Scilab Manual for Digital Signal Processing Lab by Dr Dr. R. Udaiyakumar Electronics Engineering Sri Krishna College Of Technology[1]

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Experiment: 1

Computation of N-Point DFT using DIT method

Scilab code Solution 1.0 Experiment Number 1

```
1  //AIM:Computation of N-Point DFT using DIT method.
2  //Software version Scilab 5.5.2
3  //OS windows 10
4  clc;
5  clear;
6  //Let N=4
7  //We will compute four point DFT for x(n)={5,6,7,8}
       using Decimation in Time-Fast
8  //Fourier transform (i.e. DIT-FFT )
9  //Let us begin with the programming.For
       understanding,let us write the given
10 //data as
11 //x(0)=5;x(1)=6,x(2)=7,x(3)=8
12 x0=5;
13 x2=7;
14 x1=6;
15 x3=8;
16
17 X0=(x2+x0)*(1)+(x3+x1)*(1)
```

```
18 disp(X0,'X(0)=')
19
20 X1=(x3-x1)*(-1)*(-sqrt(-1))+(x2-x0)*(-1);
21 disp(X1,'X(1)=')
22
23 X2=((x3+x1)*(1)-(x2+x0)*(1))*(-1);
24 disp(X2,'X(2)=')
25
26 X3=((x3-x1)*(-1)*(-sqrt(-1))-(x2-x0)*(-1))*(-1);
27 disp(X3,'X(3)=')
28
29 disp({X0,X1,X2,X3},'So,the DFT of x(n) using
     Decimation-in-Time Fast Fourier Transform(DIT-FFT
     ) is X(k)=')
30
31 //Expected output:X(k)={26,-2+2i,-2,-2-2i}
```

Scilab code Solution 1.1 Experiment Number 1

```
1 //AIM:Computation of N-Point DFT using DIT method.
2 //Software version Scilab 5.5.2
3 //OS windows 10
4 clc;
5 clear;
6 // We will compute the DFT of the sequence x(n)
     ={1,2,3,4,5,6} using DIT
7 //(Split radix) method for N=6(2*3)
8 x0=1;//DIT-FFT,so arranging the input in shuffled
     order
9 x2=3;//DIT-FFT,so arranging the input in decimated
     order
10 x4=5;//DIT-FFT,so arranging the input in decimated
     order
11 x1=2;//DIT-FFT,so arranging the input in decimated
     order
```

```
12 x3=4;//DIT-FFT,so arranging the input in decimated
      order
13 x5=6;//DIT-FFT,so arranging the input in decimated
      order
14
15 // Twiddle factors
16 W0=cos(((2*%pi)/6)*0)-sqrt(-1)*sin(((2*%pi)/6)*0)
17 W1=cos(((2*%pi)/6)*1)-sqrt(-1)*sin(((2*%pi)/6)*1)
18 W2=cos(((2*%pi)/6)*2)-sqrt(-1)*sin(((2*%pi)/6)*2)
19 W3=cos(((2*%pi)/6)*3)-sqrt(-1)*sin(((2*%pi)/6)*3)
20 W4=cos(((2*%pi)/6)*4)-sqrt(-1)*sin(((2*%pi)/6)*4)
21 W5=cos(((2*%pi)/6)*5)-sqrt(-1)*sin(((2*%pi)/6)*5)
22 W6=cos(((2*%pi)/6)*6)-sqrt(-1)*sin(((2*%pi)/6)*6)
23
24 // Stage 1 computation
25 X0a=x0+x2+x4
26 X1b=x0+x2*W2+x4*W4;//at line 2 x2 and x4 are to be
      multiplied by twiddle factor of W2 and W4
      respectively
27 X2c=x0+x2*W4+x4*W2;//at line 3 x2 and x4 are to be
      multiplied by twiddle factor of W4 and W2
      respectively
28 X3d=x1+x3+x5
29 X4e=x1+x3*W2+x5*W4;//at line 5 x3 and x5 are to be
      multiplied by twiddle factor of W2 and W4
      respectively
30 X5f=x1+x3*W4+x5*W2;//at line 6 x2 and x4 are to be
      multiplied by twiddle factor of W4 and W2
      respectively
31
32 // Stage 2 computation
33 X0=X0a+X3d
34 X1=X1b+X4e*W1;//at line 2 X4e is to be multiplied by
       factor W1
35 X2=X2c+X5f*W2;//at line 3 X5f is to be multiplied by
       factor W2
36 X3=X0a+X3d*W3;//at line 4 X3d is to be multiplied by
       factor W3
```

```
37 X4=X1b+X4e*W4;//at line 5 X4e is to be multiplied by
       factor W4
38 X5=X2c+X5f*W5;//at line 6 X5f is to be multiplied by
       factor W5
39
40 //displaying the output
41 disp(X0,"X0=")
42 disp(X1,"X1=")
43 disp(X2,"X2=")
44 disp(X3,"X3=")
45 disp(X4,"X4=")
46 disp(X5,"X5=")
47 disp({X0,X1,X2,X3,X4,X5},'So,the DFT of x(n) using
      Decimation-in-Frequency Fast Fourier Transform(
      DIF-FFT) is X(k)=')
48
49 //Expected output:X(k)={21,-3+5.1961524i
      ,-3+1.7320508i,-3,-3-1.7320508i,-3- 5.1961524i}
```

Scilab code Solution 1.2 Experiment Number 1

```
1 //AIM:Computation of N-Point DFT using DIT method.
2 //Software version Scilab 5.5.2
3 //OS windows 10
4 clc;
5 clear;
6 // We will compute the DFT of the sequence x(n)
      ={1,2,3,4,5,6} using DIT
7 //(Split radix) method for N=6(3*2)
8 x0=1;//DIT-FFT,so arranging the input in decimated
      order
9 x3=4;//DIT-FFT,so arranging the input in decimated
      order
10 x1=2;//DIT-FFT,so arranging the input in decimated
      order
```

```
11 x4=5;//DIT-FFT,so arranging the input in decimated
      order
12 x2=3;//DIT-FFT,so arranging the input in decimated
      order
13 x5=6;//DIT-FFT,so arranging the input in decimated
      order
14
15 // Twiddle factors
16 W0=cos(((2*%pi)/6)*0)-sqrt(-1)*sin(((2*%pi)/6)*0)
17 W1=cos(((2*%pi)/6)*1)-sqrt(-1)*sin(((2*%pi)/6)*1)
18 W2=cos(((2*%pi)/6)*2)-sqrt(-1)*sin(((2*%pi)/6)*2)
19 W3=cos(((2*%pi)/6)*3)-sqrt(-1)*sin(((2*%pi)/6)*3)
20 W4=cos(((2*%pi)/6)*4)-sqrt(-1)*sin(((2*%pi)/6)*4)
21 W5=cos(((2*%pi)/6)*5)-sqrt(-1)*sin(((2*%pi)/6)*5)
22 W6=cos(((2*%pi)/6)*6)-sqrt(-1)*sin(((2*%pi)/6)*6)
23 // Stage 1 computation
24 X0a=x0+x3
25 X1b=x0+x3*W3;//at line 2 x3 is to be multiplied by
      twiddle factor of W3
26 X2c=x1+x4;
27 X3d=x1+x4*W3;//at line 4 x4 is to be multiplied by
      twiddle factor of W3
28 X4e=x2+x5;
29 X5f=x2+x5*W3;//at line 6 x5 is to be multiplied by
      twiddle factor of W3
30
31 // Stage 2 computation
32 X0=X0a+X2c+X4e;
33 X1=X1b+X3d*W1+X5f*W2;//at line 2 X3d and X5f are to
      be multiplied by factor W1 and W2 respectively
34 X2=X0a+X2c*W2+X4e*W4;//at line 3 X2c and X4e are to
      be multiplied by factor W2 and W4 respectively
35 X3=X1b+X3d*W3+X5f;//at line 4 X3d and X5f are to be
      multiplied by factor W3 respectively
36 X4=X0a+X2c*W4+X4e*W2;//at line 5 X2c and X4e are to
      be multiplied by factor W4 and W2 respectively
37 X5=X1b+X3d*W5+X5f*W4;//at line 6 X3d and X5f are to
      be multiplied by factor W5 and W4 respectively
```

```
38
39 //displaying the output
40 disp(X0,"X0=")
41 disp(X1,"X1=")
42 disp(X2,"X2=")
43 disp(X3,"X3=")
44 disp(X4,"X4=")
45 disp(X5,"X5=")
46 disp({X0,X1,X2,X3,X4,X5},'So,the DFT of x(n) using
     Decimation-in-Frequency Fast Fourier Transform(
     DIF-FFT) is X(k)=')
47 //Expected output:X(k)={21,-3+5.1961524i
     ,-3+1.7320508i,-3,-3-1.7320508i,-3-5.1961524i}
```

