Scilab Manual for Advanced Digital Communication by Prof S K Satyanarayana Electronics Engineering Sreenidhi Institute Of Science And Technology[1]

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Experiment: 1

Reed Solomon Codes

check Appendix AP 9 for dependency:

ReedSolomon_Codes.sci

Scilab code Solution 1.1 1

```
1 //Reed-Solomon Codes
2 //Windows 7
3 //Scilab 6.0.0
4
5
6 //Note: Please run the ReedSolomon_Codes.sci
     dependency file before executing this program
7 n=16          //code word
8 k=4           //information bit
9 s=8           //no of bit symbols
10 ReedSolomon_Codes(n,k,s)
11
12 //n=16
13 //k=4
14 //s=8
15 //ReedSolomon_Codes(n,k,s)
16 //parity bits length in  s-bit byte n-k=
```

```
17 //
18 //    12.
19 //
20 // Code rate:r = k/n =
21 //
22 //    0.25
23 //
24 // It can detect any error upto =
25 //
26 //    12.
27 //
28 // It can correct any error upto =
29 //
30 //    6.
```

Experiment: 2

Duobinary Encoder & Decoder

check Appendix AP 8 for dependency:

```
xor_new.sci
```

Scilab code Solution 2.2 2

```
1  //Duobinary Encoding
2  //Windows 7
3  //Scilab 6.0.0
4
5  clc;
6  close;
7  //Note: Please run the xor.sci dependency file
       before executing this program
8  //Note: Don't run the clear command after running
       the dependency(xor.sci) as it contains the
       required funtion which will be cleared by the
       clear command
9  b=[0 ,1 ,0 ,1 ,1 ,1 ,0]; // input binary sequence :
       precoder input
10 a(1)=xor_new(1,b(1));
11 if(a(1)==1)
12 a_volts(1)=1;
```

```
end
for k=2:length(b)
    a(k)=xor_new(a(k-1),b(k));
    if(a(k)==1)
        a_volts(k)=1;
    else
        a_volts(k)=-1;
    end
end
a=a';
a_volts=a_volts';
disp(a,'Pre coder output in binary form : ')
disp(a_volts,'Pre coder output in volts : ')

//Duobinary coder output in volts
c(1)=1+ a_volts(1);
for k =2:length(a)
    c(k)=a_volts(k -1)+a_volts(k);
end
c=c';
disp(c,'Duobinary coder output in volts : ')

//Duobinary decoder output by applying decision rule
for k =1:length(c)
    if(abs(c(k))>1)
        b_r(k)=0;
    else
        b_r ( k ) = 1;
    end
end
b_r=b_r';
disp(b_r,'Recovered original sequence at detector
   output :')

//Output
// Pre coder output in binary form :
//
//    1.    0.    0.    1.    0.    1.    1.
```

```
50 //
51 // Pre coder output in volts :
52 //
53 //    1.   -1.   -1.    1.   -1.    1.    1.
54 //
55 // Duobinary coder output in volts :
56 //
57 //    2.    0.   -2.    0.    0.    0.    2.
58 //
59 // Recovered original sequence at detector output :
60 //
61 //    0.    1.    0.    1.    1.    1.    0.
```

