Scilab Textbook Companion for Electronic Communications: Principles and Systems by W. D. Stanley & J. M. Jeffords[1]

Created by
Manish Rajput
B.tech
Others
Shri Mata Vaishno Devi University,Katra,J&K
College Teacher
Rakesh Kumar Jha
Cross-Checked by
Chaya Ravindra

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Book Description

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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.

Contents

List of Scilab Codes

Chapter 1

Introduction

Scilab code Exa 1.1 Determine Wavelength

```
clc;
//page 4
//ex-1.1
c=3*10^8;       //in m/s
f=1*10^6;       //in Hz
lembda=c/f;
disp(lembda,'Wavelength (in m):');
```

Scilab code Exa 1.2 Determine Wavelength

```
clc;

//page 4
//ex-1.2
c=3*10^8;       //in m/s
f=100*10^6;       //in Hz
lembda=c/f;
disp(lembda,'Wavelength (in m):');
```

Scilab code Exa 1.3 dB Power gain

```
clc;

//page 9
//ex-1.3
G=175;      //absolute gain
Gdb=10*log10(175);    //decibell gain
disp('dB',Gdb,+'The decibell power gain is:');
```

Scilab code Exa 1.4 Absolute Power gain

```
clc;
//page 9
//ex-1.4
Gdb=28;    //decibell gain
G=10^(Gdb/10);  //Absolute power gain
disp(G,'The absolute power gain is:');
```

Scilab code Exa 1.5 Voltage gain

```
clc;
//page 10
//ex-1.5

Gdb=28;    //decibell gain
G=10^(Gdb/10);  //Absolute power gain
Av=G^0.5;  //Voltage gain
disp(Av,'The voltage gain is:');
```

Scilab code Exa 1.6 dB gain and loss

```
clc;
//page 10
//ex-1.6

G=0.28; //Absolute gain
Gdb=10*log10(G);
disp('dB',Gdb,+'Decibell gain is');
P1=1;
P2=.28;  //28 % of input power
Ldb=10*log10(P1/P2); //dB loss
disp('dB',Ldb,+'Decibell loss is:');
```

Scilab code Exa 1.7 Signal Level

```
clc;
//page 11
//ex-1.7

PmW=100; //power in mW
PdBm=10*log10(PmW/1);  //P in dBm level
disp('dBm',PdBm,+'(a).   Power in dBm level is:');
PdBW=PdBm-30;  //P in dBW level
disp('dBW',PdBW,+'(b).   Power in dBW level is:');
PdBf=PdBm+120;  //Pin dBf level
disp('dBf',PdBf,+'(c)   Power in dBf level is:');
```

Scilab code Exa 1.8 Calculate gains

```
clc;

//page 13
//ex-1.8

G1=5000;
L=2000;
G2=400;
G=G1*(1/L)*G2;    //Absolute gain
disp(G,'(a)  Net absolute gain is:');
GdB=10*log10(G);  //System decibell gain
disp('dB',GdB,+'(b)  System Decibel gain is:');
G1dB=10*log10(G1);
LdB=10*log10(L);
G2dB=10*log10(G2);
disp('(c)   Individual stage gains are:');
disp(G1dB,'G1dB=');
disp(LdB,'LdB=');
disp(G2dB,'G2dB=');
GdB=G1dB-LdB+G2dB;
disp('dB',GdB,+'The net dB gain is:');
```

Scilab code Exa 1.9 Power level

```
clc;
//page 13
//ex-1.9

G1=5000;
L=2000;
G2=400;
Ps=0.1;   //in mW
P1=G1*Ps;   //in mW
disp('mW',P1,'(a)  Power level P1 is:');
P2=P1/L;   //in mW
```

```
disp('mW',P2,'Line output power P2:');
Po=G2*P2;   //in mW
disp('mW',Po,'System output power Po:');
PsdBm=10*log10(Ps/1);
G1dB=10*log10(G1);
LdB=10*log10(L);
G2dB=10*log10(G2);
disp('(b)  Output power power levels in dBm are');
P1dBm=PsdBm+G1dB;
disp('dBm',P1dBm,'P1(dBm)=');
P2dBm=P1dBm-LdB;
disp('dBm',P2dBm,'P2(dBm)=');
PodBm=P2dBm+G2dB;
disp('dBm',PodBm,'Po(dBm)=');
```

Scilab code Exa 1.10 Signal level and gain

```
clc;

//page 14
//ex-1.10
function [V]=voltage(PdBm)
    P=1*10^(-3)*(10^(PdBm/10));
    V=(75*P)^0.5;
endfunction
S=10;   //dBm
G1=13;   //dB
L1=26;   //dB
G2=20;   //dB
L2=29;   //dB
disp('(a)  The output levels are');
PdBm=S;
V=voltage(PdBm);
disp(V,'in Volts:',PdBm,'1. Signal source in dBm:');
PdBm=S+G1;
```

```
V=voltage(PdBm);
disp(V,'in Volts:',PdBm,'2. Line Amplifier in dBm:');
PdBm=S+G1-L1;
V=voltage(PdBm);
disp(V,'in Volts:',PdBm,'3. Cable section A in dBm:');
PdBm=S+G1-L1+G2;
V=voltage(PdBm);
disp(V,'in Volts:',PdBm,'4. Booster amplifier in dBm:');
PdBm=S+G1-L1+G2-L2;
V=voltage(PdBm);
disp(V,'in Volts:',PdBm,'5. Cable section B in dBm:');
disp('(b).  The output power to get a voltage of 6V');
V=6;    //volts
R=75;   //ohm
Po=(V^2)/R;
disp('W',Po,);
PodBm=10*log10(Po*1000/1);
disp('dBm',PodBm,'power in dBm');
GrdB=PodBm-PdBm;
disp('dB',GrdB,'The required gain is');
```

Scilab code Exa 1.11 S N ratio

```
clc;
//page 17
//ex-1.11

P=5;    //In mW
N=100*10^-6;   //in mW
S2N=P/N;
```

```
disp(S2N,'(a)    Absolute signal to noise ratio :');
S2NdB=10*log10(S2N);
disp('dB',S2NdB,'(b)   dB signal to noise ratio is:'
   )
PdBm=10*log10(P/1);
disp('dBm',PdBm,'(c)    Signal Power is');
NdBm=10*log10(N/1);
disp('dBm',NdBm,'Noise power is');
S2NdB=PdBm-NdBm;
disp('dB',S2NdB,'Decinel S/N ratio is');
```

Chapter 2

Spectral Analysis I Fourier Series

Scilab code Exa 2.1 Signal terminology

```
clc;

//page no 31
//problem 2.1
//v(t)=12coos(2pi*2000t)
A=12;   //in volts
disp('V',A,'(a)  The amplitude is idetified as');
w=2*%pi*2000;
disp('rad/s',w,'(b)  The radian frequincy is');
f=w/(2*%pi);
disp('Hz',f,'(c)  The cyclic frequency is');
T=1/f;
disp('s',T,'(d)  The period is');
```

Scilab code Exa 2.2 Express function

```
clc;

//page no 32
//problem 2.2
//i(t)=4cos50t + 3sin50t
A=4;
B=3;
C=sqrt(A^2+B^2);  //right triangle
theta=-1*atan(3/4);  //in rad
disp('rad',theta,'(a) The current is expressed as 5 cos(50t + theta),where theta is');
phi=acot(3/4);  //from figure 2.5 in radian
disp('rad',phi,'(b) The current is expressed as 5 sin(50t+phi), where phi is');
phi=phi*180/%pi;
disp('degree',phi,'or');
```

Scilab code Exa 2.3 Spectral process

```
clc;

//page no 37
//problem 2.3
T=12.5*10^-6; //in sec
f0=0;   //dc
f1=1/T*10^-3;   //in kHz
f2=f0+2*f1;
f3=f0+3*f1;
f4=f0+4*f1;
disp('kHz',f4,f3,f2,f1,f0,'The lowest five frequencies are (in kH)');
```

Scilab code Exa 2.4 Fourier series

```
clc;

//page no 40
//problem 2.4
//all frequencies are in Hz
f=0;
f1=500;  //fundamental freq.
f2=1000;  f3=1500;  //harmonics
disp(f3,f2,f1,f,'(a) The frequencies in signal are');
//for plot
fHz=[0:1600];
Cn=[5 zeros(1:f1-1) 8 zeros(f1+1:f2-1) 6 zeros(f2+1:f3-1) 3 zeros(f3+1:1600)]
clf
plot2d(fHz,Cn,[3],rect=[-0.5,0,1550,10])
xtitle('Linear amplitude spectrum','f,Hz','Cn(V)')
xgrid
disp('(c) The required bandwidth is 1500 Hz');
```