Scilab code Solution 1.3 Experiment Number 1

```
1 //AIM:Computation of N-Point DFT using DIT method.
2 //Software version Scilab 5.5.2
3 //OS windows 10
4 clc;
5 clear;
6 // We will compute the DFT of the sequence x(n)
     ={0,0.25,0.5,0.75,1,0.75,0.5,0.25,0}
7 //using DIT(Split radix) method for N=9(3*3)
8 //Let us begin with the programming.For
     understanding,let us write the given data as
9 //x(0)=0;x(1)=0.25,x(2)=0.5,x(3)=0.75,x(4)=1,x(5)
     =0.75,x(6)=0.5,x(7)=0.25,x(8)=0
10 x0=0;
11 x3=0.75;
12 x6=0.5;
13 x1=0.25;
14 x4=1;
15 x7=0.25;
16 x2=0.5;
```

```
x5=0.75;
x8=0;
W0=cos((2*%pi/9)*0)-(sqrt(-1))*sin((2*%pi/9)*0)
disp(W0,'W0=')
W1=cos((2*%pi/9)*1)-(sqrt(-1))*sin((2*%pi/9)*1)
disp(W1,'W1=')
W2=cos((2*%pi/9)*2)-(sqrt(-1))*sin((2*%pi/9)*2)
disp(W2,'W2=')
W3=cos((2*%pi/9)*3)-(sqrt(-1))*sin((2*%pi/9)*3)
disp(W3,'W3=')
W4=cos((2*%pi/9)*4)-(sqrt(-1))*sin((2*%pi/9)*4)
disp(W4,'W4=')
W5=cos((2*%pi/9)*5)-(sqrt(-1))*sin((2*%pi/9)*5)
disp(W5,'W5=')
W6=cos((2*%pi/9)*6)-(sqrt(-1))*sin((2*%pi/9)*6)
disp(W6,'W6=')
W7=cos((2*%pi/9)*7)-(sqrt(-1))*sin((2*%pi/9)*7)
disp(W7,'W7=')
W8=cos((2*%pi/9)*8)-(sqrt(-1))*sin((2*%pi/9)*8)
disp(W8,'W8=')
//Stage I computation
X0a=x0+x3+x6;
disp(X0a,'Stage-I output at line 1=')
X3b=x0+x3*W3+x6*W6;//at line 2 x3,x6 are to be
   multiplied by twiddle factor W3 and W6
   respectively
disp(X3b,'Stage-I output at line 2=')
X6c=x0+x3*W6+x6*W3;//at line 3 x3,x6 are to be
   multiplied by twiddle factor W6 and W3
   respectively
disp(X6c,'Stage-I output at line 3=')
X1d=x1+x4+x7;
disp(X1d,'Stage-I output at line 4=')
X4e=x1+x4*W3+x7*W6;//at line 4 x3,x6 are to be
   multiplied by twiddle factor W3 and W6
   respectively
disp(X4e,'Stage-I output at line 5=')
X7f=x1+x4*W6+x7*W3;//at line 2 x3,x6 are to be
```

```
      multiplied by twiddle factor W6 and W3
      respectively
49 disp(X7f,'Stage-I output at line 6=')
50 X2g=x2+x5+x8;
51 disp(X2g,'Stage-I output at line 7=')
52 X5h=x2+x5*W3+x8*W6;//at line 2 x3,x6 are to be
      multiplied by twiddle factor W3 and W6
      respectively
53 disp(X5h,'Stage-I output at line 8=')
54 X8i=x2+x5*W6+x8*W3;//at line 2 x3,x6 are to be
      multiplied by twiddle factor W6 and W3
      respectively
55 disp(X8i,'Stage-I output at line 9=')
56
57 //Stage II computation
58 X0=X0a+X1d+X2g;
59 disp(X0,'Stage-II output at line 1=')
60 X1=X3b+X4e*W1+X5h*W2;//at line 2 X4e,X5h are to be
      multiplied by twiddle factor W1 and W2
      respectively
61 disp(X1,'Stage-II output at line 2=')
62 X2=X6c+X7f*W2+X8i*W4;//at line 2 X7f,X8i are to be
      multiplied by twiddle factor W2 and W4
      respectively
63 disp(X2,'Stage-II output at line 3=')
64 X3=X0a+X1d*W3+X2g*W6;//at line 2 X1d,X2g are to be
      multiplied by twiddle factor W3 and W6
      respectively
65 disp(X3,'Stage-II output at line 4=')
66 X4=X3b+X4e*W4+X5h*W8;//at line 2 X4e,X5h are to be
      multiplied by twiddle factor W4 and W8
      respectively
67 disp(X4,'Stage-II output at line 5=')
68 X5=X6c+X7f*W5+X8i*W1;//at line 2 X7f,X8i are to be
      multiplied by twiddle factor W5 and W10
      respectively
69 disp(X5,'Stage-II output at line 6=')
70 X6=X0a+X1d*W6+X2g*W3;//at line 2 X1d,X2g are to be
```

```
    multiplied by twiddle factor W6 and W3
    respectively
71 disp(X6,'Stage-II output at line 7=')
72 X7=X3b+X4e*W7+X5h*W5;//at line 2 X4e,X5h are to be
    multiplied by twiddle factor W7 and W5
    respectively
73 disp(X7,'Stage-II output at line 8=')
74 X8=X6c+X7f*W8+X8i*W7;//at line 2 X7f,X8i are to be
    multiplied by twiddle factor W8 and W7
    respectively
75 disp(X8,'Stage-II output at line 9=')
76 disp({X0,X1,X2,X3,X4,X5,X6,X7,X8},'So,the DFT of x(n
    ) using Decimation-in-Time Fast Fourier Transform
    (DIT-FFT) is X(k)=')
77
78 //Expected output:{4,-1.9477148-0.7089102i
    ,0.0542204+0.0454963i,-0.125-0.2165064i
    ,0.0184945+0.1048875i,
79 //0.0184945-0.1048875i,-0.125+0.2165064i
    ,0.0542204-0.0454963i,-1.9477148+0.7089102i}
```

