Scilab Textbook Companion for
Analog Communication
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Scilab numbering policy used in this document and the relation to the above book.

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

AP Appendix to Example(Scilab Code that is an Appednix to a particular Example of the above book)

For example, Exa 3.51 means solved example 3.51 of this book. Sec 2.3 means a scilab code whose theory is explained in Section 2.3 of the book.

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Chapter 2

Signals An Introduction

Scilab code Exa 2.1.A Periodicity

```
1
2 clear;
3 clc;
4            //a) periodicity os 5sin(6t-pi/4)
5 t=0:0.001:1;
6 w=6;
7 theta=%pi/4;
8 T=2*%pi/w;
9 x=cos(t*w+theta);
10 y=cos((t+T)*w+theta);
11 if ceil(x)==ceil(y) then
12     disp(' a) cos(6t+pi/4) is periodic with T=2*pi/6
           (sec) ')
13
14 else
15     disp('nonperiodic')
16 end
17
18
19            //b) periodicity of e^(j3t)
20
```

```
21    w=3;
22    t=0:0.001:1;
23    T=2*%pi/w;
24    x=exp(3*%i*t);
25    y=exp(3*%i*(t+T));
26     if ceil(x)==ceil(y) then
27      disp(' b) exp(j3t) is periodic with T=2*pi/3 (
          sec) ')
28
29 else
30      disp('nonperiodic')
31 end
32
33
34        //c) periodicity of cot(3t+theta)
35
36      t=0:0.001:1;
37 w=5;
38 T=%pi/w;
39
40   x=cotg(t*w+theta);
41   y=cotg((t+T)*w+theta);
42 if ceil(x)==ceil(y) then
43      disp(' c) cot(3t+Theta) is periodic with T=pi/5
          (sec) ')
44
45 else
46      disp('nonperiodic')
47 end
```

Scilab code Exa 2.2.A Even and Odd Part of function

```
1 clc;
2 clear;
3 t = 0:1:10;
```

```
 4
 5  for i = 1:length(t)
 6     x(i) = (t(i)^6) + 2*(t(i)^4)+ 3*(t(i)^2)+4  ;
 7  end
 8
 9  for i = 1:length(t)
10     y(i) = ((-t(i))^6)+ 2*((-t(i))^4)+ 3*((-t(i))^2)+4
            ;
11  end
12
13  // checking if the function is even x(t)=x(-t)
14  if x==y then
15      disp("the function is even");
16  end
17  //odd part of the signal=0.5(x(t)-x(-t))
18
19  z=0.5*(x-y);
20  if z==0 then
21      disp("the odd part is 0")
22  end
```

Scilab code Exa 2.2 Real and Imaginary part

```
 1  clc;
 2  clear;
 3
 4  /// e^j(*2*pi*f*t+theta)
 5
 6  syms pi f0 t theta A
 7  K=2*pi*f0*t+theta;
 8
 9  disp("the given signal is complex");
10  disp("e^(j*theta) can be written as");
11  disp("cos(theta)+j*sin(theta)");
12
```

```
13  Re=A*cos(K);
14  Img=A*sin(K);
15  mag=sqrt(Re^2+Img^2);
16
17  disp(Re,"real part is ");
18  disp(Img,"the imaginary part ");
19  disp(mag,"Magnitude of signal is |A|=");
20  disp(K,"phase of the signal ");
```

Scilab code Exa 2.3.A Power and Rms power of Signal

```
1  clear;
2  clc;
3
4    //x(t)=5u(t)....
5    amp=5; //amplitude is 5
6  t=0:0.01:1;
7  x0=0;
8  x1=0:0.1:10; //  over a time interval of T
9  disp("the power of the signal (in watts) is");
10   X=(integrate('25','x',x0,10)/(2*10)); // power of
        the signal
11  disp(X);
12
13  rms=amp/sqrt(2);
14  disp(rms,"the rms value of power is (in watts)");
```

Scilab code Exa 2.3 Energy of Signal

```
1  clc;
2  clear;
3
4  //x(t)=2 over an interval of (-2,2)
```

11

```
5
6  disp("the energy of the signal (in J) is");
7   Ex=(integrate('4','x',-2,2)); // energy content of
        the signal
8  disp(Ex);
```

Scilab code Exa 2.5 Properties of Impulse Signal

```
1  clc;
2  clear;
3
4
5  // delta(t)
6
7     for j = 1:1000
8           if j==1
9           delta(j)=1;
10      else
11          delta(j)=0;
12       end
13      end
14
15 // a)
16 figure(1)
17   t=-1;
18   plot2d4(t,0);
19      for j=1:1:10
20           t=t+1;
21         z(j)=(cosd(j-1)*delta(j));
22          plot2d3(t,z(j));
23          disp(z(j));
24
25      end
26
27
```

```
28  //b)
29  figure(2)
30   t=1.5;
31   plot2d4(t,0);
32      for j=3:1:10
33          t=t+1;
34          z(j)=abs(cosd(2.5)*delta(2*j-5));
35          plot2d3(t,z(j));
36
37      end
38
39  //c)
40  syms t;
41
42  A=(-1)*exp(-1*t); //property 8
43  disp(diff(A,t));
44
45  disp("when  t=3");
46
47  A=exp(-3);
48  disp(A);
```

Scilab code Exa 2.10 Laplace Transform

```
1
2
3  //x(t) = del(t)
4  syms t s;
5
6  L =laplace('delta(t)',t,s)
7  disp(L)
8  // x(t) = u(t)
9
10  L1 =laplace('1',t,s);
11  disp(L1)
```

13

```
12  //x(t) = sin(w0*t)u(t)
13
14  L2 =laplace('sin(w0*t)',t,s);
15  disp(L2)
```

Scilab code Exa 2.11 Z transform

```
1
2  clc;
3  clear;
4
5  // a) z-transform of unit impulse function
6  syms n z;
7  x=1;
8  X=symsum(x*(z^-n),n,0,0);
9  disp(X,'X(z)=');
10
11 //b) z-transform of unit step function
12
13 y=ones(1);
14 Y=symsum(y*(z^-n),n,0,%inf);
15 disp(Y,'Y(z)=');
```