Scilab code Exa 2.5 Power in a Fourier series

```
clc;

//page no 43
//problem 2.5
//All voltages are in V
//All power in watts
R=5;  //ohm
C0=5;  //dc value
C1=8;
C2=6;
C3=3;   //volts
Vrms=sqrt(C0^2+0.5*(C1^2+C2^2+C3^2));  //rms voltage
disp(Vrms,'(a) The rms value of voltage is');
```

```
P=Vrms^2/R;    //watts
disp('W',P,'(b)  The average power dissipated in resistor is')
P0=C0^2/R;
disp(P0,'(c)  The dc power is ');
P1=C1^2/(2*R);
disp(P1,'The power in fundamental is');
P2=C2^2/(2*R);
P3=C3^2/(2*R);
disp(P3,P2,'The second and third harmonics are');
//for plot
fHz=[0:1600];
f1=500;  //fundamental freq.
f2=1000;  f3=1500;
Pn=[P0 zeros(1:f1-1) P1 zeros(f1+1:f2-1) P2 zeros(f2+1:f3-1) P3 zeros(f3+1:1600)]
clf
plot2d(fHz,Pn,[3],rect=[0,0,1600,8])
xtitle('Power spectrum','f,Hz','Pn(W)')
xgrid
```

Scilab code Exa 2.6 Spectral Rollof

```
clc;

//page no 48
//problem 2.6
//All frequencies in Hz
//There is no dc component
T=4*10^-3;
f1=1/T;
disp(f1,'The fundmental frequency is');
//The function have only odd numbered components
disp(9*f1,7*f1,5*f1,3*f1,f1,'The five lowest frequencies are ');
disp('(b)  The rolloff rate is −6dB/octave');
```

Scilab code Exa 2.7 Table of fourier series

```
clc;

//page no 51
//problem 2.7
//All frequencies in kHz
//The time is in ms
//Power in WATTS
//All voltage in volts
T=0.2;  //ms
f1=1/T;
disp(f1,'The fundamental frequency is');
//There are only odd numbered harmonics
Ap2p=40; // peak to peak
R=50;  //ohm
A=Ap2p/2;
C1=4*A/%pi;
C3=4*A/(3*%pi);
C5=4*A/(5*%pi);
disp('respectively',C5,C3,C1,'The magnitude of fundamental , third and fifth harmonics are ');
function [Pn]=Power(Cn,R)
    Pn=Cn^2/(2*R);
endfunction
P1=Power(C1,R);
P3=Power(C3,R);
P5=Power(C5,R);
//power is calculated using the function Power defined above
disp('Frequency  Amplitude   Power')
table={f1,C1,P1;3*f1,C3,P3;5*f1,C5,P5};
disp(table);
```

Scilab code Exa 2.8 Spectral component

```
clc;

//page no 52
//problem 2.8
//All frequencies in kHz
//The time is in ms
//Power in WATTS
//All voltage in volts
//following values are copied from Ex2-7
T=0.2;  //ms
f1=1/T;
//There are only odd numbered harmonics
Ap2p=40; // peak to peak
R=50;  //ohm
A=Ap2p/2;
C1=4*A/%pi;
C3=4*A/(3*%pi);
C5=4*A/(5*%pi);
function [Pn]=Power(Cn,R)
    Pn=Cn^2/(2*R);
endfunction
P1=Power(C1,R);
P3=Power(C3,R);
P5=Power(C5,R);


//Ex2-8
Vrms=A;
P=Vrms^2/R;
disp('W',P,'Total power is');
P135=P1+P3+P5
disp(P135,'Power of fundamental , third and fifth
harmonics is');
prcnt=P135/P*100;
disp(prcnt,'The percent of power is ');
```

Scilab code Exa 2.9 Two sided spectrum

```
clc;
clear all;
//page no 54
//problem 2.9
f0=0;
f1=500;  //fundamental freq.
f2=1000;  f3=1500;  //harmonics

//Values from ex 2.4
C=[5 8 6 3]//  Values in Volts
//Values from ex 2.5
P=[5 6.4 3.6 .9];   //poweer in watts
clf;
// plot two sided linear amplitude spectrum
fHz=-1510:10^-2:1510;    //x-axis matrix
//Y-axis matrix
Cn=[C(1)]
for i=2:4
    Cn=[zeros(-500+10^-2:10^-2:0-10^-2) Cn zeros(0+10^-2:10^-2:500-10^-2)]
    Cn=[C(i)/2 Cn C(i)/2];
end
Cn=[zeros(-10+10^-2:10^-2:0) Cn zeros(0:10^-2:10-10^-2)]
subplot(211)
plot2d(fHz,Cn,[2],rect=[-2000,0,2000,6])
xtitle('Two-sided Linear amplitude spectrum','f,Hz','Vn(V)')
xgrid
```

```

// plot two power spectrum
fHz=-1510:10^-2:1510;    //x-axis matrix
//Y-axis matrix
Pn=[P(1)]
for i=2:4
    Pn=[zeros(-500+10^-2:10^-2:0-10^-2) Pn zeros(0+10^-2:10^-2:500-10^-2)]
    Pn=[P(i)/2 Pn P(i)/2];
end
Pn=[zeros(-10+10^-2:10^-2:0) Pn zeros(0:10^-2:10-10^-2)]
subplot(212)
plot2d(fHz,Pn,[6],rect=[-2000,0,2000,6])
xtitle('Two-sided power] spectrum','f,Hz','Pn(W)')
xgrid
```

Chapter 3

Spectral Analysis II Fourier Transform and Pulse Spectra

Scilab code Exa 3.1 Fourier Transform

```
clc;
clear all;
//chapter 3
//page no 75
//example 3.1
A=1    //arbitrary value provided
T=10    //T represents tau (arbitrary value provided)
//plot for non periodic pulse
t=-2*T:.001:2*T;
vt=[zeros(-2*T:.001:-T/2) A*ones(-T/2+.001:.001:T/2-.001) zeros(T/2:.001:2*T)]
clf
subplot(211)
plot2d(t,vt,[2],rect=[-2*T,0,2*T,A+1])
xtitle('(a) Non periodic pulse','t','v(t)')

//plot for amplitude spectum
f=-4/T:.001:4/T;
```

```
Vf=[]
for i=1:length(f)
    if f(i)==0 then
        Vf=[Vf A*T];    //according to L'Hopitals rule sin(x)/x=1 at lim x->0
        else
            Vf=[Vf A*T*sin(%pi*f(i)*T)/(%pi*f(i)*T)]
end
end
subplot(212)
plot2d(f,Vf,[5])
xtitle('(b) Amplitude spectrum','f','V(f)')
xgrid
```

Scilab code Exa 3.2 Fourier Transform

```
clc;
clear all;
//chapter 3
//page no 76
//example 3.2
//plot for impulse function
t=-2:.001:2;
vt=[zeros(-2:.001:0-.001) 1 zeros(0+.001:.001:2)]  //impulse function matrix
clf
subplot(211)
plot2d(t,vt,[2],rect=[-2,0,2,2])
a=gca(); // Handle on axes entity
a.x_location = ”origin”;
a.y_location = ”origin”;

xtitle('(a) Unit Impulse function','t','v(t)')

//plot for amplitude spectum
```

```
f=-2:.001:2;
Vf=[ones(-2:.001:2)]
subplot(212)
plot2d(f,Vf,[5])
a=gca(); // Handle on axes entity
a.x_location = "origin";
a.y_location = "origin";

xtitle('(b) Amplitude spectrum','f','V(f)')
xgrid
```

Scilab code Exa 3.3 Amplitude spectrum

```
clc;
clear all;
//chapter 3
//page no 82
//example 3.3
A=20;     //Volts
T=1*10^-3;     //second
function Vf=Fourier_transform(f,T,A)
    if f==0 then
        Vf=A*T;
    else
        Vf=A*T*sin(%pi*f*T)/(%pi*f*T);

    end
endfunction
mprintf('(a)Equation for fourier transform is \n V(f)=%.2f*sin(%.3f*pi*f)/(%.3f*pi*f)',A*T,T,T);
//Part b Calculation
f=[0 500 1000 1500];
for i=1:4
    Vf(i)=Fourier_transform(f(i),T,A)
end
```

```
//Part c calculation
RdB=20*log10(Vf ./ .02)
//Result Table
mprintf('\nf(Hz)      V(f)in V      RdB\n')
for i=1:4
    mprintf('%5i   %f    %f \n',f(i),Vf(i),RdB(i))
end
//All values are precise
```