Scilab code Solution 1.4 Experiment Number 1

```
1 //AIM:Computation of N-Point DFT using DIT method.
2 //Software version Scilab 5.5.2
3 //OS windows 10
4 clc;
5 clear;
6 // We will compute the DFT of the sequence x(n)
    ={0,1,2,3,4,5,6,7,8,9,10,11}
7 //using DIT(Split radix) method for N=12(3*4)
8 //Let us begin with the programming.For
    understanding,let us write the given data as
9 //x(0)=0,x(1)=1,x(2)=2,x(3)=3,x(4)=4,x(5)=5,x(6)=6,x
    (7)=7,x(8)=8,x(9)=9,x(10)=10,x(11)=11
```

```
10 x0=0;//DIT-FFT; so arranging the input in shuffled
     order
11 x4=4;//DIT-FFT; so arranging the input in shuffled
     order
12 x8=8;//DIT-FFT; so arranging the input in shuffled
     order
13 x1=1;//DIT-FFT; so arranging the input in shuffled
     order
14 x5=5;//DIT-FFT; so arranging the input in shuffled
     order
15 x9=9;//DIT-FFT; so arranging the input in shuffled
     order
16 x2=2;//DIT-FFT; so arranging the input in shuffled
     order
17 x6=6;//DIT-FFT; so arranging the input in shuffled
     order
18 x10=10;//DIT-FFT; so arranging the input in shuffled
      order
19 x3=3;//DIT-FFT; so arranging the input in shuffled
     order
20 x7=7;//DIT-FFT; so arranging the input in shuffled
     order
21 x11=11;//DIT-FFT; so arranging the input in shuffled
      order
22
23 //Twiddle factors
24 W0=cos(((2*%pi)/12)*0)-sqrt(-1)*sin(((2*%pi)/12)*0)
25 W1=cos(((2*%pi)/12)*1)-sqrt(-1)*sin(((2*%pi)/12)*1)
26 W2=cos(((2*%pi)/12)*2)-sqrt(-1)*sin(((2*%pi)/12)*2)
27 W3=cos(((2*%pi)/12)*3)-sqrt(-1)*sin(((2*%pi)/12)*3)
28 W4=cos(((2*%pi)/12)*4)-sqrt(-1)*sin(((2*%pi)/12)*4)
29 W5=cos(((2*%pi)/12)*5)-sqrt(-1)*sin(((2*%pi)/12)*5)
30 W6=cos(((2*%pi)/12)*6)-sqrt(-1)*sin(((2*%pi)/12)*6)
31 W7=cos(((2*%pi)/12)*7)-sqrt(-1)*sin(((2*%pi)/12)*7)
32 W8=cos(((2*%pi)/12)*8)-sqrt(-1)*sin(((2*%pi)/12)*8)
33 W9=cos(((2*%pi)/12)*9)-sqrt(-1)*sin(((2*%pi)/12)*9)
34 W10=cos(((2*%pi)/12)*10)-sqrt(-1)*sin(((2*%pi)/12)
     *10)
```

```
35 W11=cos(((2*%pi)/12)*11)-sqrt(-1)*sin(((2*%pi)/12)
      *11)
36
37 //First stage
38 X0a=x0+x3+x6+x9;
39 X1b=x0+x3*W3+x6*W6+x9*W9; //At line 2; x3,x6 and x9
      are to be multiplied by factor W3,W6 and W9
      respectively
40 X2c=x0+x3*W6+x6*1+x9*W6; //At line 3; x3,x6 and x9
      are to be multiplied by factor W6,W12=1 and W6
      respectively
41 X3d=x0+x3*W9+x6*W6+x9*W3;//At line 4; x3,x6 and x9
      are to be multiplied by factor W9,W6 and W3
      respectively
42 X4e=x1+x4+x7+x10;
43 X5f=x1+x4*W3+x7*W6+x10*W9; //At line 6; x4,x7 and
      x10 are to be multiplied by factor W3,W6 and W9
      respectively
44 X6g=x1+x4*W6+x7*1+x10*W6; //At line 7; x4,x7 and x10
       are to be multiplied by factor W6,W12=1 and W6
      respectively
45 X7h=x1+x4*W9+x7*W6+x10*W3;//At line 8; x4,x7 and x10
       are to be multiplied by factor W9,W6 and W3
      respectively
46 X8i=x2+x5+x8+x11;
47 X9j=x2+x5*W3+x8*W6+x11*W9; //At line 10; x5,x8 and
      x11 are to be multiplied by factor W3,W6 and W9
      respectively
48 X10k=x2+x5*W6+x8*1+x11*W6; //At line 11; x5,x8 and
      x11 are to be multiplied by factor W6,W12=1 and
      W6 respectively
49 X11l=x2+x5*W9+x8*W6+x11*W3;//At line 12; x5,x8 and
      x11 are to be multiplied by factor W9,W6 and W3
      respectively
50
51 //Second stage
52 X0=X0a+X4e+X8i;
53 X1=X1b+X5f*W1+X9j*W2;//At line 2; X5f and X9j are to
```

```
      be multiplied by twiddle factor W1 and W2
      respectively
54 X2=X2c+X6g*W2+X10k*W4;//At line 3; X6g and X10k are
      to be multiplied by twiddle factor W2 and W4
      respectively
55 X3=X3d+X7h*W3+X11l*W6;//At line 4; X7h and X11l are
      to be multiplied by twiddle factor W3 and W6
      respectively
56 X4=X0a+X4e*W4+X8i*W8;//At line 5; X4e and X8i are to
      be multiplied by twiddle factor W4 and W8
      respectively
57 X5=X1b+X5f*W5+X9j*W10;//At line 6; X5f and X9j are
      to be multiplied by twiddle factor W5 and W10
      respectively
58 X6=X2c+X6g*W6+X10k*1;//At line 7; X6g and X10k are
      to be multiplied by twiddle factor W6 and W12=1
      respectively
59 X7=X3d+X7h*W7+X11l*W2;//At line 8; X7h and X11l are
      to be multiplied by twiddle factor W7 and W2
      respectively
60 X8=X0a+X4e*W8+X8i*W4;//At line 9; X4e and X8i are to
      be multiplied by twiddle factor W8 and W4
      respectively
61 X9=X1b+X5f*W9+X9j*W6;//At line 10;X5f and X9j are to
      be multiplied by twiddle factor W9 and W6
      respectively
62 X10=X2c+X6g*W10+X10k*W8;//At line 11; X6g and X10k
      are to be multiplied by twiddle factor W10 and W8
      respectively
63 X11=X3d+X7h*W11+X11l*W10;//At line 12; X7h and X11l
      are to be multiplied by twiddle factor W11 and
      W10 respectivelyy
64
65 //Output
66 disp(X0)
67 disp(X1)
68 disp(X2)
69 disp(X3)
```

```
70 disp(X4)
71 disp(X5)
72 disp(X6)
73 disp(X7)
74 disp(X8)
75 disp(X9)
76 disp(X10)
77 disp(X11)
78 disp({X0,X1,X2,X3,X4,X5,X6,X7,X8,X9,X10,X11},'So,the
       DFT of x(n) using DecimAtion-in-Time Fast
       Fourier Transform(DIT-FFT) is X(k)=')
79
80 //Expected output:X(k)={66,-6+22.392305i
       ,-6+10.392305i,-6+6i,-6+3.4641016i,
81 //-6+1.6076952i,-6-9.797D-16i,-6-1.6076952i
       ,-6-3.4641016i,-6-6i,-6-10.392305i,-6-22.392305i}
```

Scilab code Solution 1.5 Experiment Number 1

```
1  //AIM:Computation of N-Point DFT using DIT method.
2  //Software version Scilab 5.5.2
3  //OS windows 10
4  clc;
5  clear;
6  // We will compute the DFT of the sequence x(n)
       ={0,1,2,3,4,5,6,7,8,9,10,11}
7  //using DIT(Split radix) method for N=12(4*3)
8  //For understanding,let us write the given data as
9  //x(0)=0,x(1)=1,x(2)=2,x(3)=3,x(4)=4,x(5)=5,x(6)=6,x
       (7)=7,x(8)=8,x(9)=9,x(10)=10,x(11)=11
10 x0=0;//DIT-FFT so arranging the input in shuffled
       order
11 x4=4;//DIT-FFT so arranging the input in shuffled
       order
12 x8=8;//DIT-FFT so arranging the input in shuffled
```

```
    order
13  x1=1;//DIT-FFT so arranging the input in shuffled
    order
14  x5=5;//DIT-FFT so arranging the input in shuffled
    order
15  x9=9;//DIT-FFT so arranging the input in shuffled
    order
16  x2=2;//DIT-FFT so arranging the input in shuffled
    order
17  x6=6;//DIT-FFT so arranging the input in shuffled
    order
18  x10=10;//DIT-FFT so arranging the input in shuffled
    order
19  x3=3;//DIT-FFT so arranging the input in shuffled
    order
20  x7=7;//DIT-FFT so arranging the input in shuffled
    order
21  x11=11;//DIT-FFT so arranging the input in shuffled
    order
22
23
24  //twiddle factors
25  W0=cos(((2*%pi)/12)*0)-sqrt(-1)*sin(((2*%pi)/12)*0)
26  W1=cos(((2*%pi)/12)*1)-sqrt(-1)*sin(((2*%pi)/12)*1)
27  W2=cos(((2*%pi)/12)*2)-sqrt(-1)*sin(((2*%pi)/12)*2)
28  W3=cos(((2*%pi)/12)*3)-sqrt(-1)*sin(((2*%pi)/12)*3)
29  W4=cos(((2*%pi)/12)*4)-sqrt(-1)*sin(((2*%pi)/12)*4)
30  W5=cos(((2*%pi)/12)*5)-sqrt(-1)*sin(((2*%pi)/12)*5)
31  W6=cos(((2*%pi)/12)*6)-sqrt(-1)*sin(((2*%pi)/12)*6)
32  W7=cos(((2*%pi)/12)*7)-sqrt(-1)*sin(((2*%pi)/12)*7)
33  W8=cos(((2*%pi)/12)*8)-sqrt(-1)*sin(((2*%pi)/12)*8)
34  W9=cos(((2*%pi)/12)*9)-sqrt(-1)*sin(((2*%pi)/12)*9)
35  W10=cos(((2*%pi)/12)*10)-sqrt(-1)*sin(((2*%pi)/12)
    *10)
36  W11=cos(((2*%pi)/12)*11)-sqrt(-1)*sin(((2*%pi)/12)
    *11)
37
38
```

```
39 //first stage
40 X0a=x0+x4+x8;
41 X1b=x0+x4*W4+x8*W8; //At line 2; x4 and x8, are to
      be multiplied by factor W4 and W8 respectively
42 X2c=x0+x4*W8+x8*W4; //At line 3; x4 and x8 are to be
      multiplied by factor W8 and W4 respectively
43 X3d=x1+x5+x9;
44 X4e=x1+x5*W4+x9*W8; //At line 5; x5 and x9 are to be
      multiplied by factor  W4 and W8 respectively
45 X5f=x1+x5*W8+x9*W4; //At line 6; x5 and x9 are to be
      multiplied by factor W8 and W4 respectively
46 X6g=x2+x6+x10;
47 X7h=x2+x6*W4+x10*W8; // At line 8; x6 and x10 are to
      be multiplied by factor  W4 and W8 respectively
48 X8i=x2+x6*W8+x10*W4; //At line 9; x6 and x10 are to
      be multiplied by factor W8 and W4 respectively
49 X9j=x3+x7+x11;
50 X10k=x3+x7*W4+x11*W8; //At line 11; x7 and x11 are
      to be multiplied by factor W8 and W4 respectively
51 X11l=x3+x7*W8+x11*W4; //At line 12; x7 and x11 are
      to be multiplied by factor W8 and W4 respectively
52
53 //second stage
54 X0=X0a+X3d+X6g+X9j;
55 X1=X1b+X4e*W1+X7h*W2+X10k*W3;//At line 2; X4e,X7h
      and X10k are to be multiplied by twiddle factor
      W1, W2 and W3 respectively
56 X2=X2c+X5f*W2+X8i*W4+X11l*W6;//At line 3; X5f,X8i
      and X11l are to be multiplied by twiddle factor
      W2,W4 and W6 respectively
57 X3=X0a+X3d*W3+X6g*W6+X9j*W9;//At line 4; X3d,X6g and
       X9j are to be multiplied by twiddle factor W3,
      W6 and W9 respectively
58 X4=X1b+X4e*W4+X7h*W8+X10k*1;//At line 5; X4e,X7h and
       X10k are to be multiplied by twiddle factor W4,
      W8 and W12=1 respectively
59 X5=X2c+X5f*W5+X8i*W10+X11l*W3;//At line 6; X5f,X8i
      and X11l are to be multiplied by twiddle factor
```

```
   W5,W10 and W11 respectively
60 X6=X0a+X3d*W6+X6g*1+X9j*W6;//At line 7; X3d,X6g and
   X9j are to be multiplied by twiddle factor W6,
   W12=1 and W6 respectively
61 X7=X1b+X4e*W7+X7h*W2+X10k*W9;//At line 8; X4e,X7h
   and X10k are to be multiplied by twiddle factor
   W7, W2 and W9 respectively
62 X8=X2c+X5f*W8+X8i*W4+X11l*1;//At line 9; X5f,X8i and
    X11l are to be multiplied by twiddle factor W8,
   W4 and W11 respectively
63 X9=X0a+X3d*W9+X6g*W6+X9j*W3;//At line 10; X3d,X6g
   and X9j are to be multiplied by twiddle factor W9
   , W6 & W3 respectively
64 X10=X1b+X4e*W10+X7h*W8+X10k*W6;//At line 11; X4e,X7h
    and X10k are to be multiplied by twiddle factor
   W10, W8 & W6 respectively
65 X11=X2c+X5f*W11+X8i*W10+X11l*W9;//At line 12; X5f,
   X8i and X11l are to be multiplied by twiddle
   factor W11,W10 & W9 respectively
66
67 //Output
68 disp(X0)
69 disp(X1)
70 disp(X2)
71 disp(X3)
72 disp(X4)
73 disp(X5)
74 disp(X6)
75 disp(X7)
76 disp(X8)
77 disp(X9)
78 disp(X10)
79 disp(X11)
80 disp({X0,X1,X2,X3,X4,X5,X6,X7,X8,X9,X10,X11},'So,the
    DFT of x(n) using Decimation-in-Time Fast
   Fourier Transform(DIT-FFT) is X(k)=')
81
82 //Expected output:X(k)={66,-6+22.392305i
```

```
    ,-6+10.392305i,-6+6i,-6+3.4641016i,-6+1.6076952i
    ,-6-4.409D-15i,
83  //-6-1.6076952i,-6-3.4641016i,-6-6i,-6-10.392305i
    ,-6-22.392305i}
```