Chapter 3

Amplitude Modulation

Scilab code Exa 3.1.A AM Sidebands

```
1  clc ;
2  clear ;
3  Fc =500;// carrier  frequency  in  kHz
4  Fm =1;//  message  signal  frequency  in  kHz
5  //a )
6
7  USB = Fc + Fm ;
8  LSB = Fc - Fm ;
9  disp ( USB ,"USBI ( in  kHZ )=" ) ;
10 disp ( LSB ,"LSB ( in  kHz )=" ) ;
11
12 //b )
13
14 Bandwidth = USB - LSB ;
15 disp ( Bandwidth ,"Bandwidth ( in  kHZ )=" )
16 //c )
17
18 Fm =1.5;// message  signal  frequency  in  kHz
19
```
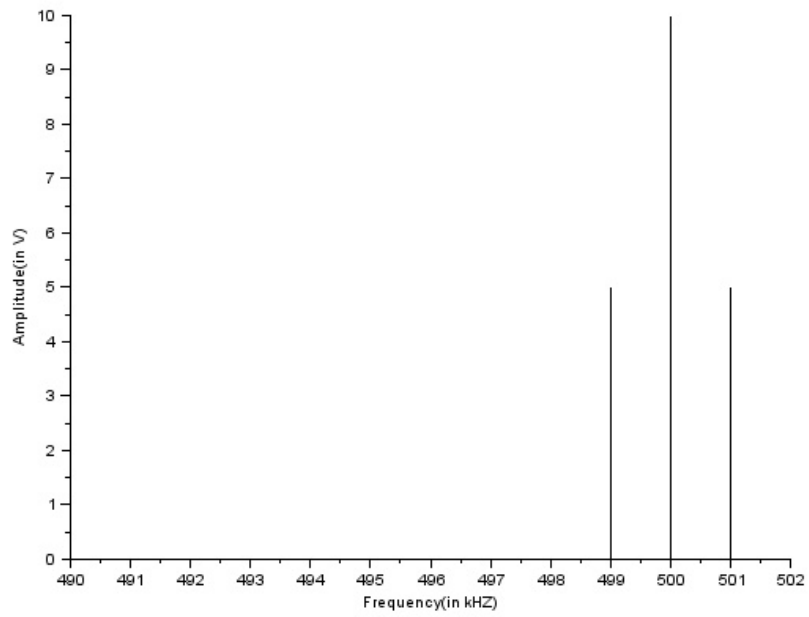
Figure 3.1: AM Sidebands

```
20  USB1=Fc+Fm;
21  LSB1=Fc-Fm;
22  disp(USB1,"USB( in  kHz)=" );
23  disp(LSB1,"LSB( in  kHZ)=" );
24
25
26  //d)
27
28  Amplitude=[0 0 0 0 0 0 0 0 0 5 10 5 0]; //sample
         values  as  denoted  in  textbook
29  frequency=490:1:502;
30
31   plot2d3(frequency,Amplitude);
32  xlabel(" Frequency( in  kHZ)" );
33  ylabel(" Amplitude( in  V)" );
```

Scilab code Exa 3.1 amplitude modulation

```
 1  clc;
 2  clear;
 3  Vm=3;// amplitude  of  message  signal  in  V
 4  Vc=5;//amplitude  of  carrier  signal  in  V
 5  m=Vm/Vc; //modulation  index
 6  disp(" modulation  index" );
 7  disp(m,"=" );
 8  disp(" Upper  Sideband  Frequency( in  MHz)" );
 9  Fm=4;//Frequency  in  KHz
10  Fc=5;//Frequency  in  MHz
11  disp(Fc+(Fm*10^(-3)),"=" );
12  disp(" Lower  Sideband  Frequency( in  MHz)" );
13  disp(Fc-(Fm*10^(-3)),"=" );
14  disp(" AMplitude  of  each  Sideband( in  V)" );
15  disp(m*Vc/2,"=" );
```
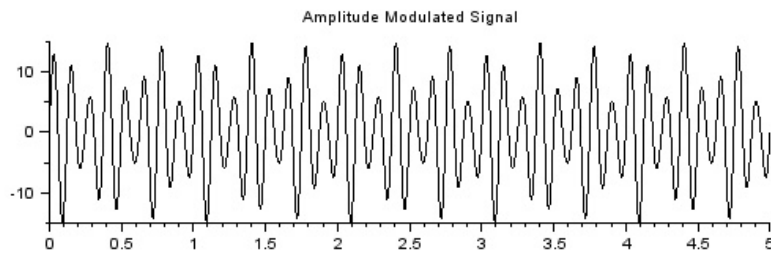
Figure 3.2: Amplitude Modulation

Scilab code Exa 3.2.A Amplitude Modulation

```
1 clear;
2 clc;
3
4
5 Fm=3; //frequency of message signal
6 Fc=8; //frequency of carrier signal
7 Ea=5;
8 Eb=10;
```

```
9  m=Ea/Eb; //modulation index
10
11 disp(m,"m=");
12 USf=Fc+Fm*10^(-3);//Upper Sideband frequency
13 LSf=Fc-Fm*10^(-3);//Lower sideband frequency
14 disp(USf,"USf(Mhz)=");
15 disp(LSf,"LSf(Mhz)=");
16 Amp=m*Eb/2;// amplitude of each sideband
17 disp(Amp,"amp(v)=");
18
19
20
21 function[x,Vm,Vc]=ampmod(Ea,Eb,m,Fc,Fm)
22     t=0:0.005:5;
23
24     Vm = Ea*sin(2*%pi*Fm*t);
25     Vc = Eb*sin(2*%pi*Fc*t);
26
27     x = ((Eb+Ea*sin(2*%pi*Fm*t))).*(sin(2*%pi*Fc*t))
         ;
28
29     subplot(3,1,2);
30     plot2d(t,x);
31     title('Amplitude Modulated Signal');
32 endfunction
33
34 ampmod(Ea,Eb,m,Fc,Fm)//amplitude modulation
```

Scilab code Exa 3.2 Total power of AM wave

```
1 clc;
2 clear;
3 Pc=300;// Power of the carrier in W
4 m=0.6// modulation index
5 Pt=Pc*(1+(m^2)/2); //total power
```

```
6 disp(" Total power in the modulated wave(in W) is");
7 disp(Pt);
```

___

Scilab code Exa 3.3.A Efficiency of DSBFC

```
1  clc;
2  clear;
3  disp(" efficiency (n)=(useful power/total power)*100%"
       );
4  disp("          =total sideband power/(total sideband
       power+carrier power)*100%");
5
6  syms m Pc
7  N=[((m^2)*Pc/2)/(Pc*(1+(m^2)/2))];
8  disp("*100% ",N);
9
10 disp("
   _____
       ");
11 m=0.7 //modulation index
12
13
14 n=[m^2/(m^2+2)]*100;  //efficiency
15 disp(n," the percentage of useful power is ");
```

___

Scilab code Exa 3.3 Modulation index

```
1  clc;
2  clear;
3  Pt=11.5;//Total power in kW
4  Pc=10;// Carrier power in kW
5  //a)
6
```

```
7  m_square=2*((Pt/Pc)-1);
8  m=sqrt(m_square);//modulation index
9
10 //b)
11 m2=0.5;
12 mt=sqrt(m^2 +m2^2);
13 Pt=Pc*(1+mt^2/2); //total power in kW
14
15 disp(m,"modulation index is ");
16 disp(Pt,"Total carrier power(in kW) ");
```

Scilab code Exa 3.4.A DSBFC

```
1  clc;
2  clear;
3  Vc=8;// carrier signal voltage in V
4  m=1;//modulation index
5  R=8;//resistance in ohms
6  //a)
7
8  Pc=Vc^2/(2*R);
9  disp(Pc,"power of the carrier(in W) is");
10 Ps=m^2*Pc/4;
11 disp(Ps,"Power in each Side-Bands(in W)");
12
13 //b)
14 disp(2*Ps,"Total sideband Power(in W)");
15
16 //c)
17 disp(Pc+2*Ps,"Total Power of Modulated wave(in W)");
18
19 //d)
20 disp(2*Ps/(Pc+2*Ps)*100,"Efficiency Percentage");
```

Scilab code Exa 3.4 Modulation index and power

```
1  clc ;
2  clear ;
3  m1 =0.3;
4  m2 =0.4;
5  m3 =0.5;
6  m4 =0.6; // modulation indices
7  Pc =150; // power of carrier in Watts
8
9  mt = sqrt ( m1^2+m2^2+m3^2+m4^2 ) ; // total modulation
       index
10
11 Pt = Pc *(1+ mt^2/2) ; // Total transmitted power in Watts
12
13 Ps =( mt^2 ) * Pc /4; // Sideband Power in Watts
14
15 disp ( mt ," Total Modulation index ") ;
16
17 disp ( Pt ," Total Transmitted Power ( in W )") ;
18
19 // change in answer as compared to book , due to
       approximation error ..
20 disp ( Ps ," Sideband Power ( in W )")
```