Experiment: 3

Differential Phase Shift Keying

check Appendix AP 8 for dependency:

```
xor_new.sci
```

Scilab code Solution 3.3 3

```
1 //Generation of Differential Phase Shift Keying
    Signal
2 //Windows 7
3 //Scilab 6.0.0
4
5 clc;
6 close;
7 //Note: Please run the xor_new.sci dependency file
    before executing this program
8 //Note: Don't run the clear command after running
    the dependency(xor_new.sci) as it contains the
    required funtion which will be cleared by the
    clear command
9 bk = [1,0,1,1,0,1,1,1];//input digital sequence
10 for i = 1:length(bk)
11   if(bk(i)==1)
12     bk_not(i) =~1;
```

```
13    else
14      bk_not(i)= 1;
15    end
16  end
17  dk_1(1) = 1&bk(1);  //initial value of differential
       encoded sequence
18  dk_1_not(1)=0&bk_not(1);
19  dk(1) = xor_new(dk_1(1),dk_1_not(1))//first bit of
       dpsk encoder
20  for i=2:length(bk)
21    dk_1(i) = dk(i-1);
22    dk_1_not(i) = ~dk(i-1);
23    dk(i) = xor_new((dk_1(i)&bk(i)),(dk_1_not(i)&
         bk_not(i)));
24  end
25  for i =1:length(dk)
26    if(dk(i)==1)
27      dk_radians(i)=0;
28    elseif(dk(i)==0)
29      dk_radians(i)=%pi;
30    end
31  end
32  disp(bk,'(bk)')
33  bk_not = bk_not';
34  disp(bk_not,'(bk_not)')
35  dk = dk';
36  disp(dk,'Differentially encoded sequence (dk)')
37  dk_radians = dk_radians';
38  disp(dk_radians,'Transmitted phase in radians')
39
40  //Output
41  //(bk)
42  //
43  //    1.    0.    1.    1.    0.    1.    1.    1.
44  //
45  // (bk_not)
46  //
47  //    0.    1.    0.    0.    1.    0.    0.    0.
```

```
48 //
49 // Differentially encoded sequence (dk)
50 //
51 //    1.    0.    0.    0.    1.    1.    1.    1.
52 //
53 // Transmitted phase in radians
54 //
55 //
56 //          column 1 to 7
57 //
58 //    0.    3.1415927    3.1415927    3.1415927    0.
      0.    0.
59 //
60 //          column 8
61 //
62 //    0.
63 //
```

Experiment: 4

PseudoNoise Sequence Generator

check Appendix AP 7 for dependency:

```
xor.sci
```

Scilab code Solution 4.4 4

```
1
2 //Generate Maximum Length Pseudo Noise Sequence
3 //Windows 7
4 //Scilab 6.0.0
5
6 //Note: Please run the xor.sci dependency file
     before executing this program
7 //Assign Initial value for PN generator
8 x0= 1;
9 x1= 0;
10 x2 =0;
11 x3 =0;
12 x4= 0;
13 x5= 0;
14 x6= 0;
```

```
x7= 0;
x8= 0;
N = input('Enter the period of the signal')
for i =1:N
  x1 = x0;
  x8 =x7
  x7 =x6
  x0 =xor(x7,x1)
  x6 =x5
  x5 =x4
  x0 =xor(x1,x5)
  x4 =x3
  x3 =x2;
  x2 =x1;
  x0 =xor(x1,x3);
  disp(i,'The PN sequence at step')
  x = [x1 x2 x3 x4 x5 x6 x7 x8];
  disp(x,'x=')
end
m = [7,8,9,10,11,12,13,17,19];
Nl = 2^m-1;
disp('Table Range of PN Sequence lengths')
disp('Length of shift register (m)')
disp(m)
disp('PN sequence Length (N)')
disp(Nl)

//Execution
//Enter the period of the signal
//5
//
//
// The PN sequence at step
//
//    1.
//
// x=
//
```

```
53 //    1.    1.    0.    0.    0.    0.    0.    0.
54 //
55 // The PN sequence at step
56 //
57 //    2.
58 //
59 // x=
60 //
61 //    1.    1.    1.    0.    0.    0.    0.    0.
62 //
63 // The PN sequence at step
64 //
65 //    3.
66 //
67 // x=
68 //
69 //    0.    0.    1.    1.    0.    0.    0.    0.
70 //
71 // The PN sequence at step
72 //
73 //    4.
74 //
75 // x=
76 //
77 //    1.    1.    0.    1.    1.    0.    0.    0.
78 // The PN sequence at step
79 //
80 //    5.
81 //
82 // x=
83 //
84 //    1.    1.    1.    0.    1.    1.    0.    0.
85 //
86 // Table Range of PN Sequence lengths
87 //
88 // Length of shift register (m)
89 //
```

```
90 //    7.    8.    9.    10.    11.    12.    13.    17.
       19.
91 //
92 // PN sequence Length (N)
93 //
94 //
95 //          column 1 to 7
96 //
97 //    127.    255.    511.    1023.    2047.    4095.
       8191.
98 //
99 //          column 8 to 9
100 //
101 //    131071.    524287.
```