Scilab code Solution 1.6 Experiment Number 1

```
1  //AIM:Computation of N-Point DFT using DIT method.
2  //Software version Scilab 5.5.2
3  //OS windows 10
4  clc;
5  clear;
6  // We will compute the DFT of the sequence x(n)
       ={0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15}
7  //using DIT(Split radix) method for N=16(4*4)
8  //For understanding,let us write the given data as
9  //x(0)=0,x(1)=1,x(2)=2,x(3)=3,x(4)=4,x(5)=5,x(6)=6,x
       (7)=7,x(8)=8,x(9)=9,x(10)=10,x(11)=11,x(12)=12,x
       (13)=13,x(14)=14,x(15)=15
10 x0=0;//DIT-FFT so arranging the input in shuffled
       order
11 x4=4;//DIT-FFT so arranging the input in shuffled
       order
12 x8=8;//DIT-FFT so arranging the input in shuffled
       order
13 x12=12;//DIT-FFT so arranging the input in shuffled
       order
14 x1=1;//DIT-FFT so arranging the input in shuffled
       order
15 x5=5;//DIT-FFT so arranging the input in shuffled
       order
16 x9=9;//DIT-FFT so arranging the input in shuffled
       order
17 x13=13;//DIT-FFT so arranging the input in shuffled
       order
```

```
18 x2=2;//DIT-FFT so arranging the input in shuffled
      order
19 x6=6;//DIT-FFT so arranging the input in shuffled
      order
20 x10=10;//DIT-FFT so arranging the input in shuffled
      order
21 x14=14;//DIT-FFT so arranging the input in shuffled
      order
22 x3=3;//DIT-FFT so arranging the input in shuffled
      order
23 x7=7;//DIT-FFT so arranging the input in shuffled
      order
24 x11=11;//DIT-FFT so arranging the input in shuffled
      order
25 x15=15;//DIT-FFT so arranging the input in shuffled
      order
26
27 //Computing the Twiddle factors
28 W0=cos(((2*%pi)/16)*0)-sqrt(-1)*sin(((2*%pi)/16)*0)
29 W1=cos(((2*%pi)/16)*1)-sqrt(-1)*sin(((2*%pi)/16)*1)
30 W2=cos(((2*%pi)/16)*2)-sqrt(-1)*sin(((2*%pi)/16)*2)
31 W3=cos(((2*%pi)/16)*3)-sqrt(-1)*sin(((2*%pi)/16)*3)
32 W4=cos(((2*%pi)/16)*4)-sqrt(-1)*sin(((2*%pi)/16)*4)
33 W5=cos(((2*%pi)/16)*5)-sqrt(-1)*sin(((2*%pi)/16)*5)
34 W6=cos(((2*%pi)/16)*6)-sqrt(-1)*sin(((2*%pi)/16)*6)
35 W7=cos(((2*%pi)/16)*7)-sqrt(-1)*sin(((2*%pi)/16)*7)
36 W8=cos(((2*%pi)/16)*8)-sqrt(-1)*sin(((2*%pi)/16)*8)
37 W9=cos(((2*%pi)/16)*9)-sqrt(-1)*sin(((2*%pi)/16)*9)
38 W10=cos(((2*%pi)/16)*10)-sqrt(-1)*sin(((2*%pi)/16)
      *10)
39 W11=cos(((2*%pi)/16)*11)-sqrt(-1)*sin(((2*%pi)/16)
      *11)
40 W12=cos(((2*%pi)/16)*12)-sqrt(-1)*sin(((2*%pi)/16)
      *12)
41 W13=cos(((2*%pi)/16)*13)-sqrt(-1)*sin(((2*%pi)/16)
      *13)
42 W14=cos(((2*%pi)/16)*14)-sqrt(-1)*sin(((2*%pi)/16)
      *14)
```

```
43 W15=cos(((2*%pi)/16)*15)-sqrt(-1)*sin(((2*%pi)/16)
   *15)
44
45 //First stage
46 X0a=x0+x4+x8+x12
47 X1b=x0+x4*W4+x8*W8+x12*W12; //at line 2; x4, x8 &
   x12 are to be multiplied by factor W4, W8 and W12
    respectively
48 X2c=x0+x4*W8+x8*1+x12*W8; //at line 3; x4, x8 & x12
   are to be multiplied by factor W8, W16=1,and W8
   respectively
49 X3d=x0+x4*W12+x8*W8+x12*W4;// at line 4; x4, x8 &
   x12 are to be multiplied by factor W12, W8 and W4
    respectively
50 X4e=x1+x5+x9+x13
51 X5f=x1+x5*W4+x9*W8+x13*W12; //at line 6; x5, x9 &
   x13 are to be multiplied by factor W4, W8 and W12
    respectively
52 X6g=x1+x5*W8+x9*1+x13*W8; //at line 7; x5, x9 & x13
   are to be multiplied by factor W8, W16=1,and W8
   respectively
53 X7h=x1+x5*W12+x9*W8+x13*W4; // at line 8; x5, x9 &
   x13 are to be multiplied by factor W12, W8 and W4
    respectively
54 X8i=x2+x6+x10+x14
55 X9j=x2+x6*W4+x10*W8+x14*W12; //at line 10; x6, x10 &
    x14 are to be multiplied by factor W4, W8 and
   W12 respectively
56 X10k=x2+x6*W8+x10*1+x14*W8;  //at line 11; x6, x10 &
    x14 are to be multiplied by factor W8, W16=1,and
    W8 respectively
57 X11m=x2+x6*W12+x10*W8+x14*W4; //at line 12; x6, x10
   & x14 are to be multiplied by factor W12, W8 and
   W4 respectively
58 X12n=x3+x7+x11+x15;
59 X13o=x3+x7*W4+x11*W8+x15*W12; //at line 14; x7, x11
   & x15 are to be multiplied by factor W4, W8 and
   W12 respectively
```

```
60 X14p=x3+x7*W8+x11*1+x15*W8; //at line 15; x7, x11 &
     x1 are to be multiplied by factor W8, W16=1,and
     W8 respectively
61 X15q=x3+x7*W12+x11*W8+x15*W4; //at line 16; x7, x11
     & x15 are to be multiplied by factor W12, W8 and
     W4 respectively
62
63 //Second stage
64 X0=X0a+X4e+X8i+X12n
65 X1=X1b+X5f*W1+X9j*W2+X13o*W3; // at line 2; X5f, x9j
     and X13o are to be multiplied by factor W1 W2
     and W3 respectively
66 X2=X2c+X6g*W2+X10k*W4+X14p*W6; //at line 3; X6g,
     X10k and X14p are to be multiplied by factor W2,
     W4 and W6 respectively
67 X3=X3d+X7h*W3+X11m*W6+X15q*W9; //at line 4; X7h,
     X11m, and X15q are to be multipled by factor W3,
     W6 and W9 respectively
68 X4=X0a+X4e*W4+X8i*W8+X12n*W12; // at line 5; X4e,
     X8i and X12n are to be multiplied by factor W4,
     W8 and W12 respectively
69 X5=X1b+X5f*W5+X9j*W10+X13o*W15; //at line 6; X5f,
     x9j and X13o are to be multiplied by factor W5
     W10 and W15 respectively
70 X6=X2c+X6g*W6+X10k*W12+X14p*W2; //at line 7; X6g,
     X10k and X14p are to be multiplied by factor W6,
     W12 and W2 respectively
71 X7=X3d+X7h*W7+X11m*W14+X15q*W5; //at line 8;X7h,
     X11m, and X15q are to be multipled by factor W7,
     W14 and W5 respectively
72 X8=X0a+X4e*W8+X8i*1+X12n*W8; // at line 9;X4e, X8i
     and X12n are to be multiplied by factor W8, 1 and
     W8 respectively
73 X9=X1b+X5f*W9+X9j*W2+X13o*W11; // at line 10; X5f,
     x9j and X13o are to be multiplied by factor W9 W2
     and W11 respectively
74 X10=X2c+X6g*W10+X10k*W4+X14p*W14; //at line 11; X6g,
     X10k and X14p are to be multiplied by factor W10
```

```
      W4 & W14 respectively
75 X11=X3d+X7h*W11+X11m*W6+X15q*W1; //at line 12;X7h,
     X11m, and X15q are to be multipled by factor W11,
      W6 and W1 respectively
76 X12=X0a+X4e*W12+X8i*W8+X12n*W4; //at line 13;X4e,
     X8i and X12n are to be multiplied by factor W12,
     W8 and W4 respectively
77 X13=X1b+X5f*W13+X9j*W10+X13o*W7; //at line 14; X5f,
     x9j and X13o are to be multiplied by factor W13
     W10 and W7 respectively
78 X14=X2c+X6g*W14+X10k*W12+X14p*W10; //at line 15;X6g,
      X10k and X14p are to be multiplied by factor W14
      W12 and W10 respectively
79 X15=X3d+X7h*W15+X11m*W14+X15q*W13; //at line 16;X7h,
     X11m & X15q are to be multipled by factor W15,W14
      & W13 respectively
80 disp(X0)
81 disp(X1)
82 disp(X2)
83 disp(X3)
84 disp(X4)
85 disp(X5)
86 disp(X6)
87 disp(X7)
88 disp(X8)
89 disp(X9)
90 disp(X10)
91 disp(X11)
92 disp(X12)
93 disp(X13)
94 disp(X14)
95 disp(X15)
96 disp({X0,X1,X2,X3,X4,X5,X6,X7,X8,X9,X10,X11,X12,X13,
     X14,X15})
97
98 //Expected output:X(k)={120,-8+ 40.218716i
     ,-8+19.313708i,-8+11.972846i,-8+8i,-8+5.3454291i
     ,-8+3.3137085i, //-8+1.5912989i,-8-7.838D-15i
```

```
    ,-8-1.5912989i,-8-3.3137085i,-8-5.3454291i,-8-8i
    ,-8-11.972846i,-8-19.313708i,
99  //-8-40.218716i}
```

