
35 DF1=(Tmax1-Tmin1)/F0
36 Dp1=(Dp/2);
37 Ds1=Ds;
38 disp('Hertz',DF1,"The calculated value of  F1 =")
39 disp(Dp1,"The calculated value of  p1 =")
40 disp(Ds1,"The value of  s1 = s =")
41 N1=((( -10*log10(Dp1*Dp1) -13)/(14.6*DF1))+1); //
    Computing the filter length(N1) of Stage-I
42 disp(N1,"Filter length ,N1=")
43 NR1=int(N1); //Extracting only the integer part from
    N1
44 x1=N1-int(N1); //x1 is the decimal part of overall N1

```

```

45 if (x1>0) //If the decimal part is greater than zero
46     NR1=NR1+1 //Then increment the extracted integer
           part i.e. NR1 by 1 to get a round-off value
           of the length of filter of Stage-I
47 disp(NR1," Filter length N1(round-off value)now known
           as NR1=")
48 // calculations for stage-II...
49 //Step 1:Passband:0<=F<=Fp that means 0<= F<= 40
           Hertz
50 //Step 2:Stopband: Fi-Fstop<=F<=F(i-1)/2
51 //Here i=2 for Stage-II
52 disp("-----Now displaying the values for
           stage-II-----")
53 LROS2=F2-Fstop; //Here, LROS2=Lowest limit of
           stopband for Stage-II
54 HROS2=F1/2//Here, HROS2=Highest limit of stopband
           for Stage-II
55 disp(" Hertz",LROS2,"The lowest limit of stopband(for
           Stage-II) =")
56 disp(" Hertz",HROS2,"The highest limit of stopband(
           for Stage-II) =")
57 disp(" Hertz",HROS2,"<=F<="," Hertz",LROS2,"So the
           range of stopband for Stage-II is:",)
58 //If transition band is given in the question,then
           always given transition width is applicable for
           the second stage.
59 //Given transition width is 40Hz to 50Hz.
60 //It indicates that for this stage,the stopband
           should start at 50Hz.
61 a=50;
62 disp(" Hertz",a,"The new value of the lowest limit of
           stopband(for Stage-II) =")
63 disp(" Hertz",HROS2,"The highest limit of stopband is
           re-written(for Stage-II) which is =")
64 disp(" Hertz",HROS2,"<=F<="," Hertz",a,"So the new
           modified range of stopband for Stage-II is:",)
65 Tmax2=50;
66 Tmin2=Fp;

```

```

67 DF2=(Tmax2-Tmin2)/F1
68 Dp2=(Dp/2);
69 Ds2=Ds;
70 disp('Hertz ',DF2,"The calculated value of F2 =")
71 disp(Dp2,"The calculated value of p2 =")
72 disp(Ds2,"The value of s2 = s1 = s =")
73 N2=(((-10*log10(Dp2*Dp2)-13)/(14.6*DF2))+1); //
    Computing the filter length (N2) of Stage-II
74 disp(N2," Filter length ,N2=")
75 NR2=int(N2); //Extracting only the integer part from
    N2
76 x2=N2-int(N2); //x is the decimal part of overall N2
77 if (x2>0) //If the decimal part is greater than zero
78     NR2=NR2+1 //Then increment the extracted integer
    part i.e. NR2 by 1 to get a round-off value
    of the length of filter of Stage-II
79 disp(NR2," Final filter length ,N2(round-off value)now
    known as NR2=")
80 // Calculation of MPS(Multiplications per second) and
    TSR(Total Storage requirement)...
81 //MPS= of [i=1 to I](Ni*Fi)
82 //Here I=Total No. of stages=2
83 MPS=(NR1*F1)+(NR2*F2);
84 disp(MPS,"The value of No. of MPS(Multiplications
    per second)=")
85 //TSR= of [i=1 to I](Ni)
86 //Here I=Total No. of stages=2
87 TSR=NR1+NR2
88 disp(TSR,"The value of TSR(Total storage requirement
    )=")

```

Experiment: 14

Compute Dft Using Matrix Approach And Then Using Dft Properties.

Scilab code Solution 14.0 Experiment Number 14

```
1 //Compute DFT using matrix approach & then using DFT
  properties .
2 // (i) : x(n)={1,2,3,4}, find DFT X(k)
3 // (ii) : Using results obtained in part (i) & not
  otherwise ,
4 // find DFT of following sequences :
5 // x1(n)={4,1,2,3}
6 // x2(n)={2,3,4,1}
7 // x3(n)={3,4,1,2}
8 // x4(n)={4,6,4,6}
9 //Software version Scilab 5.5.2
10 //OS windows 10
11 clc;
12 clear;
13 //Let us first define the W4 matrix
14 W4=[1 1 1 1 ;1 -sqrt(-1) -1 sqrt(-1);1 -1 1 -1;1
     sqrt(-1) -1 -sqrt(-1)];
```