Experiment: 5

Unipolar NRZ

Scilab code Solution 5.5 5

```
1  //Unipolar NRZ
2  //Windows 7
3  //Scilab 6.0.0
4
5  clc;
6  clear;
7  close;
8
9  x = [0 1 0 0 0 1 0 0 1 1];
10 binary_zero = [0 0 0 0 0 0 0 0 0 0];
11 binary_one = [1 1 1 1 1 1 1 1 1 1];
12 L = length(x);
13 L1 = length(binary_zero);
14 total_duration = L*L;
15
16 //plotting
17 a =gca();
18 a.data_bounds =[0 -2;L*L1 2];
19 for i =1:L
```

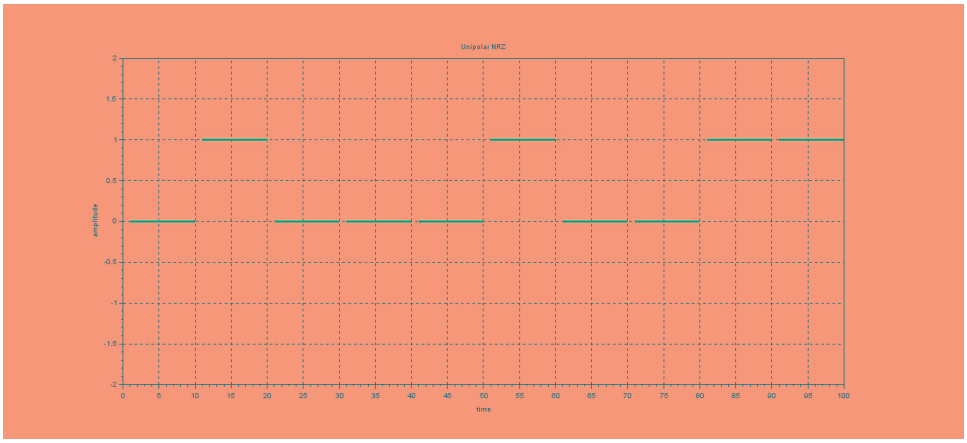


Figure 5.1: 5

```
20    if(x(i)==0)
21      plot([i*L-L+1:i*L],binary_zero);
22      poly1= a.children(1).children(1);
23      poly1.thickness =3;
24    else
25      plot([i*L-L+1:i*L],binary_one);
26      poly1= a.children(1).children(1);
27      poly1.thickness =3;
28    end
29  end
30  xgrid(1)
31  title('Unipolar NRZ')
32  xlabel('time')
33  ylabel('amplitude')
```

Experiment: 6

Uniform Quantization PCM

check Appendix AP 6 for dependency:

uniform_pcm.sci

Scilab code Solution 6.6 6

```
1
2 //Uniform Quantization - PCM
3 //Windows 7
4 //Scilab 6.0.0
5
6 //Note: Please run the uniform_pcm.sci dependency
     file before executing this program
7 x=[1,0,1,0,1,0,1,0]       //input sequence
8 L=3              //no of quantization levels
9 [SQNR,xq,en_code] = uniform_pcm(x,L)
10 disp(SQNR,'SQNR:')
11 disp(xq,'xq:')
12 disp(en_code,'en_code:')
13
14 //Execution
15 //[SQNR,xq,en_code] = uniform_pcm(x,L)
16 // en_code  =
```

```
17 //
18 //    2.    1.    2.    1.    2.    1.    2.    1.
19 //
20 // xq  =
21 //
22 //
23 //          column 1 to 4
24 //
25 //    0.6666667    0.    0.6666667    0.
26 //
27 //          column 5 to 8
28 //
29 //    0.6666667    0.    0.6666667    0.
30 //
31 // SQNR  =
32 //
33 //    9.5424251
```