Experiment: 2

Computation of N-Point DFT using DIF method

Scilab code Solution 2.0 Experiment Number 2

```
1  //AIM:Computation of N-Point DFT using DIF method.
2  //Software version Scilab 5.5.2
3  //OS windows 10
4  clc;
5  clear;
6  //Let N=4
7  //Computing four point DFT for x(n)={5,6,7,8} using
       Decimation in Frequency-Fast
8  //Fourier transform (i.e. DIF-FFT )
9  x0=5;
10 x1=6;
11 x2=7;
12 x3=8;
13
14 X0=(((x3+x1)*(1))+((x2+x0)*(1)))*(1);
15 disp(X0,'X(0)=')
16
17 X2=(((x3+x1)*(1))-((x2+x0)*(1)))*(-1);
18 disp(X2,'X(2)=')
```

```
19
20 X1=((x3-x1)*(-1)*(-sqrt(-1))+(x2-x0)*(-1))*(1);
21 disp(X1,'X(1)=')
22
23 X3=((x3-x1)*(-1)*(-sqrt(-1))-(x2-x0)*(-1))*(-1);
24 disp(X3,'X(3)=')
25
26 disp({X0,X1,X2,X3},'So,the DFT of x(n) using
     Decimation-in-Frequency Fast Fourier Transform (
     DIF-FFT) is X(k)=')
27
28 //Expected output:X(k)={26,-2+2i,-2,-2-2i}
```

Scilab code Solution 2.1 Experiment Number 2

```
1 //AIM:Computation of N-Point DFT using DIF method.
2 //Software version Scilab 5.5.2
3 //OS windows 10
4 clc;
5 clear;
6 // We will compute the DFT of the sequence x(n)
     ={1,2,3,4,5,6}
7 //using DIF(Split radix) method for N=6(2*3)
8 //Let us begin with the programming.For
     understanding,let us write the given data as
9 //x(0)=1;x(1)=2,x(2)=3,x(3)=4,x(4)=5,x(5)=6
10 x0=1;//DIF-FFT,so arranging the input in natural
     order
11 x1=2;//DIF-FFT,so arranging the input in natural
     order
12 x2=3;//DIF-FFT,so arranging the input in natural
     order
13 x3=4;//DIF-FFT,so arranging the input in natural
     order
14 x4=5;//DIF-FFT,so arranging the input in natural
```

```
    order
15 x5=6;//DIF-FFT,so arranging the input in natural
    order
16
17 //Computing the twiddle factors
18 W0=cos((2*%pi/6)*0)-(sqrt(-1))*sin((2*%pi/6)*0)
19 disp(W0,'W0=')
20 W1=cos((2*%pi/6)*1)-(sqrt(-1))*sin((2*%pi/6)*1)
21 disp(W1,'W1=')
22 W2=cos((2*%pi/6)*2)-(sqrt(-1))*sin((2*%pi/6)*2)
23 disp(W2,'W2=')
24 W3=cos((2*%pi/6)*3)-(sqrt(-1))*sin((2*%pi/6)*3)
25 disp(W3,'W3=')
26 W4=cos((2*%pi/6)*4)-(sqrt(-1))*sin((2*%pi/6)*4)
27 disp(W4,'W4=')
28 W5=cos((2*%pi/6)*5)-(sqrt(-1))*sin((2*%pi/6)*5)
29 disp(W5,'W5=')
30
31 //Stage I computations
32 x0a=x0+x2+x4;
33 x1b=x1+x3+x5;
34 x2c=x0+x2*W2+x4*W4;//at line  x2,x4 are to be
    multiplied by twiddle factor W2 and W4
    respectively
35 x3d=x1+x3*W2+x5*W4;//at line  x3,x5 are to be
    multiplied by twiddle factor W2 and W4
    respectively
36 x4e=x0+x2*W4+x4*W2;//at line  x2,x4 are to be
    multiplied by twiddle factor W4 and W2
    respectively
37 x5f=x1+x3*W4+x5*W2;//at line  x3,x5 are to be
    multiplied by twiddle factor W4 and W2
    respectively
38
39 //Stage II computations
40 X0=x0a+x1b*W0;//at line 1, x1b is to be multiplied
    by twiddle factor W0 respectively
41 X3=x0a+x1b*W0*W3;//at line 2, x1b is to be
```

```
    multiplied by twiddle factor W0 and W3
    respectively
X1=x2c+x3d*W1;//at line 3, x3d is to be multiplied
    by twiddle factor W1 respectively
X4=x2c+x3d*W1*W3;//at line 4, x3b is to be
    multiplied by twiddle factor W1 and W3
    respectively
X2=x4e+x5f*W2;//at line 5, x5f is to be multiplied
    by twiddle factor W2 respectively
X5=x4e+x5f*W2*W3;//at line 6, x5f is to be
    multiplied by twiddle factor W2 and W3
    respectively

disp(X0,'X(0)=')
c= - 3. - 1.470D-15
X3=ceil(c)
disp(X3,'X(3)=')
disp(X1,'X(1)=')
disp(X4,'X(4)=')
disp(X2,'X(2)=')
disp(X5,'X(5)=')
disp({X0,X1,X2,X3,X4,X5},'So,the DFT of x(n) using
    Decimation-in-Frequency Fast Fourier Transform(
    DIF-FFT) is X(k)=')

//Expected output:X(k)={21,-3+5.1961524i
    ,-3+1.7320508i,-3,-3-1.7320508i,-3- 5.1961524i}
```