Scilab code Exa 3.5.A Amplitude Modulation

```
1  clc ;
2  clear ;
3  m1 =0.3;
4  m2 =0.4;
5  m3 =0.5;
```

```
6  m4 =0.6;  //modulation indices
7  Pc =80; // Power in carrier signal
8
9  mt = sqrt ( m1 ^2+ m2 ^2+ m3 ^2+ m4 ^2);
10
11 //a)
12 disp ( mt ," Total Coefficient of Modulation ");
13
14 // calculation error in book
15
16 //b)
17 Ps =( mt ^2)* Pc /2;
18 disp ( Ps ," Sideband powers ( in W) ");
19
20 //c)
21 disp ( Pc +2* Ps ," Total Transmitted Power ( in W)");
22
23 //d)
24 disp (( Ps /( Pc +2* Ps ))*100 ," Efficiency Percentage");
```

Scilab code Exa 3.5 Peak Envelope Power and average power

```
1  clc ;
2  clear ;
3  fLSB1 =395;
4  fLSB22 =397.5; // Two LSB frequencies in kHz
5  E1 =4;
6  E2 =3; // peak voltages of modulating signal in V
7  R =60; // resistor in ohms
8
9  Et = sqrt ( E1 ^2+ E2 ^2);
10
11 Erms = Et *0.707;
12
13 PEP =(( Et *0.707)^2)/ R ; // Pak Envelope Power in W
```

```
14
15 Avg_Power=PEP/2;
16
17 disp(PEP,"Peak Envelope Power(in W)");
18 disp(Avg_Power,"Average Power(in W)");
```

Scilab code Exa 3.7.A Diagonal Clipping

```
1 clc;
2 clear;
3 Fc=10;// carrier Frequency in kHz
4 R=15;// Resistance in Kohms
5 C=660;// Capacitance in pF
6 a=1/R;
7 b=2*%pi*Fc*10^(3)*C*10^(-12);
8 Y=a+%i*b;
9 Z=1/abs(Y);
10 // after rounding off
11 Z=12.83// Impedence in Kohms
12 m=Z/(R);// modulation index
13 disp(m,"MAximum modulation index to avoid diagonal
       clipping is");
```

Scilab code Exa 3.8.A Sideband Frequencies

```
1 clc;
2 clear;
3
4
5 syms Ec Fc Fm pi t
6
7 Wave=Ec*cos(2*pi*Fm*t)*cos(2*pi*Fc*t)+Ec*sin(2*pi*Fm
      *t)*sin(2*pi*Fc*t);
```

```
 8   disp("when the wave is");
 9   disp(Wave);
10
11  f_upper=Ec*cos(2*pi*(Fc+Fm)*t);
12  disp("We get the upper sideband as");
13  disp(f_upper);
14
15
16  f_lower=Ec*cos(2*pi*(Fc-Fm)*t);
17  disp("We get the lower sideband as");
18  disp(f_lower);
```

Chapter 4

Angle Modulation

Scilab code Exa 4.1.A Frequency Deviation

```
1
2 clc;
3 clear;
4 Freq_dev=6; //Frequency Deviation in kHz
5 Vm=3; //Modulating Voltage in V
6
7 Dev=Freq_dev*10^(3)/Vm;
8
9 // for Vm=6V
10
11 Vm=6;
12 Freq_dev_new=Dev*Vm;
13
14 disp(Freq_dev_new,"the new deviation( in Hz)");
```

Scilab code Exa 4.1 phase and frequency deviation

```
1 clc;
```

```
2  clear;
3
4  t=0:0.01:1;
5  Freq=2*%pi*10^(5)+3*2*%pi*100*cos(2*%pi*100*(t));//
        Phase=2*%pi*10^(5)*t+3*sin(2*%pi*100*t);
6
7  t1=0.4;// time in ms
8  Ang_Freq=2*%pi*10^(5)+3*2*%pi*100*cos(2*%pi*100*(t1
        *10^(-3)));
9  Freq=Ang_Freq/(2*%pi);
10
11  //change in answer due to calculation error in book
12  disp(Freq,"Instantaneous Frequency(in Hz) at (t=0.4
        ms)N =");
13
14
15  Max_pha_Dev=3;  //max(3 sin(2*%pi*100 t))
16
17  disp(Max_pha_Dev," Maximum Phase Deviation(in rad) =
        ");
18
19  Max_fre_Dev=6*%pi*100;//max(6*pi*100*cos(2*pi*100t))
20
21
22
23  disp(Max_fre_Dev/(2*%pi),"MAximum Frequency Deiation
        (in Hz)");
```

Scilab code Exa 4.2.A Power in FM system

```
1  clc;
2  clear;
3  Wc=8*10^(8);// Angular Frequency of Carrier Signal
4  fc=Wc/(2*%pi);
5
```

```
 6  Wm=1300;//Angular Frequency of Message Signal
 7  fm=Wm/(2*%pi);
 8
 9  B=3;//Modulation Index
10  R=12;
11  Vc_rms=15/sqrt(2);
12
13  Max_dev=B*fm;
14  Power=Vc_rms^(2)/R;
15
16  disp(Power,"Power Dissipated (in W) is");
```

Scilab code Exa 4.2 Peak Frequency Deviation

```
 1  clc;
 2  clear;
 3  a=3;//amplitude in volts
 4  Dev_sen=4;// deviation sensitivity in KHz/volts
 5  fm=1.5;// frequency modulating signal in KHz
 6
 7  f=Dev_sen*10^(3)*3;//peak frequency deviation
 8  B=f/(fm*10^3);
 9
10  disp(f,"Peak Frequency Deviation( in Hz) ");
11  disp(B,"modulation index ");
```

Scilab code Exa 4.3.A BAndwidth of FM

```
 1  clc;
 2  clear;
 3  fm=3; //Modulating Frequency in kHZ
 4  Max_Dev=18; //MAximum Deviation in kHz
 5
```

```
6   B=Max_Dev/fm; //modulation index
7
8   J=12;//from Bessel Table, for B=6
9   Bw=fm*J*2*10^(3);
10
11  disp(Bw,"The Bandwidth (in Hz) is") ;
```

Scilab code Exa 4.3 Peak Phase Deviation

```
1  clc;
2  clear;
3  Dev_sen=3.5;// Deviation Sensitivity in rad/volt
4  a=2.5;// amplitude in volts
5
6  B=a*Dev_sen; //Peak Phase Deviation
7
8  disp(B,"Peak Phase Deviation( in rad)");
```

Scilab code Exa 4.4.A Peak Deviation in FM

```
1  clc;
2  clear;
3  Wm=18850;//Angular Frequency of message signal
4  fm=Wm/(2*%pi);
5  a=3;// amplitude of message signal
6
7  Dev_sen=6;//Deviation Sensitivity in kHz/V
8  Max_Freq_Dev=a*Dev_sen*10^(3);
9
10 B=Max_Freq_Dev/(fm);
11
12 disp(Max_Freq_Dev,"Maximum Frequency Deviation(in Hz
       )");
```

```
13  disp(B,"Modulation Index");
```