Scilab code Exa 3.4 Baseband pulse function

```
clc;
clear all;
//chapter 3
//page no 85
//example 3.4
A=20;     //Volts
T=1*10^-3;     //seconds
f=[-3/T:3/T];     //in kHz
Vf=[]
for i=1:length(f)
    if f(i)==0 then
        Vf=[Vf A*T];
    else
        Vf=[Vf A*T*sin(%pi*f(i)*T)/(%pi*f(i)*T)];

end
end
clf;
plot2d(f,Vf,[5])
a=gca(); // Handle on axes entity
a.x_location = "origin";
a.y_location = "origin";

xtitle('Amplitude Spectrum','f,Hz','V(f)');
```

```
xgrid
```

Scilab code Exa 3.5 Sketch spectrum

```
clc;
clear all;
//chapter 3
//page no 86
//example 3.5
A=20;    //Volts
T=5*10^-3;    //period in seconds
tau=1*10^-3;    //pulse width in second
d=tau/T;          //duty cycle
f1=1/T;          //Fundamental frequency in Hz

//for plot
n=[-14:15];    //in Hz
Vf=[]
for i=1:length(n)
    if n(i)==0 then
        Vf(i*200)=A*d;
    else
       Vf(i*200)=A*d*sin(%pi*d*n(i))/(%pi*d*n(i))
    end
    //to get the magnitudes of components
    if Vf(i*200)<0 then
        Vf(i*200)=-Vf(i*200)
    end

end
f=-3000:3000-1
clf;
plot2d(f,Vf,[5],rect=[-3000,0,3000,5])
a=gca(); // Handle on axes entity
a.x_location = ”origin”;
```

```
a.y_location = "origin";

xtitle('Amplitude Spectrum','f,Hz','Vn');
xgrid
```

Scilab code Exa 3.6 RF pulse functions

```
clc;
clear all;
//chapter 3
//page no 89
//example 3.6
A=1    //arbitrary value provided
Tau=10^-3     //in seconds
fc=30*10^6;  //centre frequency in Hz
//plot for amplitude spectum
f=-3/Tau:3/Tau;
Vf=[]
for i=1:length(f)
    if f(i)==0 then
        Vf=[Vf A*Tau];    //according to L'Hopitals rule sin(x)/x=1 at lim x->0
        else
            Vf=[Vf A*Tau*sin(%pi*f(i)*Tau)/(%pi*f(i)*Tau)]
end
end
f=f+fc   //shifting
f=f.*10^-6   //MHz
clf
plot2d(f,Vf,[5])

xtitle('Amplitude spectrum','f,MHz','Vrf(f)')
xgrid
```

Scilab code Exa 3.7 RFpulse amplitude spectrum

```
clc;
clear all;
//chapter 3
//page no 89
//example 3.7
A=1;     //arbitrary vaule
T=(1+4)*10^-3;      //period in seconds
tau=1*10^-3;    //pulse width in second
fc=30*10^6;     //centre frequency in Hz
d=tau/T;         //duty cycle
f1=1/T;         //Fundamental frequency in Hz

//for plot
n=[-14:15];     //in Hz
Vf=[]
for i=1:length(n)
    if n(i)==0 then
        Vf(i*200)=A*d;
    else
       Vf(i*200)=A*d*sin(%pi*d*n(i))/(%pi*d*n(i))
    end

end
f=-3000:3000-1
f=f+fc;     //Shifting by fc
f=f*10^-6;    //in MHz
clf;
plot2d(f,Vf,[5])
xtitle('Amplitude Spectrum','f,MHz','Vn');
xgrid
```

Scilab code Exa 3.8 Spectrum analyser

```
clc;
clear all;
//chapter 3
//page no 90
//example 3.8
mprintf('(a) The RF burst frequency is 500 MHz\n');
mprintf(' (b) The pulse repetition rate is 1 MHz\n');
f0=10*10^6;     //Zero crossing frequency in Hz
tau=1/f0;      //in second
mprintf(' (c) The pulse width is %.1f micro second\n',tau*10^6);
```

Chapter 4

Communication Filters and Signal Transmission

Scilab code Exa 4.5 Amplitude response

```
clc;
clear all;
//chapter 4
//page no 120
//example 4.5
f=[500 2000 10000];     //frequency in Hz
Af=1 ./sqrt(1+(f./1000)^8);    //Linear amplitude response
AdBf=20*log10(Af);
mprintf('    f,Hz       A(f)          AdB(f)\n')
for i=1:3
    mprintf(' %5i Hz    %.5f       %.3f dB\n',f(i),Af(i),AdBf(i))
end
```

Scilab code Exa 4.6 Parrale resonant circuit

```
clc;
clear all;
//chapter 4
//page no 123
//example 4.6
L=4*10^-6;    //Henry
C=9*10^-12;   //Farad
R=20*10^3;     //ohm

f0=1/(2*%pi*sqrt(L*C));     //frequency in Hz
mprintf('(a) The resonant frequency is f0=%.2f  MHz\n',f0*10^-6)
Q=R*sqrt(C/L)
mprintf(' (b) The Q is %i\n',Q);
B=f0/Q;
mprintf(' (c) The 3-dB bandwidth is B=%i KHz\n',B*10^-3);
```

Scilab code Exa 4.7 Determine Bandwidth

```
clc;
clear all;
//chapter 4
//page no 125
//example 4.7
//misprinted example number
pulse_width=2*10^-6;     //second
rise_time=10*10^-9;       //second
B=.5/pulse_width;        //in Hz
mprintf('(a) The aproximate bandwidth for coarse reproduction is B=%i  KHz\n',B*10^-3)
B=.5/rise_time;
mprintf(' (b) The aproximate bandwidth for fine reproduction is B=%i  MHz\n',B*10^-6)
```

Chapter 5

Frequency Generation and Translation

Scilab code Exa 5.1 Oscillator circuits

```
clc;
//page no 147
//prob no. 5.1
// refer fig 5.7
//The capacitance in pF
C1=200;
C2=2400;
C3=8;
t=1/C1+1/C2+1/C3; //temperary variable
Ceq=1/t;//pF
Ceq=Ceq*10^-12;//In Farad
L=2*10^-6;//In H
f0=1/(2*%pi*sqrt(L*Ceq))*10^-6; // IN MHz
disp('MHz',f0,'(a) The oscillation frequency is');
f0=1/(2*%pi*sqrt(L*C3*10^-12))*10^-6; // IN MHz
disp('MHz',f0,'(b) Assuming Ceq~C3 , the oscillation frequency is');
B=-C1/C2;  //based on eq 5.3
disp(B,'(c) The feedback fraction is ');
```

```
A=1/B;
disp(A,'The gain is');
```

Scilab code Exa 5.2 Crystal controlled portable transmitter

```
clc;
//page no 148
//prob no. 5.2
function [f]=frequency(f0,k,T,T0)
    f=f0+k*f0*(T-T0);
endfunction;
k=40*10^-6;
f=148;
fmax=frequency(f,k,32,20);
fmin=frequency(f,k,-8,20);
disp('Mhz',fmax,'The maximum possible frequency , fmax= ');
disp('Mhz',fmin,'The maximum possible frequency , fmin= ');
```

Scilab code Exa 5.3 PLL loop

```
clc;
//page no 150
//prob no. 5.3
//Refer figure 5-10
N=5;
M=8;
fi=4;// in MHz
f0=M/N*fi;
disp('MHz',f0,'(a) The output frequency is f0=');
f1=fi/N;
disp('MHz',f1,'(b) The frequency f1 is');
```

```
f2=f0/M;
disp('MHz',f2,' The frequency f2 is ');
//The two frequencies are same as required
```