Scilab code Solution 2.2 Experiment Number 2

```
//AIM:Computation of N-Point DFT using DIF method.
//Software version Scilab 5.5.2
//OS windows 10
clc;
clear;
```

```
6  // We will compute the DFT of the sequence x(n)
       ={1,2,3,4,5,6}
7  //using DIF(Split radix) method for N=6(3*2)
8  //Let us begin with the programming.For
       understanding,let us write the given data as
9  //x(0)=1;x(1)=2,x(2)=3,x(3)=4,x(4)=5,x(5)=6
10 x0=1;//DIF-FFT,so arranging the input in natural
       order
11 x1=2;//DIF-FFT,so arranging the input in natural
       order
12 x2=3;//DIF-FFT,so arranging the input in natural
       order
13 x3=4;//DIF-FFT,so arranging the input in natural
       order
14 x4=5;//DIF-FFT,so arranging the input in natural
       order
15 x5=6;//DIF-FFT,so arranging the input in natural
       order
16
17 //Computing the twiddle factors
18 W0=cos((2*%pi/6)*0)-(sqrt(-1))*sin((2*%pi/6)*0)
19 disp(W0,'W0=')
20 W1=cos((2*%pi/6)*1)-(sqrt(-1))*sin((2*%pi/6)*1)
21 disp(W1,'W1=')
22 W2=cos((2*%pi/6)*2)-(sqrt(-1))*sin((2*%pi/6)*2)
23 disp(W2,'W2=')
24 W3=cos((2*%pi/6)*3)-(sqrt(-1))*sin((2*%pi/6)*3)
25 disp(W3,'W3=')
26 W4=cos((2*%pi/6)*4)-(sqrt(-1))*sin((2*%pi/6)*4)
27 disp(W4,'W4=')
28 W5=cos((2*%pi/6)*5)-(sqrt(-1))*sin((2*%pi/6)*5)
29 disp(W5,'W5=')
30
31 //Stage I computations
32 x0a=x0+x3;
33 x1b=x1+x4;
34 x2c=x2+x5;
35 x3d=x0-x3;
```

```
x4e=x1-x4;
x5f=x2-x5;

//Stage II computations
X0=x0a+x1b+x2c;
X2=x0a+x1b*W2+x2c*W4;//at line 2, x1b and x2c are to be multiplied by twiddle factor W2 and W4 respectively
X4=x0a+x1b*W4+x2c*W2;//at line 3, x1b and x2c are to be multiplied by twiddle factor W4 and W2 respectively
X1=x3d+x4e*W1+x5f*W2;//at line 4, x4e and x5f are to be multiplied by twiddle factor W1 and W2 respectively
X3=x3d+x4e*W1*W2+x5f*W2*W4;//at line 5, x4e and x5f are to be multiplied by twiddle factor W1,W2 and W2,W4 respectively
X5=x3d+x4e*W1*W4+x5f*W2*W2;//at line 6, x4e and x5f are to be multiplied by twiddle factor W1,W4 and W2,W2 respectively

disp(X0,'X(0)=')
disp(X2,'X(2)=')
disp(X4,'X(4)=')
disp(X1,'X(1)=')
c=- 3. - 1.332D-15
X3=ceil(c)
disp(X3,'X(3)=')
disp(X5,'X(5)=')
disp({X0,X1,X2,X3,X4,X5},'So,the DFT of x(n) using Decimation-in-Frequency Fast Fourier Transform(DIF-FFT) is X(k)=')

//Expected output:X(k)={21,-3+5.1961524i,-3+1.7320508i,-3,-3-1.7320508i,-3-5.1961524i}
```

Scilab code Solution 2.3 Experiment Number 2

```
1  //AIM:Computation of N-Point DFT using DIF method.
2  //Software version Scilab 5.5.2
3  //OS windows 10
4  clc;
5  clear;
6  // We will compute the DFT of the sequence x(n)
       ={1,2,3,4,5,6,7,8,9}
7  //using DIF(Split radix) method for N=9(3*3)
8  //For understanding,let us write the given data as
9  //x(0)=1;x(1)=2,x(2)=3,x(3)=4,x(4)=5,x(5)=6,x(6)=7,x
       (7)=8,x(8)=9
10 x0=1;//DIF-FFT,so arranging the input in natural
       order
11 x1=2;//DIF-FFT,so arranging the input in natural
       order
12 x2=3;//DIF-FFT,so arranging the input in natural
       order
13 x3=4;//DIF-FFT,so arranging the input in natural
       order
14 x4=5;//DIF-FFT,so arranging the input in natural
       order
15 x5=6;//DIF-FFT,so arranging the input in natural
       order
16 x6=7;//DIF-FFT,so arranging the input in natural
       order
17 x7=8;//DIF-FFT,so arranging the input in natural
       order
18 x8=9;//DIF-FFT,so arranging the input in natural
       order
19
20 //Computing the twiddle factors
21 W0=cos((2*%pi/9)*0)-(sqrt(-1))*sin((2*%pi/9)*0)
```

```
22 disp(W0,'W0=')
23 W1=cos((2*%pi/9)*1)-(sqrt(-1))*sin((2*%pi/9)*1)
24 disp(W1,'W1=')
25 W2=cos((2*%pi/9)*2)-(sqrt(-1))*sin((2*%pi/9)*2)
26 disp(W2,'W2=')
27 W3=cos((2*%pi/9)*3)-(sqrt(-1))*sin((2*%pi/9)*3)
28 disp(W3,'W3=')
29 W4=cos((2*%pi/9)*4)-(sqrt(-1))*sin((2*%pi/9)*4)
30 disp(W4,'W4=')
31 W5=cos((2*%pi/9)*5)-(sqrt(-1))*sin((2*%pi/9)*5)
32 disp(W5,'W5=')
33 W6=cos((2*%pi/9)*6)-(sqrt(-1))*sin((2*%pi/9)*6)
34 disp(W6,'W6=')
35 W7=cos((2*%pi/9)*7)-(sqrt(-1))*sin((2*%pi/9)*7)
36 disp(W7,'W7=')
37 W8=cos((2*%pi/9)*8)-(sqrt(-1))*sin((2*%pi/9)*8)
38 disp(W8,'W8=')
39
40 //Stage I computations
41 x0a=x0+x3+x6;
42 x1b=x1+x4+x7;
43 x2c=x2+x5+x8;
44 x3d=x0+x3*W3+x6*W6;//at line 4; x3 & x6 are to be
      multiplied by twiddle factor W3 and W6
      respectively
45 x4e=x1+x4*W3+x7*W6;//at line 5; x4 & x7 are to be
      multiplied by twiddle factor W3 and W6
      respectively
46 x5f=x2+x5*W3+x8*W6;//at line 6; x5 & x8 are to be
      multiplied by twiddle factor W3 and W6
      respectively
47 x6g=x0+x3*W6+x6*W3;//at line 7; x3 & x6 are to be
      multiplied by twiddle factor W3 and W6
      respectively
48 x7h=x1+x4*W6+x7*W3;//at line 8; x4 & x7 are to be
      multiplied by twiddle factor W3 and W6
      respectively
49 x8i=x2+x5*W6+x8*W3;//at line 9; x5 & x8 are to be
```

```
    multiplied by twiddle factor W3 and W6
    respectively
50
51 //Stage-II Computations
52 X0=x0a+x1b+x2c;
53 X3=x0a+x1b*W3+x2c*W6;//at line 2; x1b & x2c are to
    be multiplied by twiddle factor W3 and W6
    respectively
54 X6=x0a+x1b*W6+x2c*W3;//at line 3; x1 & x2c are to be
     multiplied by twiddle factor W6 and W3
    respectively
55 X1=x3d+x4e*W1+x5f*W2;//at line 4; x4e & x5f are to
    be multiplied by twiddle factor W1 and W2
    respectively
56 X4=x3d+x4e*W1*W3+x5f*W2*W6;//at line 5; x4e & x5f
    are to be multiplied by twiddle factor W3,W1 and
    W2,W6 respectively
57 X7=x3d+x4e*W1*W6+x5f*W2*W3;//at line 6; x4e & x5f
    are to be multiplied by twiddle factor W1,W6 and
    W2,W3 respectively
58 X2=x6g+x7h*W2+x8i*W4;//at line 7; x7h & x8i are to
    be multiplied by twiddle factor W2 and W4
    respectively
59 X5=x6g+x7h*W2*W3+x8i*W4*W6;//at line 8; x7h & x8i
    are to be multiplied by twiddle factor W2,W3 and
    W4,W6 respectively
60 X8=x6g+x7h*W2*W6+x8i*W4*W3;//at line 9; x7h & x8i
    are to be multiplied by twiddle factor W2,W6 and
    W4,W3 respectively
61
62 //Output
63 disp(X0,'X(0)=')
64 disp(X3,'X(3)=')
65 disp(X6,'X(6)=')
66 disp(X1,'X(1)=')
67 disp(X4,'X(4)=')
68 disp(X7,'X(7)=')
69 disp(X2,'X(2)=')
```

```
70 disp(X5,'X(5)=')
71 disp(X8,'X(8)=')
72 disp({X0,X1,X2,X3,X4,X5,X6,X7,X8},'So,the DFT of x(n
   ) using Decimation-in-Frequency Fast Fourier
   Transform(DIF-FFT) is X(k)=')
73
74 //Expected output:X(k)={45,-4.5+12.363648i
   ,-4.5+5.3628912i,-4.5+2.5980762i,-4.5+0.7934714i
   ,-4.5-0.7934714i,-4.5-2.5980762i,-4.5-5.3628912i
   ,-4.5-12.363648i}
```