Scilab code Exa 4.4 Frequency Modulation

```
1  clc;
2  clear;
3  a=3; //amplitude in Volts
4  Dev=4;// Deviation in kHz
5  fm=1;// modulating frequency in kHz
6
7  Dev_sen=Dev*10^(3)/a; //Deviation Sensitivity
8  B=Dev/fm; // Modulation Index
9
10 disp(Dev_sen,"Deviation Sensitivity(in kHz/V)");
11 disp(B,"Modulation Index");
12
13 //a)
14 a=5;
15 Dev_sen_1=a*Dev_sen;
16 B=Dev_sen_1/(fm*10^(3));
17
18 disp(Dev_sen_1,"Deviation Sensitivity for 5V (in Hz)
      ");
19 disp(B,"Modulation index");
20
21
22 //b)
23 a=10;
24 fm=400;
25 Dev_sen_2=a*Dev_sen;
26 B=Dev_sen_2/fm;
27
28
29 disp(Dev_sen_2,"Deviation Sensitivity for 10V (in Hz
      )");
```

```
30 disp(B,"Modulation index");
```

Scilab code Exa 4.5.A side frequencies and Aplitudes

```
1  clc;
2  clear;
3  disp("for B=2, The number of significant frequencies
         are 6");
4  disp("They are J1,J2,J3,J4,J5 and J6");
5  disp('Their amplitudes with carriers are');
6  J0= 0.224*8;
7  J1= 0.577*8;
8  J2= 0.353*8;
9  J3= 0.129*8;
10 J4= 0.034*8;
11 J5= 0.007*8;
12 J6= 0.001*8;
13 disp(J6, J5,J4,J3,J2,J1,J0,"they are (in V)");
```

Scilab code Exa 4.5 CArson Bandwidth

```
1  clc;
2  clear;
3  fm=3; //Modulating Frequency in kHZ
4  Max_dev=15;// Maximum Deviatin in kHZ
5
6  B=Max_dev/fm;
7
8  J=8; // Bessel table,the highest J coefficient
9  BW=J*fm*10^(3);//Bandwidth in kHz
10
11 BW1=2*(fm+Max_dev)*10^(3);//  According to carson
       rule , BAndwidth
```

```
12
13 disp(BW,"Bandwidth required (in Hz)");
14 disp(BW1,"According to Carsons rule, Bandwidth(in Hz
       )");
```

Scilab code Exa 4.6.A Carson Bandwidth

```
1  clc;
2  clear;
3  Max_Freq_Dev=12; //Maximum Frequency Deviation in
       kHZ
4  fm=6; //Modulating frquency in kHz
5
6  B=Max_Freq_Dev/fm;// Modulation index
7
8  J=6;//From Bessel Table, for B=2
9
10 Bw=2*J*6*10^(3);
11 BW_carson=2*(fm + Max_Freq_Dev)*10^(3);
12
13 disp(Bw," Minimum Bandwidth (in Hz) is");
14 disp(BW_carson," Approximate Minimum Bandwidth
       according to carson rule( in Hz) is");
```

Scilab code Exa 4.6 Average Power of signal

```
1  clc;
2  clear;
3  a=10; //Amplitude in V
4  Pt=a*(0.18^2 +2*(0.33^2
       +0.05^2+0.36^2+0.39^2+0.26^2+0.13^2+0.05^2+0.02^2+0.01^2)
       );
5
```

```
6  disp (" For B=5 from the Bessel table ,The Bessel
       Function is taken upto J9 ") ;
7  disp (Pt ," Hence the average power of the modulated
       signal ( in W) is ") ;
8  disp (" Hence , the average power of the modulated
       signal is equal to ") ;
9  disp (" unmodulated carrier power ") ;
```

Scilab code Exa 4.7.A Unmodulated Carrier Power

```
1  clc ;
2  clear ;
3  a =8;// amplitude in V
4  r =30;  // resistance in ohms
5
6  Pc_unmodulated = a ^2/(2* r ) ;
7  Pt =1.792^2/(2*30) +2*(4.616) ^2/(2*30) +2*(2.824^2)
       /(2*30) +2*(1.032) ^2/(2*30) +2*(0.272) ^2/(2*30)
       +2*(0.056) ^2/(2*30) +2*(0.008) ^2/(2*30) ;
8
9  // change in answer due to approximations in the
       book
10
11 disp (Pc_unmodulated ," Unmodulated Power Carrier ( in W)
       =") ;
12 disp (Pt ," Total Power  in modulated wave ( in W)=") ;
13 disp (" Power in the modulated wave is equal to ") ;
14 disp (" power  in the unmodulated wave ") ;
15 disp (" Small error due to rounded off values in
       Bessel functions ") ;
```

Scilab code Exa 4.7 Phase Modulation

```
1  clc;
2  clear;
3  syms t pi;
4
5  Pha_dev=3; //Phase_Deviation constant in rad/V
6
7  // Phase Modulation Function
8
9  Pha_function=Pha_dev*4*sin(2*pi*1.5*10^(3)*t);
10 Mod_wave=8*cos(2*pi*10^(4)*t) +Pha_function
11
12 disp( Pha_function,"the Phase Modulation Function =
       ");
13
14 disp(Mod_wave ,"The Modulated Wave Function = ");
```

Scilab code Exa 4.8.A Balanced Modulator

```
1  clc;
2  clear;
3
4  initial_Freq_Dev=5; //frequency in kHz
5  B_initial=0.5; //modulation index
6  fm_initial=10;// message signal frequency in kHz
7  fc_initial=800; //carrier frequency in kHz
8
9  disp("The outputs of the balanced modulator for
       these parameters");
10 disp("are same as the inputs");
11 disp("They remain unaltered");
12
13 //at the output of the multiplier
14
15 m=12;// multiplication factor
16
```

```
17  final_Freq_Dev=initial_Freq_Dev*m;
18  B_final=0.5*m;
19  fm_final=10; //modulating signal remains unaltered
20  fc_final=800*m;
21
22  disp("At the output of the Multiplier,");
23  disp(fc_final,"Fc(in kHz)=",fm_final,"Fm(in kHz)=",
        B_final,"B=");
24  disp(final_Freq_Dev," Frequency Deviation(in kHz)=")
        ;
```

Scilab code Exa 4.9.A Frequency Deviation

```
1  clc;
2  clear;
3  ft=100.2; //final carrier frequency in MHz
4  Freq_Dev_ft=60;// Frequency Deviation in KHz at
        power amplifier
5  fm=10;//modulating frequency in KHz
6  m=25;//multiplication factor
7
8  //a)
9  fc=ft/25;
10
11 //b)
12 Freq_Dev=Freq_Dev_ft/25;
13
14 //c)
15 B=Freq_Dev/fm;
16
17 //d)
18 Bt=B*m;
19
20 disp(fc,"a) MAster Oscillator Centre Frequency(in
        MHz) =");
```

```
21  disp(Freq_Dev, "b) Frequency Deviation at the output
        of modulator(in KHz)=");
22  disp(B,"c)Devaition ratio at the output of modulator
        ");
23  disp(Bt,"d)deviation ratio at power amplifier");
```

Scilab code Exa 4.10.A Angle Modulation

```
1  clc;
2  clear;
3
4  // f(t)=5cos(Wc*t+3sin(2000*t)+5sin(2000*pi*t))
5
6  fm=2000*%pi/(2*%pi); //bandwidth is the highest
        frequency component
7
8  //a)
9
10  Freq_dev=(6000+10000*%pi)/(2*%pi);
11
12  //b)
13
14  B=Freq_dev/fm;
15
16  //c)
17  Phase_dev=8;//Highest value of [3sin(2000t)+5sin
        (2000*pi*t)]
18
19  //d)
20  Bw= 2*(fm+Freq_dev);
21
22  disp(Freq_dev," a) Frequency Deviation(in Hz)=");
23  disp(B," b) Devaition Ratio=");
24  disp(Phase_dev," c) Phase Deviation( in rad)=");
25  disp(Bw," d) Bandwidth( in Hz)=")
```