Scilab code Exa 5.5 mixer

```
clc;
clear all;
//page no 152
//prob no. 5.5

//for input spectrum
f=[-20:.001:20];   //x axis
V=[1 zeros(-20+.001:.001:20-.001) 1];        //y axis
clf;
subplot(211);
plot2d(f,V,[5],rect=[-130,0,130,2])
a=gca(); // Handle on axes entity
a.x_location = "origin";
a.y_location = "origin";
xtitle('Input Spectrum','f,kHz','');
xgrid

//for output spectrum
f=[-120:.01:120];       //x axis
V=[1 zeros(-120+.01:.01:-80-.01) 1 zeros
   (-80+.01:0.01:80-0.01) 1 zeros
   (80+.01:.01:120-.01) 1]
subplot(212);
plot2d(f,V,[5],rect=[-130,0,130,2])
a=gca(); // Handle on axes entity
a.x_location = "origin";
a.y_location = "origin";
xtitle('Output Spectrum','f,kHz','');
xgrid
```

Scilab code Exa 5.6 Frequency conversion

```
clc;
clear all;
//page no 157
//prob no. 5.6

fLO=110;      //MHz
//for V2(f)
f=[0:.01:231+.01];    //x axis
function V=pulse()
    V=[]
    for i=1:.005:1.5
        V=[V i]
    end
endfunction
V2=[zeros(0:.01:120-fLO-.01) pulse() zeros(121-fLO
   +.01:.01:120+fLO-.01) pulse() 0];       //y axis
clf;
subplot(211);
plot2d(f,V2,[5],rect=[0,0,240,2])
xtitle('Spectral diagram','f,MHz','V2(f)');

//for V3(f)
f=[0:.01:11+.01];    //x axis
V3=[zeros(0:.01:120-fLO-.01) pulse() 0];       //y
   axis
subplot(212);
plot2d(f,V3,[5],rect=[0,0,20,2])
xtitle('Spectral Diagram','f,MHz','V3(f)');
```

Scilab code Exa 5.7 Frequency conversion

```
clc;
clear all;
//page no 158
//prob no. 5.7

fLO=40;    //MHz
//function for ascending pulse
function V=pulse_a()
    V=[]
    for i=1:.005:2
        V=[V i]
    end
endfunction
//function for descending pulse
function V=pulse_d()
    V=[]
    for i=2:-.005:1
        V=[V i]
    end
endfunction

//for V2(f)
f=[0:.01:48+.01];   //x axis

V2=[zeros(0:.01:-8+fLO-.01) pulse_d() zeros(-6+fLO+.01:.01:6+fLO-.01) pulse_a() 0];      //y axis
clf;
subplot(211);
plot2d(f,V2,[5],rect=[0,0,50,2])
xtitle('Spectral diagram','f,MHz','V2(f)');

//for V3(f)
f=[0:.01:48+.01];   //x axis

V3=[zeros(0:.01:6+fLO-.01) pulse_a() 0];      //y axis
subplot(212);
plot2d(f,V3,[5],rect=[0,0,50,2])
```

```
xtitle('Spectral Diagram','f,MHz','V3(f)');
```

Scilab code Exa 5.8 Frequency conversion

```
clc;
clear all;
//page no 159
//prob no. 5.8

//function for ascending pulse
function V=pulse_a()
    V=[]
    for i=1:.005:1.5
        V=[V i]
    end
endfunction
//function for descending pulse
function V=pulse_d()
    V=[]
    for i=1.5:-.005:1
        V=[V i]
    end
endfunction
fLO=200-10;

//for fLO=190 MHz
f=[0:.01:10.5+.01];   //x axis

V=[zeros(0:.01:199.5-fLO-.01) pulse_a() 0];      //y axis
clf;
subplot(211);
plot2d(f,V,[5],rect=[0,0,12,2])
xtitle('Spectral diagram:for fLO=190','f,MHz','V(f)');
```

```

//for fLO=210
fLO=200+10;     //MHz
f=[0:.01:10.5+.01];     //x axis

V=[zeros(0:.01:-200.5+fLO-.01) pulse_d() 0];       //y axis
subplot(212);
plot2d(f,V,[5],rect=[0,0,12,2])
xtitle('Spectral Diagram:for fLO=210','f,MHz','V(f)');
```

Scilab code Exa 5.9 Double conversion system

```
clc;
clear all;
//page no 160
//prob no. 5.9

//function for ascending pulse
function V=pulse_a()
    V=[]
    for i=1:.005:1.5
        V=[V i]
    end
endfunction
//function for descending pulse
function V=pulse_d()
    V=[]
    for i=1.5:-.005:1
        V=[V i]
    end
endfunction
//plots of page 161
//spectrum at point 1
```

```
f1=[17.5-.01:.01:20.5+.01];    //x axis

V1=[0 pulse_d() zeros(18.5+.01:.01:19.5-.01) pulse_a() 0];       //y axis
clf;
subplot(221);
plot2d(f1,V1,[5],rect=[17,0,21,2])
xtitle('Spectrum at Point 1','f,MHz','');

//spectrum at point 2
f2=[17.5-.01:.01:20.5+.01];    //x axis

V2=[0 zeros(17.5:.01:19.5-.01) pulse_a() 0];       //y axis
subplot(222);
plot2d(f2,V2,[5],rect=[17,0,21,2])
xtitle('Spectrum at Point 2','f,MHz','');

//spectrum at point 3
f3=[359.5-.01:.01:400.5+.01];    //x axis

V3=[0 pulse_d() zeros(360.5+.01:.01:399.5-.01) pulse_a() 0];       //y axis
subplot(223);
plot2d(f3,V3,[5],rect=[359,0,401,2])
xtitle('Spectrum at Point 3','f,MHz','');

//spectrum at point 4
f4=[359.5-.01:.01:400.5+.01];    //x axis

V4=[0 zeros(359.5:.01:399.5-.01) pulse_a() 0];       //y axis
subplot(224);
plot2d(f4,V4,[5],rect=[359,0,401,2])
xtitle('Spectrum at Point 4','f,MHz','');
```

Scilab code Exa 5.10 Reciever

```
clc;
//page no 167
//prob no. 5.10
//All frequencies in MHz
fc=40;
fIF=5
fLO=fc+fIF;
disp(fLO,'(a)  The LO frequency is ');
fImage=fLO+fIF;
disp(fImage,'(b)  The image frequency is ');
```

Scilab code Exa 5.11 Reciever

```
clc;
//page no 167
//prob no. 5.11
//All frequencies in MHz
fc=40;
fIF=5
fLO=fc-fIF;
disp(fLO,'(a)  The LO frequency is ');
fImage=fLO-fIF;
disp(fImage,'(b)  The image frequency is ');
```

Scilab code Exa 5.12 Commercial FM reciever

```
clc;
```

```
//page no 167
//prob no. 5.12
//All frequencies in Hz
B=200*10^3; //The bandwidth allocated by FCC (in Hz)
fl=88*10^6;fh=108*10^6;  //FM broadcast band low and high end freq
Q=fl/B;
disp(Q,'(a)  At the low end of FM band ,Q required is');
Q=fh/B;
disp(Q,'     At the high end of FM band ,Q required is');
fIF=10.7*10^6;// IF frequwncy (in Hz)
Q=fIF/B;
disp(Q,'(b)  At the IF frequency ,Q required is ');
disp('(c)   Signal freq = 88 to 108 MHz')
disp('      LO freq = 98.7 to 118.7 MHz')
disp('      Image freq = 109.4 to 129.4MHz')
disp('(d)   Signal freq = 88 to 108 MHz')
disp('      LO freq = 77.3 to 97.3 MHz')
disp('      Image freq = 66.6 to 86.6MHz')
```

Chapter 6

Amplitude Modulation Methods

Scilab code Exa 6.1 Transmission Bandwidth

```
clc;
//page no 186
//prob no. 6.1
//All frequencies in kHz
fc=1*10^3; //in kHz
W=15;
DSBl=fc-W;  //lowest freq of DSB signal
DSBh=fc+W;  //highest freq of DSB signal
disp(DSBh,'to',DSBl,'(a)  The range of freq is from
   ');
BT=2*W;
disp(BT,'(b)  Transmission bandwidth is ');
```

Scilab code Exa 6.2 Transmission Bandwidth

```
clc;
```

```
close();
clear();
//page no 186
//prob no. 6.2
//All frequencies in kHz
fi=250;  //input freq
LSB=[fi-1;fi-3;fi-5];
USB=[fi+1;fi+3;fi+5];
disp(LSB,'and LSB:',USB,'(a)  The upper sideband and lower sideband ,USB:' );
BT=2*5;
disp(BT,'The net transmission bandwidth is ');
```