Scilab code Solution 2.4 Experiment Number 2

```
1 //AIM:Computation of N-Point DFT using DIF method.
2 //Software version Scilab 5.5.2
3 //OS windows 10
4 clc;
5 clear;
6 // We will compute the DFT of the sequence x(n)
   ={1,1,1,1,1,1,1,1,0,0,0,0,0,0,0,0}
7 //using DIF(Split radix) method for N=16(4*4)
8 //For understanding,let us write the considered
   input data as
9 //x(0)=1;x(1)=1,x(2)=1,x(3)=1,x(4)=1,x(5)=1,x(6)=1,x
   (7)=1,x(8)=0,x(9)=0,x(10)=0,x(11)=0,x(12)=0,x(13)
   =0,x(14)=0,x(15)=0;
10 x0=1;//DIF-FFT,so arranging the input in natural
   order
11 x1=1;//DIF-FFT,so arranging the input in natural
   order
12 x2=1;//DIF-FFT,so arranging the input in natural
   order
13 x3=1;//DIF-FFT,so arranging the input in natural
   order
14 x4=1;//DIF-FFT,so arranging the input in natural
```

```
    order
15  x5=1;//DIF-FFT,so arranging the input in natural
    order
16  x6=1;//DIF-FFT,so arranging the input in natural
    order
17  x7=1;//DIF-FFT,so arranging the input in natural
    order
18  x8=0;//DIF-FFT,so arranging the input in natural
    order
19  x9=0;//DIF-FFT,so arranging the input in natural
    order
20  x10=0;//DIF-FFT,so arranging the input in natural
    order
21  x11=0;//DIF-FFT,so arranging the input in natural
    order
22  x12=0;//DIF-FFT,so arranging the input in natural
    order
23  x13=0;//DIF-FFT,so arranging the input in natural
    order
24  x14=0;//DIF-FFT,so arranging the input in natural
    order
25  x15=0;//DIF-FFT,so arranging the input in natural
    order
26
27  //Computing the necessary twiddle factors
28  W0=cos((2*%pi/16)*0)-(sqrt(-1))*sin((2*%pi/16)*0)
29  disp(W0,'W0=')
30  W1=cos((2*%pi/16)*1)-(sqrt(-1))*sin((2*%pi/16)*1)
31  disp(W1,'W1=')
32  W2=cos((2*%pi/16)*2)-(sqrt(-1))*sin((2*%pi/16)*2)
33  disp(W2,'W2=')
34  W3=cos((2*%pi/16)*3)-(sqrt(-1))*sin((2*%pi/16)*3)
35  disp(W3,'W3=')
36  W4=cos((2*%pi/16)*4)-(sqrt(-1))*sin((2*%pi/16)*4)
37  disp(W4,'W4=')
38  W5=cos((2*%pi/16)*5)-(sqrt(-1))*sin((2*%pi/16)*5)
39  disp(W5,'W5=')
40  W6=cos((2*%pi/16)*6)-(sqrt(-1))*sin((2*%pi/16)*6)
```

```
disp(W6,'W6=')
W7=cos((2*%pi/16)*7)-(sqrt(-1))*sin((2*%pi/16)*7)
disp(W7,'W7=')
W8=cos((2*%pi/16)*8)-(sqrt(-1))*sin((2*%pi/16)*8)
disp(W8,'W8=')
W9=cos((2*%pi/16)*9)-(sqrt(-1))*sin((2*%pi/16)*9)
disp(W9,'W9=')
W10=cos((2*%pi/16)*10)-(sqrt(-1))*sin((2*%pi/16)*10)
disp(W10,'W10=')
W11=cos((2*%pi/16)*11)-(sqrt(-1))*sin((2*%pi/16)*11)
disp(W11,'W11=')
W12=cos((2*%pi/16)*12)-(sqrt(-1))*sin((2*%pi/16)*12)
disp(W12,'W12=')
W13=cos((2*%pi/16)*13)-(sqrt(-1))*sin((2*%pi/16)*13)
disp(W13,'W13=')
W14=cos((2*%pi/16)*14)-(sqrt(-1))*sin((2*%pi/16)*14)
disp(W14,'W14=')
W15=cos((2*%pi/16)*15)-(sqrt(-1))*sin((2*%pi/16)*15)
disp(W15,'W15=')

x0a=x0+x8;
x1b=x1+x9;
x2c=x2+x10;
x3d=x3+x11;
x4e=x4+x12;
x5f=x5+x13;
x6g=x6+x14;
x7h=x7+x15;
x8i=x0+(-1)*x8;
x9j=(x1+(-1)*x9)*W1;
x10k=(x2+(-1)*x10)*W2;
x11l=(x3+(-1)*x11)*W3;
x12m=(x4+(-1)*x12)*W4;
x13n=(x5+(-1)*x13)*W5;
x14o=(x6+(-1)*x14)*W6;
x15p=(x7+(-1)*x15)*W7;

x0aa=x0a+x4e;
```

```
79  x1bb=x1b+x5f;
80  x2cc=x2c+x6g;
81  x3dd=x3d+x7h;
82  x4ee=x0a+(-1)*x4e;
83  x5ff=(x1b+(-1)*x5f)*W2;
84  x6gg=(x2c+(-1)*x6g)*W4;
85  x7hh=(x3d+(-1)*x7h)*W6;
86  x8ii=x8i+x12m;
87  x9jj=x9j+x13n;
88  x10kk=x10k+x14o;
89  x11ll=x11l+x15p;
90  x12mm=x8i+(-1)*x12m;
91  x13nn=(x9j+(-1)*x13n)*W2;
92  x14oo=(x10k+(-1)*x14o)*W4;
93  x15pp=(x11l+(-1)*x15p)*W6;
94
95  x0aaa=x0aa+x2cc;
96  x1bbb=x1bb+x3dd;
97  x2ccc=x0aa+(-1)*x2cc;
98  x3ddd=(x1bb+(-1)*x3dd)*W4;
99  x4eee=x4ee+x6gg;
100 x5fff=x5ff+x7hh;
101 x6ggg=x4ee+(-1)*x6gg;
102 x7hhh=(x5ff+(-1)*x7hh)*W4;
103 x8iii=x8ii+x10kk;
104 x9jjj=x9jj+x11ll;
105 x10kkk=x8ii+(-1)*x10kk;
106 x11lll=(x9jj+(-1)*x11ll)*W4;
107 x12mmm=x12mm+x14oo;
108 x13nnn=x13nn+x15pp;
109 x14ooo=x12mm+(-1)*x14oo;
110 x15ppp=(x13nn+(-1)*x15pp)*W4;
111
112 //Final output
113 X0=x0aaa+x1bbb;
114 X8=x0aaa+(-1)*x1bbb;
115 X4=x2ccc+x3ddd;
116 X12=x2ccc+(-1)*x3ddd;
```

```
117 X2=x4eee+x5fff;
118 X10=x4eee+(-1)*x5fff;
119 X6=x6ggg+x7hhh;
120 X14=x6ggg+(-1)*x7hhh;
121 X1=x8iii+x9jjj;
122 X9=x8iii+(-1)*x9jjj;
123 X5=x10kkk+x11lll;
124 X13=x10kkk+(-1)*x11lll;
125 X3=x12mmm+x13nnn;
126 X11=x12mmm+(-1)*x13nnn;
127 X7=x14ooo+x15ppp;
128 X15=x14ooo+(-1)*x15ppp;
129 disp({,X8,X4,X12,X2,X10,X6,X14,X1,X9,X5,X13,X3,X11,
      X7,X15,},'The computed values are')
130 disp({X0,X1,X2,X3,X4,X5,X6,X7,X8,X9,X10,X11,X12,X13,
      X14,X15},'So,the DFT of x(n) using Decimation-in-
      Frequency Fast Fourier Transform(DIF-FFT) is X(k)
      =')
131
132 //Expected output:X(k)={8,1.-5.0273395i
      ,0,1-1.4966058i,0,1-0.6681786i,0,1-0.1989124i
      ,0,1+0.1989124i,0,
133 //1+0.6681786i,0,1+1.4966058i,0,1+5.0273395i}
```

Experiment: 3

Design of FIR filter

Scilab code Solution 3.0 Experiment Number 3

```
1  //AIM:Design of FIR filter.
2  //Software version Scilab 5.5.2
3  //OS windows 10
4  clc;
5  clear;
6  // We will consider a case of normalised Linear
       Phase FIR filter, with Length 7 and cut off
       frequency: 1 rad/sec.
7  M = 7;// Filter Length
8  omegac = 1;// Digital Cuttoff Freq Wc = 1 rad/sample
       (Considering Normalised)
9  L = (M-1)/2;
10 for  n = 1:M
11          hdn = omegac/%pi;
12          disp(hdn)
13      end
14 for n = 1:M;
15      wn = 1;
16 end
17 h=hdn*wn;
18 [mag,fr]=frmag(h,512);
```