Experiment: 7

Convolutional Coding using Transform Domain Approach

check Appendix AP 5 for dependency:

```
ConvolutionCode_TransDomain_new.sci
```

Scilab code Solution 7.7 7

```
1 //Convolutional Coding Using Transform Domain
    Approach
2 //Windows 7
3 //Scilab 6.0.0
4
5 clc;
6 close;
7 //Note: Please run the ConvolutionCode_TransDomain.
    sci dependency file before executing this program
8 //Note: Don't run the clear command after running
    the dependency(ConvolutionCode_TransDomain_new.
    sci) as it contains the required funtion which
    will be cleared by the clear command
9
10 //Execution
```

```
11 [x1D,x2D]= ConvolutionCode_TransDomain_new()
12
13 //Output
14 //Enter the generator polynomial 1=1+D^2+D^3
15 //
16 //Enter the generator polynomial 2=1+D^1
17 //
18 //Enter the message sequence1+D^1+D^2+D^3+D^4
19 //
20 //
21 // top output sequence
22 //
23 //    1.    1.    0.    1.    1.    0.    0.    1.
24 //
25 // bottom output sequence
26 //
27 //    1.    0.    0.    0.    0.    1.
```

Experiment: 8

Duobinary Signaling - Amplitude & Phase Response

check Appendix AP 4 for dependency:

`Duobinary_Signaling_new.sci`

Scilab code Solution 8.8 8

```
1 //Duobinary Signaling Scheme - Magnitude and Phase
    Response
2 //Windows 7
3 //Scilab 6.0.0
4
5 clc;
6 close;
7 //Note: Please run the Duobinary_Singaling.sci
    dependecy file before executing this program
8 //Note: Don't run the clear command after running
    the dependency(Duobinary_Signaling.sci) as it
    contains the required funtion which will be
    cleared by the clear command
```

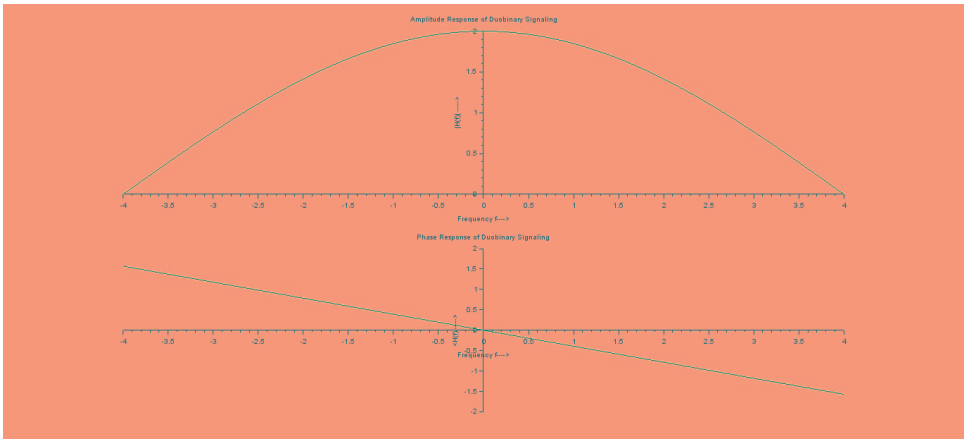


Figure 8.1: 8

```
9
10 //Execution
11 [Amplitude_Response,Phase_Response]=
       Duobinary_Signaling_new()
12
13 //Output
14 //Enter the bit rate= 8
```

Experiment: 9

Power Spectrum of Discrete PAM Signal

check Appendix AP 3 for dependency:

`PowerSpectra_PAM_new.sci`

check Appendix AP 1 for dependency:

`sinc_newfunc_new.sci`

Scilab code Solution 9.9 9

```
1 //Power Spectrum Of Discrete PAM Signals
2 //Windows 7
3 //Scilab 6.0.0
4
5 clc;
6 close;
7 //Note: Please run the sinc_newfunc.sci dependency
     file before executing this program
8 //Note: Please run the PowerSpectra_PAM.sci
     dependency file before executing this program
```