Scilab code Exa 6.3 SSB

```
clc;
//page no 190
//prob no. 6.3
//All frequencies in kHz
fc=1*10^3; //in kHz
W=15;
LSBl=fc-W;  //lowest freq of LSB
USBh=fc+W;  //highest freq of USB
disp(fc,'to',LSBl,'(a)  The range of freq(in kHz) for LSB is from ');
disp(USBh,'to',fc,'(b)  The range of freq(in kHz) for USB is from ');
BT=W;
disp(BT,'(b)  Transmission bandwidth is ');
```

Scilab code Exa 6.4 SSB

```
clc;
```

```
//page no 190
//prob no. 6.4
//All frequencies in kHz
fi=250;  //input freq
LSB=[fi-1 fi-3 fi-5];
USB=[fi+1 fi+3 fi+5];
disp(LSB,'(a)  For LSB transmission freq are' );
disp(USB,'(b)  For USB transmission freq are' );
W=5;
BT=W;
disp(BT,'(c)  The transmission bandwidth is ');
```

Scilab code Exa 6.5 Product Detectio of DSB and SSB

```
clc;
//page no 195
//prob no. 6.5
//All frequencies in kHz
//refer Ex 6.4
fi=250;  //input freq
LSB=[fi-1 fi-3 fi-5];  //from Ex 6.4
//
fc=250;  //carrier freq
f0sum=fc+LSB;
f0diff=fc-LSB;
disp(f0sum,f0diff,'(a)  The output frequencies (in kHz) are ');
disp(f0diff,'(b)  At low pass filter,the actual frequencies (in kHz) are ');
```

Scilab code Exa 6.6 Product Detection

```
clc;
```

```
//page no 195
//prob no. 6.6
//All frequencies in kHz
fi=250;  //input freq
USB=[fi+1 fi+3 fi+5]; //from Ex 6.4
//
fc=250;  //carrier freq
f0sum=fc+USB;
f0diff=USB-fc;
disp(f0sum,f0diff,'(a)  The output frequencies (in kHz) are ');
disp(f0diff,'(b)  At low pass filter,the actual frequencies (in kHz) are ');
```

Scilab code Exa 6.7 Product detection of DSB and SSB

```
clc;
//page no 195
//prob no. 6.7
//All frequencies in kHz
//refer Ex 6.4
fi=250;  //input freq
LSB=[fi-1 fi-3 fi-5];  //from Ex 6.7
//
fc=250.1;  //carrier freq
f0sum=fc+LSB;
f0diff=fc-LSB;
disp(f0sum,f0diff,'(a)  The output frequencies (in kHz) are ');
disp(f0diff,'(b)  At low pass filter,the frequencies (in kHz) are ');
```

Scilab code Exa 6.8 Envelop Detection of conventional FM

```
clc;
close();
//page no 200
//prob no. 6.8
//All frequencies in kHz
fc=250;  //carrier freq
LSB=[fc-1 fc-3 fc-5];
USB=[fc+1 fc+3 fc+5];
disp(fc,'carrier:',USB,'USB:',LSB,'(a)  The spectrum
    contains following freq.LSB:' );
W=5;
BT=2*W;
disp(BT,'The transmission bandwidth is ');
```

Scilab code Exa 6.9 Envelop detection of conventionall FM

```
clc;
close();
//page no 200
//prob no. 6.9
//All voltage in V
m=0.6;   //modulation factor
A=100;   //peak carrier level (in V)
Vmax=A*(1+m);
Vmin=A*(1-m);
disp(Vmin,'Vmin:',Vmax,'Vmax:','The maximum and
   minimum values of positive envelope is')
```

Scilab code Exa 6.10 Modulation Factor

```
clc;
close();
//page no 201
```

```
//prob no. 6.10
//All voltage in V
Ratio=.5/2;  //  Ratio=Vmin/Vmax
m=(1-Ratio)/(1+Ratio);   //modulation factor
disp(m,'The modulation factor is ');
disp(m*100,'The %age modulation is ');
```

Scilab code Exa 6.11 Determine Amplitude of sidebands

```
clc;
close();
//page no 201
//prob no. 6.11
//All voltage in V
function {As]=sideband_amplitude(m,A)
    As=m*A/2;  //As:sideband amplitude
               //m:modulation factor
               //A:carrier amplitude
endfunction
A=10;
m=0;
disp(sideband_amplitude(m,A),'(a) For m=0, sideband
   amplitude is ');
m=0.5;
disp(sideband_amplitude(m,A),'(b) For m=0.5,
   sideband amplitude is ');
m=1;
disp(sideband_amplitude(m,A),'(c) For m=1, sideband
   amplitude is ');
```

Scilab code Exa 6.12 Envelop detector

```
clc;
```

```
close();
//page no 203
//prob no. 6.12
fc=455;  //in kHz
Tc=(1/fc)*10^3;  //in micro sec
disp('micro s',Tc,'(a)  The carrier period is');
tau=10*Tc;  //in micro sec
disp('micro s',tau,'The time constant is selected 10 Tc:');
C=0.01*10^-6;  //in F
R=(tau*10^-6)/C;  //ohm
disp('ohm',R,'R is determined');
W=5;  //in kHz
Tm=1/W*10^3;  //micro sec
disp('micro sec',Tm,'The shortest modulation period Tm=');
```

Scilab code Exa 6.14 Determine power

```
clc;
close();
//page no 208
//prob no. 6.14
A=200;  // in Volts
R=50;   //in ohm
P=A^2/(4*R);  //in W
disp('W',P,'(a)  The sverage power is ');
Pp=A^2/(2*R);  //in W
disp('W',Pp,'(b)  The peak envelop power is ');
```

Scilab code Exa 6.15 Antenna rms voltage and current

```
clc;
```

```
close();
//page no 208
//prob no. 6.15
P=1000;  //in watts
R=50;  //in ohm
Vrms=sqrt(R*P);  //in V
Irms=sqrt(P/R);  //in A
disp('V',Vrms,'The unmodulated rms carrier voltage is ');
disp('A',Irms,'The unmodulated rms carrier current is ');
```

Scilab code Exa 6.16 Determine power

```
clc;
close();
//page no 209
//prob no. 6.16
//All power in Watts
global('Pc')
Pc=1000;
funcprot(0)   //to avoid function warnings
function [P]=avg_P(m)           //function for total average power
    P=(1+(m^2/2))*Pc;
endfunction
function [Pp]=peak_P(m)           //function for peak power
    Pp=(1+m)^2*Pc;
endfunction
function [Psb]=SB_P(m)           //function for SB power
    Psb=avg_P(m)-Pc;
endfunction
function display(m)           //function for
```

```
  displaying table
    table=[m*100 avg_P(m) peak_P(m) SB_P(m)];
    disp(table);
endfunction

disp('Summary for the result is displayed in the table ');
disp('Mod^n_%  Avg_Pwr  Peak_Pwr SB_Pwe');
m=0;    //for m=0
display(m);
m=0.5;    //for m=0.5
display(m);
m=1;      //for m=1
display(m);
```

Scilab code Exa 6.17 rms voltage and current

```
clc;
close();
//page no 210
//prob no. 6.17
//All power in Watts
//All voltage in volts
//All current in ampere
R=50;
m=0.5;
P=1125;  //for m=0.5
Vrms=sqrt(R*P);
Irms=sqrt(P/R);
disp('A',Irms,'V',Vrms,'(a)  For m=0.5, Vrms and Irms are:');
m=1;
P=1500;  //For m=1
Vrms=sqrt(R*P);
Irms=sqrt(P/R);
```

```
disp('A',Irms,'V',Vrms,'(b)  For m=1, Vrms and Irms
    are:');
```

Chapter 7

Angle modulation methods

Scilab code Exa 7.1 single tone angle modulation

```
clc;
close();
//page no 227
//prob no. 7.1
t=linspace(0,20);
function {theta]=theta(t)      //function for instantanious phase
    theta=3*%pi*t^2;
endfunction
function {fs]=frequency(t)      //function for instantanious phase
    Ws=6*%pi*t;
    fs=Ws/(2*%pi);
endfunction
subplot(2,1,1)
plot(t,theta,1);
xtitle('Plot1:Instantanious signal phase','t','theta',1);
fs=frequency(t);
subplot(2,1,2)
plot(t,fs,2);
```

```
xtitle('Plot2:Frequency','t','fs',1);
```