Chapter 5

Pulse Modulation

Scilab code Exa 1.A Sample and Hold

```
1 clear ;
2 clc ;
3 //(" current through the capacitor is i=C(dv/dt )");
4
5 t =15; // acquisition time in us
6 i =5; // current in mA
7 v =5; // maximum voltage across capacitor in V
8
9
10 // to satisfy current requirement
11 disp (" to satisfy current requirement ");
12 C_current_req=i*t/v;
13 disp (C_current_req ,"C(nF)=" );
14
15 //to satisfy accuracy requirement
16 disp (" to satisfy accuracy requirement ");
17
18 C_accuracy_req=t /(6.9*15) *1000;// to convert into "
    nanoFarad"
19
20 disp (C_accuracy_req ,"C(nF)=" );
```

```
21
22  disp("to satisfy both requirements,smaller of the
        two can b taken");
```

Scilab code Exa 5.1 Sampling

```
 1  clear;
 2  clc;
 3  disp("for 8-KHz sampling,the frequencies present are
        ...(in KHz)");
 4
 5  Fs=8; //sampling frequency
 6  Fst=3.5 //single tone frequency
 7
 8  disp(Fst);
 9  disp(-Fst);
10  disp(Fs-Fst);
11  disp(-(2*Fs+Fst),(2*Fs+Fst),-(Fs+Fst),(Fs+Fst),(Fs-
        Fst));
12  disp("...etc...");
13
14  disp("in this case, if the LPF is designed with cut-
        off frequency(8/2= 4-KHz)");
15  disp("then the maximum passable frequency is 3.5-KHz
        ");
16  disp("for 5-KHz sampling,the frequencies present are
        ...(in KHz)");
17
18  Fs=5;//new sampling frequency
19  disp(Fst);
20  disp(-Fst);
21  disp(Fs-Fst);
22  disp(-(2*Fs+Fst),(2*Fs+Fst),-(Fs+Fst),(Fs+Fst),(Fs-
        Fst));
23  disp("...etc...");
```

```
24
25 disp("in this case, if the LPF is designed with cut−
      off frequency(5/2=2.5−KHz)");
26 disp("then the original signal cant be passed");
27 disp("therefore, the signal cant be reconstructed");
```

Scilab code Exa 5.2.A Aliasing Frequency

```
1 clc;
2 clear;
3 F_audio=5; //Audio input Frequency in kHz
4
5 F_sampling=2*F_audio;
6
7 disp(F_sampling,"The Minimum Sampling Frequency (in
      kHz)");
8
9 disp("When the audio Frequency of 6 Khz enters the
      Sample and Hold circuit");
10 disp("it will overlap the audio spectrum, and the
      alaising frequency is 4 kHz");
```

Scilab code Exa 5.2 Sampling Rate

```
1 clc;
2 clear;
3
4 //x(t)=2sin(4000*pi*t)+3sin(5000*pi*t)+4sin(8000*pi*
      t)
5
6 fh=8000/2;
7 fl=4000/2;
8
```

```
 9  disp(fh,"a) Highest Frequency component(in Hz)");
10  disp(fl,"Lowest Frequency component(in Hz)");
11
12  fs=2*fh;
13  disp(fs," Minimum Sampling frequency(in Hz)");
14
15  Bw=fh-fl;
16  disp(Bw," b)Bandwidth(in Hz) is");
17
18  n=fh/Bw;
19  disp(n,"integer factor");
20
21  Fs_new=2*fh/n;
22  disp(Fs_new,"Required Sampling frequency in this
        case(in Hz) is");
```

Scilab code Exa 5.3.A PCM system

```
 1  clc;
 2  clear;
 3  fm=5;// maximum analog frequency in kHz
 4  Min_dyna_range=35;
 5  Vr=3;  //Voltage in the receiver in V
 6
 7  //a)
 8  F_sampling=2*fm;
 9
10  //b)
11  n=Min_dyna_range/6;
12  k=(Vr-(-Vr)+1);// inclusive of sign bit
13
14  //c)
15  Resolution=Vr/(2^(7));
16
17  //d)
```

```
18  Max_quant_Error=Resolution/2
19
20  disp(F_sampling,"a)Minimum Sampling Rate(in kHz) =")
      ;
21  disp(n,"b) Minimum dynamic Range is");
22  disp(" But Closest whole number is 6. Henc,6 bits
      must be used for amplitude" );
23  disp("But the amplitude range is from −3 to +3 V,
      hence a sign bit also   ");
24  disp( k,"becomes necessary .. Therefore ,the total
      number of bits");
25  disp(Resolution,"c) Resolution(in V) =");
26  disp(Max_quant_Error," d)MAximum Quantization Error
      (in V) ");
```

Scilab code Exa 5.4.A Bandwidth of PCM system

```
1  clc;
2  clear;
3  n=16;// Number of telephone lines
4  m=256;//Quantization levels
5  q=8;// since 2^(q)=256
6
7  fs=10;//Sampling frequency in kHz
8
9  Bw=[(16*9)+1]*10*10^(3);
10
11  disp(Bw,"Bandwidth (in Hz ) is");
```

Chapter 6

Noise

Scilab code Exa 6.A Thermal Noise Power

```
1  clc ;
2  clear ;
3  T =290;// Temperature in K
4  B =15;  // Bandwidth in KHz
5  k =1.38*10^( -23);  // Boltzman constant
6  R =60;  // resistance in ohms
7
8  N = k * T * B *10^(3);  // Therman Noise Power in watts
9  N_dBm =10* log10 ( N /0.001) ;// in dBm
10
11 Vrms = sqrt (4* R * k * T * B *10^(3));
12
13 disp ("thermal noise power (in watts) is");
14 disp ( N );
15 disp ("thermal noise power (in dBm) is");
16 disp ( N_dBm );
17 disp ("RMS noise voltage (in Volts) is");
18 disp ( Vrms );
```

Scilab code Exa 6.1 Thermal Noise

```
1 clear;
2 clc;
3 T=290; // temperature in kelvin
4 k=1.38*10^(-23); // Boltzman constant
5 B=1;// bandwidth in MHz
6
7 P=k*T*B*10^(6); // thermal noise power
8 disp("the thermal noise power (in watts) is ");
9 disp(P);
```

Scilab code Exa 6.2.A SNR and Noise Figure

```
1 clc;
2 clear;
3
4 Inp_sig_pow=1.5*10^(-9); //Input Signal Power in
      Watts
5 Inp_noi_pow=1.5*10^(-18); //Input Noise Power in
      Watts
6 Pow_gain=10^(6);
7 int_noi=4*10^(-12); //internal noise in watts
8
9 //a)
10 Inp_SNR=10*log10(Inp_sig_pow/Inp_noi_pow);// input
      SNR in dB
11
12 //b)
13 Nout=Pow_gain*Inp_noi_pow+int_noi //output output
      noise power
14
15 Pout=Pow_gain*Inp_sig_pow //output signal power
16
17 SNR=Pout/Nout;// Signal to Noise ratio
```

```
18  SNRout =10* log10 ( SNR );// Output SNR in dB
19
20  //c)
21  F =10^(9) /(273*10^(6) ); // Noise factor
22  NF =10* log10 (F );// Noise figure in dB
23
24  disp (" Input SNR ( in dB ) is ");
25  disp ( Inp_SNR );
26  disp (" Output SNR ( in dB ) is ");
27  disp ( SNRout );
28  disp (" Noise factor ");
29  disp (F );
30  disp (" Noise Figure ( in dB )");
31  disp ( NF );
```