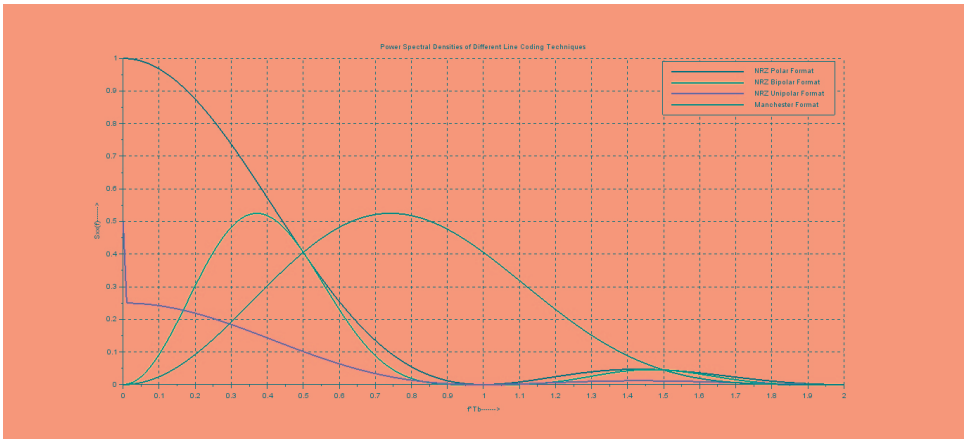


Figure 9.1: 9

```
9  //Note: Don't run the clear command after running
       the dependencies(sinc_newfunc_new.sci,
       PowerSpectra_PAM_new.sci) as it contains the
       required funtion which will be cleared by the
       clear command
10
11
12 //Execution
13 [Sxxf_NRZ_P,Sxxf_NRZ_BP,Sxxf_NRZ_UP,Sxxf_Manch]=
       PowerSpectra_PAM_new()
14
15 //Output
16 //Enter the Amplitude value:1
17 //Enter the bit rate:1
```

Experiment: 10

Power Spectrum of MSK & QPSK

check Appendix AP 2 for dependency:

`PowerSpectra_MSK_QPSK_new.sci`

check Appendix AP 1 for dependency:

`sinc_newfunc_new.sci`

Scilab code Solution 10.10 10

```
1 //Power Spectrums of QPSK and MSK
2 //Windows 7
3 //Scilab 6.0.0
4
5 clc;
6 close;
7 //Note: Please run the sinc_newfunc.sci dependency
     file before executing this program
8 //Note: Please run the PowerSpectra_MSK_QPSK.sci
     dependency file before executing this program
```

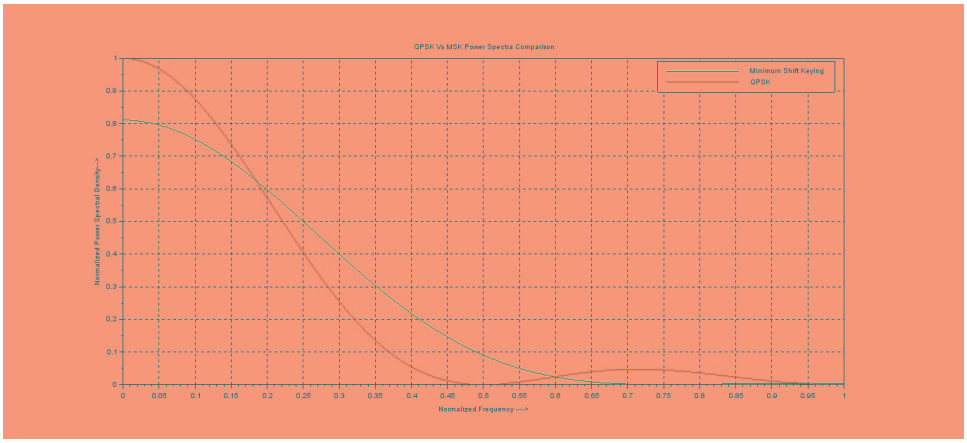


Figure 10.1: 10

```
9  //Note: Don't run the clear command after running
       the dependencies(sinc_newfunc_new.sci,
       PowerSpectra_MSK_QPSK_new.sci) as it contains the
        required funtion which will be cleared by the
       clear command
10
11 //Execution
12 [SB_MSK,SB_QPSK]= PowerSpectra_MSK_QPSK_new()
13 //Enter the bit rate in bits per second:2
14 //Enter the Energy of bit:1
```