Scilab code Exa 7.2 Spectrum of tone modulated FM signal

```
clc;
close();
//page no 230
//prob no. 7.2
//v(t)=80*cos[(2*%pi*10^8*t)+20*sin(2*%pi*10^3*t)]--eq
//v(t)=A*cos[Wc*t+Bsin(Wm*t)]      --eq7-27
//comparing the above 2 equations we get
A=80;       //volts
fc=10^8;   //Hz
fm=10^3;   //Hz
B=20;
disp('Hz',fc,'(a) The carrier cyclic frequency is ');
disp('Hz',fm,'(b) The modulating frequency is ');
disp(B,'(c) The modulation index is ');
delta_f=B*fm;
disp('Hz',delta_f,'(d) The frequency deviation is ');
R=50;   //ohm
P=A^2/(2*R);
disp('W',P,'(e) The average power is ');
```

Scilab code Exa 7.3 Maximum phase deviation

```
clc;
close();
//page no 230
//prob no. 7.3
```

```
//from ex 7.2
//v(t)=80*cos[(2*%pi*10^8*t)+20*sin(2*%pi*10^3*t)]--eq
B=20;
delta_theta=B;    //for PM
disp(delta_theta,'The maximum phase deviation for PM is ');
```

Scilab code Exa 7.4 Equation for FM signal

```
clc;
close();
//page no 231
//prob no. 7.4
disp('The equation becomes');
disp('v(t)=80*cos[(2*%pi*10^8*t)+10*sin(4*%pi*10^3*t)]');
```

Scilab code Exa 7.5 Equation for signal

```
clc;
close();
//page no 231
//prob no. 7.5
disp('The equation becomes');
disp('v(t)=80*cos[(2*%pi*10^8*t)+20*sin(4*%pi*10^3*t)]');
```

Scilab code Exa 7.6 Expression for composite FM

```
clc;
close();
//page no 231
//prob no. 7.6
delta_f=12;   //kHz
fm=4;   //kHz
B=delta_f/fm;   //modulating index for FM
disp('The expression is');
mprintf('v(t)=A*cos[(2*pi*10^8*t)+%i*sin(%i*2*pi*10^3*t)]',B,fm);
```

Scilab code Exa 7.7 Expression for PM signal

```
clc;
close();
//page no 231
//prob no. 7.7
delta_theta=6;   //kHz
fm=5;   //kHz
disp('The expression is');
mprintf('v(t)=A*cos[(2*pi*10^8*t)+%i*sin(%i*2*pi*10^3*t)]',delta_theta,fm);
```

Scilab code Exa 7.8 Transmission bandwidth

```
clc;
close();
//page no 235
//prob no. 7.8
delta_f=400;   //Hz
fm=2000;   //Hz
B=delta_f/fm;   //
disp(B,'The modulation index is');
disp('(For B<=2.5 , the signal is NBFM)');
Bt=2*fm;
mprintf('The transmission bandwidth Bt= %i Hz ',Bt)
```

Scilab code Exa 7.9 Transmission bandwidth

```
clc;
close();
//page no 235
//prob no. 7.9
delta_f=8000;    //Hz
fm=100;    //Hz
B=delta_f/fm;    //
disp(B,'The modulation index is');
disp('(For B>=50 , the signal is VWBFM)');
Bt=2*delta_f;
mprintf('The transmission bandwidth Bt= %i Hz ',Bt)
```

Scilab code Exa 7.10 Approximate transmission bandwidth

```
clc;
close();
//page no 238
//prob no. 7.10
delta_f=6;    //kHz
W=2;    //kHz
D=delta_f/W;    //deviation ratio
disp(D,'The deviation ratio is');
Bt=2*(delta_f+W);    //carsom's rule is applicable
mprintf('The transmission bandwidth Bt= %i kHz ',Bt)
```

Scilab code Exa 7.11 Transmission bandwidth

```
clc;
clear all;
close();
//page no 239
//prob no. 7.11
W=2;   //kHz  (as in ex 7.10)
delta_theta=3;
Bt=2*(1+delta_theta)*W;   //applying carsom's rule
mprintf('The transmission bandwidth Bt= %i kHz ',Bt)
```

Scilab code Exa 7.12 Determine transmission bandwidth

```
clc;
close();
//page no 239
//prob no. 7.12
delta_f=75;   //kHz
fm=[.025 .075 .75 1.5 5 10 15]   //in kHz
function B=Beta(fm,delta_f)
B=delta_f *(1 ./fm);
endfunction
function Bt=Bandwidth(fm,delta_f)
Bt(1:3) = 2 *delta_f;
for i=4:7
   Bt(i) = 2 *(delta_f + fm(i));
end
endfunction
B=Beta(fm,delta_f);
Bt=Bandwidth(fm,delta_f);   //applying carsom's rule
disp('Table - 7.2');
disp('fm(kHz)      Beta         Bt(kHz)');
for i=1:7
mprintf('%4.3f             ',fm(i));
mprintf('%4.1f          ',B(i));
mprintf('%i\n',Bt(i));
end
plot(fm,Bt);
xtitle('Bandwidth of FM','fm,kHz','Bt,kHz')
```

Scilab code Exa 7.13 Determine bandwidth

```
clc;
close();
//page no 240
//prob no. 7.13
delta_f=75;   //kHz
fm=[.025 .075 .75 1.5 5 10 15]   //in kHz (From prob -7.12)
delta_theta=delta_f/fm(7);
Bt=12*fm;   //applying carsom's rule
disp(delta_theta,'Delta theta=');
plot(fm,Bt);
xtitle('Bandwidth of PM','fm,kHz','Bt,kHz')
```

Scilab code Exa 7.14 Frequency tripler

```
clc;
close();
//page no 242
//prob no. 7.14
delta_f1=2;   //kHz
fc1=100;      //kHz
W=5;          //kHz
fc2=3*fc1;
disp(fc2,'(a) The output center frequency =');
delta_f2=3*delta_f1;
```

```
disp(delta_f2,'(b) The output frequency deviation=');
D1=delta_f1/W;
D2=3*D1;
disp(D2,'(c) The output deviation ratio =');
```

Scilab code Exa 7.16 Instantaneous frequency

```
clc;
close();
//page no 248
//prob no. 7.16
Kf=4;     //kHz/V
f0=100;   //kHz
//  Part a
vm=2;    //Volts
delta_f=Kf*vm; //kHz
f=f0+delta_f;        //kHz
disp(f,'Corresponding frequwncy to this input is',delta_f,'(a) The change in frequency is');
//Part b
vm=-3;    //Volts
delta_f=Kf*vm; //kHz
f=f0+delta_f;        //kHz
disp(f,'Corresponding frequwncy to this input is',delta_f,'(b) In this case,the change in frequency is');
```

Scilab code Exa 7.17 Transmitter design

```
clc;
close();
clear();
```

```
//page no 248
//prob no. 7.17
//All frequencies in kHz
fci=100;    //basic center frequency
fco=100000;  //output center frequency
delta_f=(3000/3072)*0.025;   //maximum frequency
   deviation at modulator
W=15;
D=delta_f/W;
Bt=2*W;
table_row1=[fci delta_f D Bt];  //At point A
function [table]=table(table_row,multiplier)
   table= [table_row(1:3)*multiplier ,table_row(4)]

endfunction
table_row2=[table(table_row1,4)];   //at point B
table_row3=[table(table_row2,4)];   //at point C
table_row4=[table(table_row3,4)];   //at point D

function [table1]=table1(table_row,multiplier)
   table1(1:3)= [table_row(1:3)*multiplier];
    Bt=2*(table1(2)+W);  //Applying carsons rule Bt
       =2*(delta_f+W)
   table1(4)= [Bt];

endfunction
table_row5=[table1(table_row4,3)];   //at point E
      ,carsons rule applied from here
table_row6=[(fco/16) table_row5(2:4)];   //at point
   F  ,center frequency after mixer
table_row7=[table1(table_row6,4)];   //at point G
table_row8=[table1(table_row7,4)];   //at point H
table_row9=table_row8;               //at point I
disp('Point    fc       delta_f      D           Bt');
function display(Point,t_row)
    mprintf(" %c    %8.0i",Point,t_row(1));
    for i=2:4
   mprintf("    %3.4f",t_row(i));
```

```
end
mprintf("\n")
endfunction
display('A',table_row1());
display('B',table_row2());
display('C',table_row3());
display('D',table_row4());
display('E',table_row5());
display('F',table_row6());
display('G',table_row7());
display('H',table_row8());
display('I',table_row9());
```