Scilab code Exa 6.2 Noise voltage

```
1  clc ;
2  clear ;
3  T =290;// temperature in kelvin
4  R =60;// resistance in ohms
5  k =1.38*10^( -23) ;
6
7  Esquare =4* R*T*k ;
8  E= sqrt ( Esquare ); // noise voltage
9
10 disp (" the noise voltage ( in volts ) is ")
11 disp (E );
```

Scilab code Exa 6.3.A Noise Voltage

```
1  clc ;
2  clear ;
```

```
 3  q=1.6*10^(-19);// electron charge
 4  Ieq=5;//equivalent shot noise current in uA
 5  Bn=8;//bandwidth in MHz
 6  Rn=200;
 7  Rs=100;//resistance in ohms
 8  k=1.38*10^(-23);// boltzman constant
 9  T=290;//temperature in K
10  Vs=10// RMS signal source volatage in uV
11
12  In=sqrt(2*Ieq*q*Bn);
13
14  Vni=Rs*In;//shot noise voltage
15
16  Vns=sqrt(4*Rs*k*T*Bn*10^(6));//thermal noise volatge
        from source
17
18  //change in answer due to calculation error in book
19  Vne=sqrt(4*Rn*k*T*Bn*10^(6));//noise voltage by
       equivalent noise resistance
20
21  Vn=sqrt(Vni^2+Vns^2+Vne^2);// total noise voltage
22
23  SNR=20*log10(Vs*10^(-6)/Vn);
24
25  disp("shot noise voltage(in V) is ");
26  disp(Vni);
27  disp("thermal noise voltage from source(in V) is");
28  disp(Vns);
29  disp("noise voltage by equivalent noise resistance(
      in V) is");
30  disp(Vne);
31  disp("total noise voltage at the input(in V) is");
32  disp(Vn);
33  disp("SNR (in dB) is");
34  disp(SNR);
```

Scilab code Exa 6.3 Thermal Noise Voltage

```
1  clear ;
2  clc ;
3  B =150; // bandwidth in KHz
4  R1 =30;
5  R2 =60; // both resistors R1 and R2 in K-ohms
6  k =1.38*10^( -23); // boltzman constant
7  T =290; // temperature in Kelvin
8
9  Esquare =4* R1 *10^(3) *k*B*10^(3) *T;
10 E= sqrt ( Esquare );
11
12 disp (" series combination Rseries ( in K-ohms )=");
13 disp ( R1+R2 );
14 Eseries =E* sqrt (3);
15 disp (" the thermal noise voltage ( in volts ) is");
16 disp ( Eseries );
17
18 disp (" series combination Rseries ( in K-ohms )=");
19 disp ( R1*R2 /( R1+R2 ));
20 Eparallel =E* sqrt (2/3);
21 disp (" the thermal noise voltage ( in volts ) is");
22 disp ( Eparallel );
```

Scilab code Exa 6.4.A Output SNR

```
1  clc ;
2  clear ;
3  S =4; // number of stages
4  SNR_input =55; // input Signal to Noise ratio in dB
5
```

```
6 SNR_output = SNR_input -10* log10 (S);
7
8 disp (" Output SNR ( in dB) is ") ;
9 disp ( SNR_output );
```

Scilab code Exa 6.4 Shot Noise

```
1 clc ;
2 clear ;
3
4 Idc =2; // direct current in mA
5 q =1.6*10^( -19) ; // electron charge
6 B =3; // bandwidth in MHz
7
8 Isquare =2* Idc *10^( -3) *q*B *10^6;
9 I= sqrt ( Isquare ); // shot noise component
10
11 disp (" the shot noise component (in amperes ) is ") ;
12 disp (I) ;
```

Scilab code Exa 6.5.A Output SNR

```
1 clc ;
2 clear ;
3 F =5; // noise figure in dB
4 SNR_input =55; // Input Signal to noise ratio in dB
5 SNR_output = SNR_input -F;
6 disp (" Output SNR (in dB) is ") ;
7 disp ( SNR_output );
```

Scilab code Exa 6.5 Output SNR

```
1  clc;
2  clear;
3  Np1=60; // Noise-Power ratio of first system in dB
4  Np2=40; // Noise-Power ratio of second system in dB
5  Np3=30; // Noise-Power ratio of third system in dB
6  Np4=50; // Noise-Power ratio of fourth system in dB
7
8   P1=10^(-6); //power ratio of first system
9   P2=10^(-4); //power ratio of second system
10  P3=10^(-3); //power ratio of third system
11  P4=10^(-5);//power ratio of fourth system
12
13  SNR=(P1+P2+P3+P4); // Overall Signal to Noise ratio
14   disp("SNR ratio is");
15   disp(SNR);
16
17   N_final=30; //since SNR is 10^(-3)
18
19  disp("overall SNR (in dB)is");
20  disp(N_final);
21
22  disp("the overall SNR is equal to that of the worst
        system")
```

Scilab code Exa 6.6.A Noise Figure

```
1  clc;
2  clear;
3  F=16;// Power ratio in dB
4  k=1.38*10^(-23) ;// boltzman constant
5  T=290; //temperature in K
6  B=5; //Bandwidth in MHz
7
```

```
8  P=(F-1)*k*T*B*10^(6);
9  disp(" Amplifier Inout noise power (in watts) is");
10 disp(P);
```

Scilab code Exa 6.6 Output SNR

```
1  clc;
2  clear;
3  N_figure=8 ;//Noise figure in dB
4  SNR_in=45; //Signal to  Noise ratio in dB
5
6  SNR_out=SNR_in-N_figure //output Signal to Noise
       ratio
7
8  disp("the Output SNR(in dB) is ");
9  disp(SNR_out);
```

Scilab code Exa 6.7.A Overall noise figure

```
1  clc;
2  clear;
3  Nf1=7; //Noise figure of first stage in dB
4  F1=5.01; //first power ratio
5  Nf2=25; //Noise figure of second stage in dB
6  F2=316.22; //second power ratio
7  pG=15; //power gain in dB
8  G1=31.62; //power ratio
9
10 F=F1+(F2-1)/G1;
11
12 disp("overall noise factor");
13 disp(F);
14 disp("Overall noise factor in dB")
```

```
15 disp (10* log10 (F));
```

Scilab code Exa 6.8.A Noise Temperature

```
1  clc ;
2  clear ;
3  Nf =15;  // noise figure in dB
4  F =31.62; // power ratio
5  T =290;  // Temperature in K
6  T_em =(F -1)*T
7
8  G1 =10^(6);  // power ratio
9  N_t =80;  // Noise temperature in K
10 T_e =N_t+T_em/G1;
11
12 disp (" Noise temperature of receiver (in K)");
13 disp (T_em);
14
15 // change in answer .... the calculation in the book
       is wrong
16
17 disp (" Overall Noise temperature of receiving system (
       in K) is");
18 disp (T_e);
```

Scilab code Exa 6.9.A Noise Temperature

```
1  clc ;
2  clear ;
3  ENR =31.62;  // 10^(1.5) ;
4  Y =6.30;  // 10^(0.8)
5  T =290; // temperature in K
6  T_h =T *( ENR +1) ;
```

```
 7
 8  T_e =(T_h -Y*(T))/(Y-1);
 9  disp("Equivalent Noise Temperature (in K) is");
10  disp(T_e);
```