```

15 disp(W4, 'W4=')
16 //Now let us define the input sequence
17 xn=[1;2;3;4]; //The input sequence x(n) has been
    arranged as a column matrix
18 //DFT is obtained by multiplying the twiddle matrix
    W4 and the input sequence
19 Xk=W4*xn;
20 disp(Xk, 'DFT : X(k)=')
21 disp('Type resume in console and press enter')
22 pause
23 X0=10
24 X1=-2+2*sqrt(-1);
25 X2=-2
26 X3=-2-2*sqrt(-1);
27
28 //(ii) : x1(n)={4,1,2,3} and x(n)={1,2,3,4}
29 //x1(n) is obtained by delaying x(n) by 1 position
    which means x1(n)=x(n-1)
30 //According to the circular time shift property : x(
    n-1) gives DFT as X(k)*e^(-j*2*%pi*k*1/N)
31 //But l=-1
32 a1=cos(0)-(sqrt(-1)*sin(0));
33 //So, for k=0,
34 X10=X0.*real(a1)-X0.*(sqrt(-1)*imag(a1))
35 disp(X10, 'X1(0)=')
36 //So, for k=1,
37 b1=int(cos(%pi/2))-(sqrt(-1)*sin(%pi/2))
38 X11=X1*b1;
39 disp(X11, 'X1(1)=')
40 //For k=2,
41 c1=int(cos(%pi))-int((sqrt(-1)*sin(%pi)));
42 X12=X2*c1;
43 disp(X12, 'X1(2)=')
44 //For k=3,
45 d1=int(cos((3*%pi)/2))-int((sqrt(-1)*sin((3*%pi)/2))
    );
46 X13=X3*d1;
47 disp(X13, 'X1(3)=')

```

```

48 disp({,X10,X11,X12,X13,},'So, X1(k)=')
49
50 // (iii) : Now moving ahead to find X2(k)
51 //x2(n)={2,3,4,1} and x(n)={1,2,3,4}
52 //x2(n) is obtained by advancing x(n) by 1 position
    which means x2(n)=x(n+1)
53 //According to the circular time shift property : x(
    n-1) gives DFT as X(k)*e^(-j*2*%pi*k*1/N)
54 //But l=2
55 a2=cos(0)+(sqrt(-1)*sin(0));
56 //So, for k=0,
57 X20=X0.*real(a2)-X0.*(sqrt(-1)*imag(a2))
58 disp(X20,'X2(0)=')
59 //So, for k=1,
60 b2=int(cos(%pi/2))+sqrt(-1)*sin(%pi/2)
61 X21=X1*b2;
62 disp(X21,'X2(1)=')
63 //For k=2,
64 c2=int(cos(%pi))+int((sqrt(-1)*sin(%pi)));
65 X22=X2*c2;
66 disp(X22,'X2(2)=')
67 //For k=3,
68 d2=int(cos((3*%pi)/2))+int((sqrt(-1)*sin((3*%pi)/2))
    );
69 X23=X3*d2;
70 disp(X23,'X2(3)=')
71 disp({,X20,X21,X22,X23,},'So, X2(k)=')
72
73 // (iv) : Now moving ahead to find X3(k)
74 //x3(n)={3,4,1,2} and x(n)={1,2,3,4}
75 //x3(n) is obtained by shifting x(n) by 2 positions
    which means x3(n)=x[n(+/-)2]
76 //According to the circular time shift property : x[
    n(+/-)2] gives DFT as X(k)*e^(-j*2*%pi*k*1/N)
77 a3=cos(0)+(sqrt(-1)*sin(0));
78 //So, for k=0,
79 X30=X0.*real(a3)-X0.*(sqrt(-1)*imag(a3))
80 disp(X30,'X3(0)=')

```

```

81 //So, for k=1,
82 b3=int(cos(%pi))-(sqrt(-1)*sin(%pi))
83 X31=X1*b3;
84 disp(X31, 'X3(1)=')
85 //For k=2,
86 c3=int(cos(2*%pi))-int((sqrt(-1)*sin(2*%pi)));
87 X32=X2*c3;
88 disp(X32, 'X3(2)=')
89 //For k=3,
90 d3=int(cos(3*%pi))-int((sqrt(-1)*sin(3*%pi)));
91 X33=X3*d3;
92 disp(X33, 'X3(3)=')
93 disp({,X30,X31,X32,X33,},'So, X3(k)=')
94
95 // (v) : Now moving ahead to find X4(k)
96 //x4(n)={4,6,4,6} and x(n)={1,2,3,4}
97 //Both are related as x4(n)=x(n)+x[n(+/-)2]
98 //Using half period shift property, X4(k)=X(k)+[(-1)
    ^k]*X(k)
99 //For k=0,
100 X40=X0+[(-1)^0]*X0
101 disp(X40, 'X40=')
102 //For k=1,
103 X41=X1+[(-1)^1]*X1
104 disp(X41, 'X41=')
105 //For k=2,
106 X42=X2+[(-1)^2]*X2
107 disp(X42, 'X42=')
108 //For k=3,
109 X43=X3+[(-1)^3]*X3
110 disp(X43, 'X43=')
111 disp({,X40,X41,X42,X43,},'So, X4(k)=')

```