Scilab code Exa 7.18 Determine output frequency

```
clc;
close();
clear();
//page no 258
//prob no. 7.18
//All frequencies in kHz
Kd=2;     //V/kHz
fc=100;
// part a
f=102.5;
delta_f=f-fc;
vd=Kd*delta_f;     //V
disp(vd,'(a)  The first case result is');
// part b
f=98.5;
delta_f=f-fc;
vd=Kd*delta_f;    //V
disp(vd,'(a)  The second case result is');
```

Scilab code Exa 7.19 Frequency division modulation

```
clc;
close();
clear();
//page no 261
//prob no. 7.19
//All frequencies in Hz
D=5;       //deviation ratio
fc=[400 560 730 960];     //Center frequency
delta_f=0.075 .*fc;      //frequency deviation
W=delta_f ./D ;          //modulating frequency
Bt=2 .*(delta_f + W);   //Bandwidth
fl=fc - Bt/2;           //Lower frequency
fh=fc + Bt/2;           //Higher frequency
figure
x=[301:1100];
y=[1.5];
y=[y zeros(302:fl(1))]
for i=1:3
y=[y ones(fl(i):fh(i))];
y=[y zeros(fh(i)+1:fl(i+1))];
end
y=[y ones(fl(4):fh(4))];
y=[y zeros(fh(4):1100)];
plot(x,y);
xtitle('Composite baseband spectrum','f,Hz');
delta_frt=D*1046;
Brt=2*(delta_frt+1046);
disp('Hz',Brt,'(b)  The RF transmission bandwidth is
    ');
```

Chapter 8

Pulse modulation and Time division multiplexing

Scilab code Exa 8.1 sampling rate

```
clc;
close();
clear();
//page no 277
//prob no. 8.1
W=5000;     //Hz
fs=2*W;
mprintf('(a)  The minimum sampling rate is %i samples per second.\n',fs);
T=1/fs;     //second
mprintf(' (b)  Maximum interval between samples is %f seconds',T);
```

Scilab code Exa 8.2 Sampling rate

```
clc;
```

```
close();
clear();
//page no 277
//prob no. 8.2
W=5000;     //Hz
fs=1.25*2*W;
mprintf('(a)  The sampling rate is %i Hz.\n',fs);
T=1/fs;     //second
mprintf('(b)  Maximum interval between samples is %f seconds',T);
```

Scilab code Exa 8.3 Determine total number of samples

```
clc;
close();
clear();
//page no 277
//prob no. 8.3
W=5000;     //Hz
fs=1.25*2*W;
tp=30*60;    //seconds
N=fs*tp;     //samples
mprintf('Total number of samples is %i ',N);
```

Scilab code Exa 8.5 List frequencies

```
clc;
close();
clear();
//page no 281
//prob no. 8.5
//All frequencies in kHz
f=1;
```

```
T=0.1;    //ms
fs=1/T;
mprintf('The positive frequencies below 45 kHz are \
  n %i\n ',f);
for i=1:1:100
    x=fs*i;   //x is a variable
    if((x+f) < 45)
        mprintf('%i  ,%i\n',x-f,x+f);
    else
        break();
        end
end
```

Scilab code Exa 8.6 Pulse amplitude modulation

```
clc;
close();
clear();
//page no 284
//prob no. 8.6
//All time in milli second
//All frequencies in kHz
fs=5;
tau=0.04;    //ms
T=1/fs;        //ms
d=tau/T;
// for plot
f=[-2:.1:28-.1];
Pn1=[ones(1,50)];
Pn=[Pn1];
for i=1:5
    Pn=[Pn Pn1*(1-d*i)];
end
ps1=[ones(1,20)];
for i=1:10
```

```
    ps1=[1-i*0.1 ps1 1-i*0.1];
end
ps1=[ps1 zeros(1:10)];
ps=[ps1];
for i=1:5
    ps=[ps ps1];
end
Vs=ps.*Pn;
clf;
plot2d(f,Vs,[5]);
xtitle('(a) Spectrum of signal after sampling','$f, kHz$','$Vs(f)$');
K1=0.5;
Bt=K1/tau;
mprintf('(b) Bandwidth required for K1=%i is %0.1f kHz\n',K1,Bt);
K1=1;
Bt=K1/tau;
mprintf('Bandwidth required for K1=%i is %i kHz',K1,Bt);
```

Scilab code Exa 8.7 Minimum bandwidth for PAM

```
clc;
close();
clear();
//page no 288
//prob no. 8.7
//All frequencies in kHz
k=7;
W=1;
Bt=k*W;
printf('Minimum Bandwidth is %i kHz',Bt);
```

Scilab code Exa 8.8 Nyquist rate based

```
clc;
close();
clear();
//page no 288
//prob no. 8.8
//All frequencies in kHz
W=1;
fs=1.25*2*W;
Tf=1/fs;
mprintf('(a) The sampling rate is %.1f kHz\n',fs);
mprintf('The frame time is %.1f ms\n',Tf);
tau=Tf/16;  //ms
Bt=0.5/tau;
mprintf('The pulse width is %i micro second\n',tau*10^3);
mprintf('The composite baseband bandwidth is %i kHz\n',Bt);
Bt=2*Bt;
mprintf('(b) The RF bandwidth is %i kHz\n',Bt);
```

Scilab code Exa 8.9 PWM minimum nyquist rate

```
clc;
close();
clear();
//page no 290
//prob no. 8.9
//All frequencies in kHz
W=10;
fs=2*W;
```

```
Tf=1/fs;
mprintf('(a) The minimum sampling rate is %i kHz\n',fs);
mprintf('The frame time is %i micro second\n',Tf*10^3);
tr=0.01*Tf  //ms
Bt=0.5/tr;
mprintf('The maximum rise time is %.1f micro second\n',tr*10^3);
mprintf('The approximate transmission bandwidth is %i kHz\n',Bt);
```

Chapter 9

Digital communication I Binary Systems

Scilab code Exa 9.1 possible PCM words

```
clc;
close();
clear();
//page no 304
//prob no. 9.1
bits=4;
printf('(a) M=%i values\n',2^bits);
bits=8;
printf('(b) M=%i values\n',2^bits);
bits=16;
printf('(c) M=%i values\n',2^bits);
```

Scilab code Exa 9.2 Minimum number of bits

```
clc;
close();
```

```
clear();
//page no 304
//prob no. 9.2
N=log2(100);
printf('(a) N=%.2f bits\n',N);
```

Scilab code Exa 9.3 Quantization

```
clc;
close();
clear();
//page no 309
//prob no. 9.3
//input graph
t=[0:.1:15-.1];
y=[(1/9)*(0:.1:1)^2 (1/8)*(1.1:.1:1.9)^2.1];
y=[y (7/8)*sin(2*%pi*t(21:150)/18.5)];
plot(t,y);
y=8*y;
//quantized form
y1=[];
for i=1:10:150
    for m=-7:7
        if y(i) < m+0.5 then
            break();
        end
     end

    y1=[y1 m*ones(1:10)]
end
y1=y1./8;
plot2d(t,y1,[5]);
a=gca(); // Handle on axes entity
a.x_location = ”origin”;
a.y_location = ”origin”;
```

```
// Some operations on entities created by plot2d ...
a=gca();
a.isoview='off';
a.children // list the children of the axes
xtitle('Analog and quantized signals','t,ms','Normalised signal level')
xgrid()
```

Scilab code Exa 9.4 Quantization error

```
clc;
close();
clear();
//page no 310
//prob no. 9.4
N=8;
Vfs=20;  //Volts
delta_Xu=2^-N;
mprintf('(a)  The normalised unipolar step size is %f\n ',delta_Xu);
delta_vu=delta_Xu*Vfs;
mprintf('(b)  The actual step size is %.2f mV\n ',delta_vu*10^3);
Xumax=1-delta_Xu;
mprintf('(c)  The normalized maximum quantized level is %f\n ',Xumax);
vumax=Xumax*Vfs;
mprintf('(d)  The actual maximum quantized level is %f V\n ',vumax);
Eu=delta_Xu/2;
mprintf('(e)  The normalized peak error is %f\n ',Eu);
eu=Eu*Vfs;
mprintf('(f)  The actual peak error is %.2f mV ',eu*10^3);
```