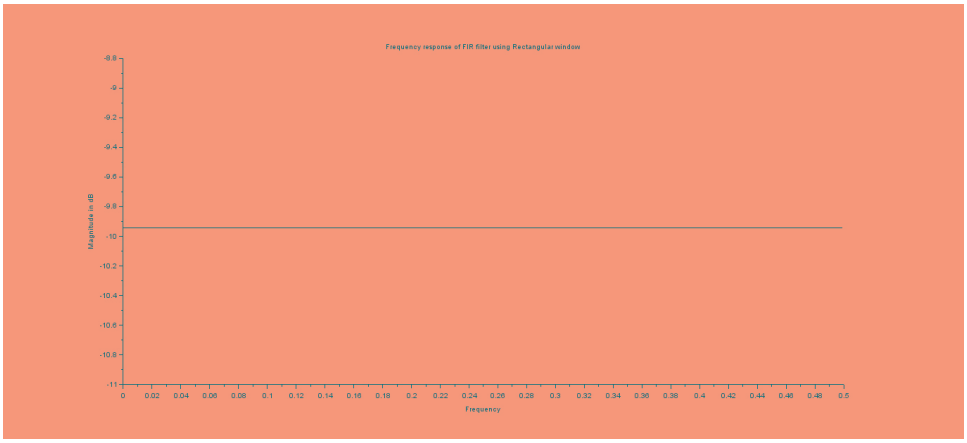

Figure 3.1: Experiment Number 3

```
19 db_magnitude= 20*log10(mag);
20 plot2d(fr,db_magnitude)
21 xlabel('Frequency');
22 ylabel('Magnitude in dB');
23 title('Frequency response of FIR filter using
      Rectangular window')
24 //Expected output
      :0.3183099,0.3183099,0.3183099,0.3183099,0.3183099,0.3183099,0.318
```

Experiment: 4

Design of IIR filter

Scilab code Solution 4.0 Experiment Number 4

```
1  //AIM:Design of IIR filter.
2  //Software version Scilab 5.5.2
3  //OS windows 10
4  clc;
5  clear;
6  //We will compute the order and the poles of
       Butterworth low pass filter
7  //using bilinear transformation(Asuming T= 1 sec);
8  s=poly(0,"s")
9  T=1;
10 Ap=0.8;//Attenuation in pass band
11 As=0.2;//Attenuation in stop band
12 wp=0.2*(%pi)
13 ws=0.6*(%pi)
14 ohmp=2/T*(tan(wp/2))
15 ohms=2/T*(tan(ws/2))
16 //ORDER CALCULATION(N);
17 a=(1/As^2-1)
18 b=(1/Ap^2-1)
19 c=log(a/b)
20 N=(1/2)*(c/(log(ohms/ohmp)))
```

```
Nr=int (N)
x=N-int(N)
if(x>0)
 Nr=Nr+1
else
   Nr=N
   end
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,'wp=')
disp(ws,'ws=')
disp(ohmp,'ohmp=')
disp(ohms,'ohms=')
disp(N,'N=')
disp(Nr,'The value of N after round-off i.e. Nr=')
disp(ohmc,'ohmc=')
disp(pi_plus,'Poles=')
disp(pi_minus,'Poles=')
h2=zeros(1,2)
h=ohmc/(s-(-0.53-0.53*%i))
h1=ohmc/(s-(-0.53+0.53*%i))
h2=h*h1;
disp(h,'H1(s)=');
disp(h1,'H2(s)=');
disp('As H(s)=H1(s)*H2(s)')
disp(h2,'So, H(s)=');
// To obtaining transfer function for digital
   fillter
Z=poly(0,"Z")
s=(2/T)*((Z-1)/(Z+1));
Z1=0.56/(s^2+1.06*s+0.56);
disp(Z1,"Transfer function of Digital filter H(Z)=")

//Expected output: Transfer function of the digital
   filter
```

```
57 //H(z)=(0.56+1.12Z+0.56Z^2)/(2.44 - 6.88Z + 6.68Z^2)
```

Scilab code Solution 4.1 Experiment Number 4

```
1  //AIM:Design of IIR filter.
2  //Software version Scilab 5.5.2
3  //OS windows 10
4  clc;
5  clear;
6  //We will design a second order bandpass digital
       Butterworth filter with
7  // passband of 300Hz to 500Hz and sampling frequency
       of 1500Hz using
8  //bilinear transformation method;considering
       prototype LPF
9  //with transfer functionH(s)= c /s+ c .
10 //Part A:Calculation of specifications for digital
       filter
11 //First we will calculate thr required specification
       of the digital filter
12 // That means specification in terms of w
13 Fu=500;//Fu is the higher cut-off frequency
14 Fl=300;//Fl is the lower cut-off frequency
15 //We want the specification in terms of wu and wl.
       For that,first we will calculate
16 //values of fu and fl by using frequency Fs=1500Hz
17 Fs=1500;
18 fu=Fu/Fs;
19 disp(fu,'fu=')
20 wu=2*%pi*fu;//It is in the units of radians/sample
21 disp(wu,'wu=')
22 fl=Fl/Fs;
23 disp(fl,'fl=')
24 wl=2*%pi*fl;//It is in the units of radians/sample
25 disp(wl,'wl=')
```

```
// As second order bandpass filter is considered,
//so the order of the filter is N=2
N=2;
//Part B: Calculation of specification for analog filter
Ts=1/Fs;
disp(Ts,'Ts=')
ohmu=(2/Ts)*(tan(wu/2));
ohml=(2/Ts)*(tan(wl/2));
disp(ohmu,'ohmu=')
disp(ohml,'ohml=')
//Part C:Calculation of system transfer fuction for analog BPF
s=poly(0,"s")
ohmc=1
Hs=ohmc/(s+ohmc);//H(s) is the transfer function of LPF
disp(Hs,'Hs=')
S=poly(0,"S")
s=(ohmc)*(((S^2)+(ohml*ohmu))/(S*(ohmu-ohml)))
disp(s,'s=')
Hs1=ohmc/(s+ohmc);
disp(Hs1,'Transfer function of the analog filter i.e. H(s)=')
//Part D: Calculation H(z) for digital filter
Z=poly(0,"Z")
S=(2/Ts)*((Z-1)/(Z+1));
Hz=(3016.5248*S)/(S^2+3016.5248*S+11325677)
disp(Hz,'Transfer function of the digital filter i.e. H(z)=')
//Plz note that manually solved answers may be a bit different due to
//roundoff being taken,while Scilab Console will display extreme precise
//values.
//Let us also calculate the gain
a=trfmod(Hz)
b=disp(a,'Transfer function of the digital filter(
```

```
    after roundoff) i.e. H(z)=')
57
58 //Expected output:
59 //Transfer function of the digital filter(after
    roundoff)
60 //          (-0.3080680+0.3080680Z^2)
61 //  H(z)= ------------------------------
62 //          (0.3838640+0.1583426Z+Z^2)
```

Scilab code Solution 4.2 Experiment Number 4

```
1  //AIM:Design of IIR filter.
2  //Software version Scilab 5.5.2
3  //OS windows 10
4  clc;
5  clear;
6  //We will design the digital high pass filter for
    cut off frequency of 30Hz and
7  //sampling frequency of 150Hz using Bilinear
    transformation
8  //Part 1 : Calculation of specification for digital
    filter
9  Fhp=30;//given cut off frequency is 30 Hz
10 Fs=150;//given sampling frequency is 150 Hz
11 fhp=Fhp/Fs;
12 disp(fhp,'fhp=')
13 omegahp=2*%pi*fhp;
14 disp(omegahp,'omegahp=')
15 //order of the filter is not given so we assume N=1
16 N=1
17 //Part 2 ; Calulation of specifications of analog
    filter
18 //Ts is not given directly so we calculate using
    formula Ts=1/Fs
19 Ts=1/Fs;
```

```
20 disp(Ts,'Ts=');
21 //Step 1: calulation of  hp
22 ohmhp=(2/Ts)*tan(omegahp/2);
23 disp(ohmhp,"The calulated value of  hp  in rad/sec=")
   ;
24 //transfer function for low pass filter is H(s)=1/(s
   -s1)
25 //since it is low pass filter s1=(-1)
26 s=poly(0,"s");
27 S=poly(0,"S");
28 H=1/(s+1);
29 //part 3 : Use frequency transformation
30 ohmc=1;
31 s=(ohmc*ohmhp)/S;
32 H1=1/(s+1)
33 disp(H1,"Transfer function of the analog high pass
   filter H(s)=");
34 //Part 4: Calculation of H(z)for digital filter
35 Z=poly(0,"Z");
36 s=(ohmc*ohmhp)/((2/Ts)*((Z-1)/(Z+1)));
37 H2=1/(s+1);
38 disp(H2,"Transfer function of the digital filter H(z
   )=")
39
40 //Expected output:
41 //Transfer function of the digital filter
42 //                 - 300 + 300Z
43 //  H(z)=    ------------------------
44 //           - 82.037242 + 517.96276Z
```