Appendix

Scilab code AP 11

```
clc;
close;

function [y]=sinc_newfunc_new(x)
i=find(x==0);
x(i)= 1;
y = sin(%pi*x)./(%pi*x);
y(i) = 1;
endfunction
```

sinc new

Scilab code AP 12

```
clc;
close;

function [SB_MSK,SB_QPSK]= PowerSpectra_MSK_QPSK_new
    ()
rb = input('Enter the bit rate in bits per second:')
    ;
Eb = input('Enter the Energy of bit:');
f = 0:1/(100*rb):(4/rb);
Tb = 1/rb; //bit duration in seconds
for i = 1:length(f)
  if(f(i)==0.5)
    SB_MSK(i) = 4*Eb*f(i);
  else
    SB_MSK(i) = (32*Eb/(%pi^2))*(cos(2*%pi*Tb*f(i))
```

```
        /((4*Tb*f(i))^2-1))^2;
14    end
15      SB_QPSK(i)= 4*Eb*sinc_newfunc_new((2*Tb*f(i)))
          ^2;
16  end
17  a = gca();
18  plot(f*Tb,SB_MSK/(4*Eb));
19  plot(f*Tb,SB_QPSK/(4*Eb));
20  poly1= a.children(1).children(1);
21  poly1.foreground = 3;
22  xlabel('Normalized Frequency ---->')
23  ylabel('Normalized Power Spectral Density---->')
24  title('QPSK Vs MSK Power Spectra Comparison')
25  legend(['Minimum Shift Keying','QPSK'])
26  xgrid(1)
27  endfunction
```

MSK QPSK new

Scilab code AP 13

```
2  close;
3
4  function [Sxxf_NRZ_P,Sxxf_NRZ_BP,Sxxf_NRZ_UP,
     Sxxf_Manch]=PowerSpectra_PAM_new()
5  a = input('Enter the Amplitude value:');
6  fb = input('Enter the bit rate:');
7  Tb = 1/fb;  //bit duration
8  f = 0:1/(100*Tb):2/Tb;
9  for i = 1:length(f)
10   Sxxf_NRZ_P(i) = (a^2)*Tb*(sinc_newfunc_new(f(i)*Tb
       )^2);
11   Sxxf_NRZ_BP(i) = (a^2)*Tb*((sinc_newfunc_new(f(i)*
       Tb))^2)*((sin(%pi*f(i)*Tb))^2);
12   if (i==1)
13     Sxxf_NRZ_UP(i) = (a^2)*(Tb/4)*((sinc_newfunc_new
         (f(i)*Tb))^2)+(a^2)/4;
14   else
```

```
15      Sxxf_NRZ_UP(i) = (a^2)*(Tb/4)*((sinc_newfunc_new
           (f(i)*Tb))^2);
16    end
17    Sxxf_Manch(i) = (a^2)*Tb*(sinc_newfunc_new(f(i)*Tb
         /2)^2)*(sin(%pi*f(i)*Tb/2)^2);
18  end
19
20  //Plotting
21  a = gca();
22  plot2d(f,Sxxf_NRZ_P)
23  poly1= a.children(1).children(1);
24  poly1.thickness = 2;  // the thickness of a curve.
25  plot2d(f,Sxxf_NRZ_BP,2)
26  poly1= a.children(1).children(1);
27  poly1.thickness = 2;  // the thickness of a curve.
28  plot2d(f,Sxxf_NRZ_UP,5)
29  poly1= a.children(1).children(1);
30  poly1.thickness = 2;  // the thickness of a curve.
31  plot2d(f,Sxxf_Manch,9)
32  poly1= a.children(1).children(1);
33  poly1.thickness = 2;  // the thickness of a curve.
34  xlabel('f*Tb------->')
35  ylabel('Sxx(f)------->')
36  title('Power Spectral Densities of Different Line
       Coding Techniques')
37  xgrid(1)
38  legend(['NRZ Polar Format','NRZ Bipolar Format','NRZ
       Unipolar Format','Manchester Format']);
39  endfunction
```