Chapter 7

Introduction to Digital Communication

Scilab code Exa 7.1.A Baud Rate and Bandwidth

```
1 clc;
2 clear;
3 bin_signal=20; //binary signal in kbps
4 N=1;//since ASK
5
6 Bw=bin_signal*10^(3);
7 Baud=bin_signal*10^(3);
8
9 disp(Bw,"Bandwidth(in Hz)=");
10 disp(Baud,"Baud rate=");
```

Scilab code Exa 7.1 Baud Rate

```
1 clc;
2 clear;
3 N=1;// since ASK
```

```
4 Bin_Sig=15;//Binary signal in kbps
5
6 BW=Bin_Sig*10^(3)/N;
7 Baud=Bin_Sig*10^(3)/N;
8 disp(BW,"Bw=");
9 disp(Baud,"Baud=");
```

Scilab code Exa 7.2.A Bandwidth and Baud Rate

```
1 clc;
2 clear;
3 mark_f=59;//MArk Frequency in Hz
4 space_f=61; //space frequency in Hz
5 input_rate=5;//input rate in kbps
6
7 Peak_Frq_Dev=abs((mark_f-space_f)/2);
8 Bw=2*(Peak_Frq_Dev+input_rate)*10^(3);
9 baud=input_rate*10^(3);
10
11 disp(Peak_Frq_Dev,"Peak Frequency Deviation (in KHz)
      =");
12 disp(Bw,"Minimum BW (in Hz)=");
13 disp(baud,"Baud=");
```

Scilab code Exa 7.2 Baud Rate and Bandwidth

```
1 clc;
2 clear;
3 mark_f=60;//Mark Frequency in KHz
4 space_f=63;//Space Frequency in KHz
5 input_bit_rate=3;// input bit rate
6
7 Peak_Frq_Dev=abs((mark_f-space_f)/2);
```

```
8  B=2*( Peak_Frq_Dev + input_bit_rate ) ;
9  Baud = input_bit_rate *10^(3) ;
10
11 disp ( Peak_Frq_Dev ,"Peak  Frequency  Deviation (in  KHz)=
      ") ;
12 disp (B ,"Minimum  Bandwidth (in  KHz)=") ;
13 disp ( Baud ,"Baud  rate=") ;
```

Scilab code Exa 7.3.A Bandwidth and Baud Rate

```
1  clc ;
2  clear ;
3  N=3;// since  8-PSK
4  bit_rate =36;// in  kbps
5
6  Bw = bit_rate *10^(3) /N ;
7  baud = bit_rate *10^(3) /N ;
8  n = bit_rate *10^(3) /Bw ;
9
10 disp (Bw ," Minimum  Bandwidth (in  Hz)=") ;
11 disp ( baud ,"Baud  rate=") ;
12 disp (n ,"Bandwidth  efficiency (in  bits  per  second  per
      cycle  of  bandwidth )=") ;
```

Scilab code Exa 7.3 Baud Rate and Bandwidth

```
1  clc ;
2  clear ;
3  bit_rate =36;// information  bit  rate  in  Kbps
4  m=3;// since  8-PSK
5
6  Baud = bit_rate *10^(3) /m ;
7  Bw =36*10^(3) /m ;
```

```
8  n =36000/12000;
9
10 disp(Baud,"Baud=");
11 disp(Bw,"BW=");
12 disp(n,"Bandwidth efficiency(in bits/cycle)=");
```

Scilab code Exa 7.4.A Nyquist Bandwidth

```
1  clc;
2  clear;
3
4  Input_bit =5;  //Input bit rate in Mbps
5
6  //bit rate in I,Q,C channels is one-third of input
       bit rate
7
8  fbI=Input_bit/3;//bit rate in I channel
9  fbC=Input_bit/3;//bit rate in C  channel
10 fbQ=Input_bit/3;////bit rate in I channel
11
12 Baud=fbI;//Baud in Mbps
13
14 fa=fbC/2;
15
16 //Output from Modulator is
17 //  0.5 cos (2* pi *49.17MHz) -0.5 cos (2* pi *50.83MHz)
18
19 Nyquist =50.83-49.17;
20
21 disp(Nyquist,"Minimum Nyquist Bandwidth(in MHz)=");
```

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Chapter 8

Information theory

Scilab code Exa 8.1.A Information Rate

```
1  clc ;
2  clear ;
3  p1 =1/8;
4  p2 =1/8;
5  p3 =5/8;
6  p4 =1/8;  // Quantization  Levels
7  //B is  the  Bandwidth  of  the  signal
8
9  H=p1*log2 (1/ p1 )+p2*log2 (1/ p2 )+p3*log2 (1/ p3 )+p4*log2
       (1/ p4 ) ;
10
11 disp (H , ”The  average  Information  ( in  bits / message )=” )
       ;
12 disp ( ”The  Information  Rate  R=rH    =2*B ( 1 . 5 5 )  =3.1B
       bits / s ” ) ;
```

Scilab code Exa 8.2.A ShannonFano and Huffman coding

```
1  clc;
2  clear;
3  m1=0.2;
4  m2=0.3;
5  m3=0.2;
6  m4=0.15;
7  m5=0.15; // probability of 5 source messages
8
9  H=m1*log2(1/m1)+m2*log2(1/m2)+m3*log2(1/m3)+m4*log2
     (1/m4)+m5*log2(1/m5);//Average information in
     bits
10
11 //a) Shannon-fano coding
12                        //coding
13 // m1   0.2   0 0          00
14 // m2   0.3   0 1          01
15 // m3   0.2   1 0          10
16 // m4   0.15  1 1 0        110
17 // m5   0.15  1 1 1        111
18
19 L=(0.2*2)+(.3*2)+(0.2*2)+(2*0.15*3) //Average code
     word length(in bits)=probability *coding length
20
21 n=H/L;
22
23 disp(n*100,"Coding efficiency for Shannon Fano
     coding is");
24
25 //b)  Huffman coding
26
27 // m1 0.2      01
28 // m2 0.3      00
29 // m3 0.2      11
30 // m4 0.15     010
31 // m5 0.15     110
32
33 L=(0.2*2)+(.3*2)+(0.2*2)+(2*0.15*3) //Average code
     word length(in bits)=probability *coding length
```

58

```
34
35  n=H/L;
36
37  disp(n*100,"Coding efficiency for Huffman coding is"
       );
38
39  //change in answer due to rounded off value in text−
       book
```

Scilab code Exa 8.3.A Gaussian Channel

```
1   clc;
2   clear;
3
4   PSD=10^(-9); //noise PSD in W/Hz
5   Bw=4000;//Wandwidth in Hz
6
7   //a)
8   E=0.1 //Energy in Joules
9   C=Bw*log2(1+E/(2*PSD*Bw));
10  disp(C,"a) Capacity of the gaussian channel(in bits/
       s) when E is 0.1J=");
11
12  //b)
13  E=0.001 //Energy in Joules
14  C=Bw*log2(1+E/(2*PSD*Bw));
15  disp(C,"b) Capacity of the gaussian channel(in bits/
       s) when E is 0.001J=");
16
17  //c)
18  Bw=10000;
19  C=Bw*log2(1+E/(2*PSD*Bw));
20  disp(C,"d) Capacity of the gaussian channel(in bits/
       s) when Bw is 10Khz=");
21
```

```
22  disp("100 times fall in Energy when the BW is
        increased by 2.5 times");
```

Scilab code Exa 8.5.A Throughput efficiency

```
1  clc;
2  clear;
3  k=973;
4  n=1023;
5  Pa=0.99;
6  Tw=10*10^(-6);
7  Tl=40*10^(-6);
8  N=4;
9
10 N_sw=(k/n)*(Pa/(1+Tl/Tw));// efficiency of stop and
        wait algorithm
11 N_sgpull=(k/n)*(1/(1+N*(1-Pa)/Pa));//efficiency of
        go-back-N algorithm
12 Nsr=(k/n)*Pa;// efficiency of selective repeat
        algorithm
13
14 disp(N_sw,"N s&w");
15 disp(N_sgpull,"Nsgpull");
16 disp(Nsr,"Nsr");
```

Scilab code Exa 8.6.A Rate of source

```
1  clc;
2  clear;
3  p1=1/2;
4  p2=1/4;
5  p3=1/8;
6  p4=1/16;
```

```
7  p5 =1/16;// probabilities
8
9  H=p1*log2(1/p1)+p2*log2(1/p2)+p3*log2(1/p3)+p4*log2
      (1/p4)+p5*log2(1/p5);
10 Bw =4000; //Bandwidth in Hz
11 R=2*H*Bw ;
12
13 disp(R,"Rate of the source ( in bits/s) is");
```

Scilab code Exa 8.7.A entropy of equiprobable source

```
1  clc;
2  clear;
3
4  // probability of all the events are same
5  syms N;
6
7  H_X=N*[(-1/N)*log(1/N)]; //H(X)=(−1/N) log (1/N)+(−1/N
      ) log (1/N) +....N times
8
9  disp(H_X,"H(X)=");
```

Scilab code Exa 8.8.A Self Information

```
1  clc;
2  clear;
3  P0 =2/3; //P(X=0)
4  P1 =2/3; //P(Y=0)
5  H_x =0.919;
6  H_y =0.919;
7  H_b =0.919; //Hb(2/3)
8
```

```
 9 //since X,Y pair is uniformly distributed on   three
      values
10 H_xy=log2(3); // H(X,Y)
11
12 H_xdivy=H_xy-H_y; //H(X/Y)=H(X,Y)-H(Y)
13 I_xdivy=H_x-H_xdivy; //I(X,Y)=H(X)-H(X/Y)
14
15 disp(I_xdivy,"I(X,Y)=");
```

Scilab code Exa 8.10.A SNR

```
1 clc;
2 clear;
3 W=3000;
4 SNR_db=39;// 10log (SNR_ratio)=SRN_db
5 SNR_ratio=7943; //10^(3.9)
6
7 C=W*log2(1+SNR_ratio);
8
9 disp(C,"Capacity (in bits/s) =");
```

Chapter 9

Introduction to Probability Random variable and Random processes

Scilab code Exa 9.1.A Multiplication Theoram

```
1 clc;
2 clear;
3
4 P_white=5/8; //P(ball is white)
5
6 //white ball is removed,the remaining balls are four
      white and three green
7
8 P_green=3/7; //P(ball is green)
9
10 P_tot=P_white*P_green;
11
12 disp(P_tot," Desired Probability using
      multiplication theoram=")
```

Scilab code Exa 9.1 Conditional Probability

```
1  clear;
2  clc;
3  // f2 be the event that " a two occurs"
4
5
6  tot=6; //total number of possible outcomes
7  f_2=1; // number of desired outcomes
8  M=3; // number of even outcomes
9
10 ///// a)
11
12 P_A=f_2/tot; //P(A)
13
14 ///// b)
15 P_M=M/tot; //P(M)
16
17 ////// c)
18 P_AintersectionM=P_A/P_M; //P(A intersection M)
19
20 disp(P_A,"a) P(A)= ");
21 disp(P_M,"b) P(M)=");
22 disp(P_AintersectionM=P_A/P_M,"c) P(A intersection M
        )=");
```

Scilab code Exa 9.2.A Theoram of Total Probability

```
1  clc;
2  clear;
3  P_box1=0.25; //P(box1)
4  P_box2=0.25; //P(box2)
5  P_box3=0.25; //P(box3)
6  P_box4=0.25; //P(box4)
7
```

```
8  Pdef_1=0.05;    //P(defective/box1)
9  Pdef_2=0.3;     //P(defective/box2)
10 Pdef_3=0.10;    //P(defective/box3)
11 Pdef_4=0.20;    //P(defective/box4)
12
13
14 Pcomp_def=(P_box1*Pdef_1)+(P_box2*Pdef_2)+(P_box3*
       Pdef_3)+(P_box4*Pdef_4); //Theoram of total
       probability
15
16 disp(Pcomp_def,"  P(component is defective)=");
```

Scilab code Exa 9.2 Conditional Probability

```
1  clc;
2  clear;
3
4  white_ball=3;
5  red_ball=2;
6  total=white_ball+red_ball;
7  P_W=white_ball/total;
8
9  P_SRFW=1/2; //Prob. of second red given  first white
10
11 P_FWSR=P_W *P_SRFW// prob. of first   white and
       second red
12
13 disp(P_FWSR," P(First Ball is White and second is
       red)=");
```

Scilab code Exa 9.3.A Error Probability

```
1  clc;
```

```
2  clear;
3
4  P_1=0.3;  //P( 1 is transmitted)
5  Pe_1=10^(-3);  //P(detecting an error when 1 is
       transmitted)
6  P_0=0.7; //P( 0 is transmitted)
7  Pe_0=10^(-7);  //P(detecting an error when 0 is
       transmitted)
8
9  error_prob=P_1*Pe_1+P_0*Pe_0;
10
11 disp(error_prob,"Error Probabillity of the channel")
       ;
```

Scilab code Exa 9.3 Bayes Theoram

```
1  clc;
2  clear;
3  P_box1=0.25;  //P(box1)
4  P_box2=0.25;  //P(box2)
5  P_box3=0.25;  //P(box3)
6  P_box4=0.25;  //P(box4)
7
8  Pdef_1=0.05;   //P(defective/box1)
9  Pdef_2=0.4;   //P(defective/box2)
10 Pdef_3=0.10;   //P(defective/box3)
11 Pdef_4=0.10;   //P(defective/box4)
12
13 //a)
14
15 Pcomp_def=(P_box1*Pdef_1)+(P_box2*Pdef_2)+(P_box3*
       Pdef_3)+(P_box4*Pdef_4);  //Theoram of total
       probability
16
17 //b)
```

```
18  Pbox2_def =( P_box2 * Pdef_2 )/(( P_box1 * Pdef_1 )+( P_box2 *
        Pdef_2 )+( P_box3 * Pdef_3 )+( P_box4 * Pdef_4 )); //Bayes
        theoram
19
20  disp ( Pcomp_def ," a) P(component is defective )=") ;
21
22  disp ( Pbox2_def ," b) P(box2| defective )=") ;
```

Scilab code Exa 9.4.A Density Function

```
1  clc ;
2  clear ;
3  //Y is a Gaussian Random Variable
4
5  syms y ;
6
7  x =5;
8  m = -3*( x )+5; //mean
9  disp ( m ," mean ") ;
10
11  var =4*7; //variance
12  disp ( var ," variance ") ;
13
14  Y = exp ( -{( y +10) ^2}/56 )/ sqrt (56*% pi );
15
16  disp (" Y is an N{ -10,28} random variable ") ;
17  disp (Y ," density function f (y)= ") ;
```