PS PAM new

Scilab code AP 14

```
2  clear;
3  close;
4
5  function [Amplitude_Response,Phase_Response]=
       Duobinary_Signaling_new()
```

```
rb =  input('Enter the bit rate=');
Tb =1/rb;  //Bit duration
f = -rb/2:1/100:rb/2;
Amplitude_Response = abs(2*cos(%pi*f.*Tb));
Phase_Response = -(%pi*f.*Tb);
subplot(2,1,1)
a=gca();
a.x_location ="origin";
a.y_location ="origin";
plot(f,Amplitude_Response)
xlabel('Frequency f---->')
ylabel('|H(f)| ------>')
title('Amplitude Response of Duobinary Signaling')
subplot(2,1,2)
a=gca();
a.x_location ="origin";
a.y_location ="origin";
plot(f,Phase_Response)
xlabel('                          Frequency f---->')
ylabel('                         <H(f) ------>')
title('Phase Response of Duobinary Signaling')
endfunction
```

Duobinary Signalling new

Scilab code AP 15

```
clc;
clear;
close;

function [x1D,x2D]= ConvolutionCode_TransDomain_new
    ()
//g1D =  generator polynomial 1
//g2D =  generator polynomial 2
//x1D = top output sequence polynomial
//x2D = bottom output sequence polynomial
D = poly(0,'D');
g1D = input('Enter the generator polynomial 1=') //
    generator polynomial 1
```

```
12 g2D = input('Enter the generator polynomial 2=') //
      generator polynomial 2
13 mD = input('Enter the message sequence')//message
      sequence polynomial representation
14 x1D = g1D*mD; //top output polynomial
15 x2D = g2D*mD; //bottom output polynomial
16 x1 = coeff(x1D);
17 x2 = coeff(x2D);
18 disp(modulo(x1,2),'top output sequence')
19 disp(modulo(x2,2),'bottom output sequence')
20 endfunction
```

Conv Code new

Scilab code AP 16

```
1 clc;
2 clear;
3 close;
4
5 function [SQNR,xq,en_code] = uniform_pcm(x,L)
6   //x = input sequence
7   //L = number of qunatization levels
8  xmax = max(abs(x));
9 xq = x/xmax;
10 en_code = xq;
11 d = 2/L;
12 q = d*[0:L-1];
13 q = q-((L-1)/2)*d;
14 for i = 1:L
15     xq(find(((q(i)-d/2)<= xq)&(xq<=(q(i)+d/2))))=...
16     q(i).*ones(1,length(find(((q(i)-d/2)<=xq)&(xq<=(
         q(i)+d/2)))));
17     en_code(find(xq == q(i)))= (i-1).*ones(1,length(
         find(xq == q(i))));
18 end
19   xq = xq*xmax;
20   SQNR = 20*log10(norm(x)/norm(x-xq));
21 endfunction
```

uniformpcm

Scilab code AP 17

```
clc;
clear;
close;

// Function to perform XOR operation on the operands
function [value] = xor(A,B)
  if(A==B)
    value = 0;
  else
    value = 1;
  end
endfunction
```

xor

Scilab code AP 18

```
clc;
clear;
close;

// Function to perform XOR operation on the operands
function [value] = xor_new(A,B)
  if(A==B)
    value = 0;
  else
    value = 1;
  end
endfunction
```

XOR new

Scilab code AP 19

```
clc;
clear;
close;

function[n,p,r] = ReedSolomon_Codes(n,k,s)
```

```
6  //Single-error-correcting RS code with a s-bit byte
7  //n=code word
8  //k=information bit
9  //s=no of bit symbols
10 t =(n-k)/2; //single bit error correction
11 //n = 2^s-1; //code word length in 2-bit byte
12 p = n-k; //parity bits length in  2-bit byte
13 r = k/n; //code rate
14 //disp(n,'code word length in s-bit byte n =')
15 disp(p,'parity bits length in  s-bit byte n-k=')
16 disp(r,'Code rate:r = k/n =')
17 disp(2*t,'It can detect any error upto =')
18 disp(t,'It can correct any error upto =')
19 endfunction
```

ReedSolomonCodes