Scilab code Exa 9.5 A to D converter

```
clc;
close();
clear();
//page no 311
//prob no. 9.5
Vfs=10;  //Volts
N=8;
delta_Xb=2^(-N+1);
mprintf('(a) The normalised bipolar step size is %f\n ',delta_Xb);
delta_vb=delta_Xb*Vfs;
mprintf('(b) The actual step size is %.2f mV\n ',delta_vb*10^3);
Xbmax=1-delta_Xb;
mprintf('(c) The normalized maximum quantized level is %f\n ',Xbmax);
vbmax=Xbmax*Vfs;
mprintf('(d) The actual maximum quantized level is %f V\n ',vbmax);
Eb=delta_Xb/2;
mprintf('(e) The normalized peak error is %f\n ',Eb);
eb=Eb*Vfs;
mprintf('(f) The actual peak error is %.2f mV ',eb*10^3);
```

Scilab code Exa 9.6 Micro compression law encoder

```
clc;
```

```
close();
clear();
//page no 313
//prob no. 9.6
Vimax=16;  //Volts
Vomax=2;  //Volts
m=255;     //meu
vi=[2 4 8 16];
vo=Vomax*log(1+m*vi/Vimax)/log(1+m);
table=[vi' vo'];
mprintf(' vi(V)    vo(V)');
disp(table);
```

Scilab code Exa 9.7 PCM TDM system

```
clc;
close();
clear();
//page no 319
//prob no. 9.7
//all time in ms
//all frequencies in kHz
W=5;
N=8;  //bits
k=19+1;  //word
fs=2*W;
mprintf('fs=%i kHz\n',fs);
Tf=1/fs;
mprintf(' Tf=%.1f ms\n',Tf);
Tw=Tf/k;
mprintf(' Tw=%i micro second\n',Tw*10^3);
tau=Tw/N;
mprintf(' tau=%.3f micro second\n',tau*10^3);
Bt=0.5/tau;
mprintf(' Bt=%ikHz',Bt);
```

Scilab code Exa 9.8 NRZ L PCM

```
clc;
close();
clear();
//page no 323
//prob no. 9.8
//all frequencies in kHz
R=200;  //kbits/s
Bt=R;   //kHz
mprintf(' Bt=%ikHz',Bt);
```

Scilab code Exa 9.9 NRZ L PCM

```
clc;
close();
clear();
//page no 326
//prob no. 9.9
//all frequencies in kHz
R=200;  //kbits/s
delta_f=150;  //f1-f0
Bt=delta_f+R;   //kHz
mprintf(' Bt=%ikHz',Bt);
```

Scilab code Exa 9.10 NRZ L PCM bandwidth

```
clc;
close();
```

```
clear();
//page no 329
//prob no. 9.10
//all frequencies in kHz
R=200;  //kbits/s
Bt=R;   //kHz
mprintf('Bt=%ikHz',Bt);
```

Chapter 10

Digital communication II M ary system

Scilab code Exa 10.1 Channel capcity

```
clc;
close();
clear();
//page no 350
//prob no. 10.1
B=4;    //kHz
C=2*B;
mprintf('(a) C=%ikbits/s\n',C);
C=2*B*log2(4);
mprintf(' (b) for 4-level encoding ,C=%ikbits/s\n',C);
C=2*B*log2(128);
mprintf(' (c) for 128-level encoding ,C=%ikbits/s',C);
```

Scilab code Exa 10.2 Maximum channel capacity

```
clc;
close();
clear();
//page no 351
//prob no. 10.2
B=4;    //kHz
SNdb=[20 30 40];    //S/N in db
SN=10 .^(SNdb./10);   //absolute S/N

C=B .*log2(1+SN);
mprintf(' S/N(db)  C(kbits/s)\n');
out=[SNdb' C'];
disp(out);
```

Scilab code Exa 10.5 Shannon limit

```
clc;
close();
clear();
//page no 352
//prob no. 10.5
B=20;    //kHz
C=160;   //kb/s
M=2^(C/B/2);
mprintf('(a) Number of encoding levels ,M= %i\n',M);
SN=2^(C/B)-1;
SNdb=10*log10(SN)    //S/N in db

mprintf(' (b) S/N= %i  S/N(db)=%.2f dB',SN,SNdb);
```

Scilab code Exa 10.6 QPSK

```
clc;
```

```
close();
clear();
//page no 356
//prob no. 10.6
R=1;  //Mb/s
Bt=R/2;    //MHz
mprintf('Bt= %i kHz',Bt*10^3);
```

Chapter 11

Computer Data communication

Scilab code Exa 11.7 Processor bandwidth

```
clc;
close();
clear();
//page no 379
//prob no. 11.7

B=800*64;    //Mb/s
mprintf('Bandwidth= %i Mb/s  or  %i MB/s',B,B/8);
```

Scilab code Exa 11.8 DDR SDRAM bandwidth

```
clc;
close();
clear();
//page no 379
//prob no. 11.8

B=400*64;    //Mb/s
```

```
mprintf('Memory bus bandwidth = %i Mb/s  or  %i MB/s
   ',B,B/8);
```

Scilab code Exa 11.9 Memory bandwidth

```
clc;
close();
clear();
//page no 379
//prob no. 11.9

B=128*400;    //Mb/s
mprintf('Memory bus bandwidth = %i Mb/s  or  %i MB/s
   ',B,B/8);
```

Chapter 12

Noise in Communication systems

Scilab code Exa 12.1 Mean square and rms values

```
clc;
close();
clear();
//page no 400
//prob no. 12.1
B=10^6;  //Hz
R=[1 100 10000] .*10^3  //ohm
Vrms=(16*10^-21*B .*R)^0.5;  //volts
mprintf(' R (K–ohm)    Vrms (micro–V)');
out=[R'.*10^-3 Vrms'.*10^6];
disp(out);
```

Scilab code Exa 12.2 rms voltage

```
clc;
close();
```

```
clear();
//page no 401
//prob no. 12.2
B=10^6;   //Hz
R=10^7 ; //ohm
Vrms=(16*10^-21*B*R)^0.5;   //volts
G=5000;   //gain
vorms=Vrms*G;
mprintf('vorms=%.1f V',vorms);
```

Scilab code Exa 12.3 net rms voltage

```
clc;
close();
clear();
//page no 403
//prob no. 12.3
B=2*10^6;   //Hz
Req=6*10^6 ; //ohm
Vrms=(16*10^-21*B*Req)^0.5;   //volts
mprintf('vrms=%.1f micro-V',Vrms*10^6);
```

Scilab code Exa 12.4 Noise power

```
clc;
close();
clear();
//page no 405
//prob no. 12.4
B=2*10^6;   //Hz
R=50 ; //ohm
kT0=4*10^-21;

```

```
Nav=kT0*B;
mprintf('Noise power=%.0f fW',Nav*10^15);
```

Scilab code Exa 12.5 output noise power

```
clc;
close();
clear();
//page no 406
//prob no. 12.5
B=2*10^6;  //Hz
R=50 ; //ohm
G=10^6;  //gain
kT0=4*10^-21;

Nav=kT0*B;
No=G*Nav;
mprintf('output Noise power=%.0f nW',No*10^9);
```

Scilab code Exa 12.6 rms noise voltage

```
clc;
close();
clear();
//page no 406
//prob no. 12.6
//data from ex 12.5
B=2*10^6;  //Hz
R=50 ; //ohm
G=10^6;  //gain
kT0=4*10^-21;

Nav=kT0*B;
```

```
No=G*Nav;
//ex12.6
Vrms=(No*50)^0.5;
mprintf('Vrms=%.1f micro-V',Vrms*10^6);
```

Scilab code Exa 12.7 Power spectral density

```
clc;
close();
clear();
//page no 408
//prob no. 12.7
R=50 ; //ohm
G=10^8;  //gain
kT0=4*10^-21;
So=G*kT0;
mprintf('Output spectral density So(f)=%.0f fW/Hz', So*10^15);
```

Scilab code Exa 12.8 white noise

```
clc;
close();
clear();
//page no 409
//prob no. 12.8
ns=6*10^-18;   //W/Hz
k=1.38*10^-23;
Ts=ns/k;
mprintf('(a) Equilant source temperature is Ts=%.0f K\n',Ts);
Gdb=43;  //gain in dB
G=10^(Gdb/10);
```

```
mprintf(' (b) Absolute gain G=%.3f\n',G);
G=20*10^3;    //Approximate
Si=ns;
So=G*Si;
mprintf('Output spectral density So(f)=%.0f fW/Hz\n',So*10^15);
B=12*10^6;    //Hz
no=So;
No=no*B;
mprintf(' (c)Total Output Noise power ,No=%.3f micro-W',No*10^6);
```

Scilab code Exa 12.9 output noise power

```
clc;
close();
clear();
//page no 409
//prob no. 12.9
Gdb1=10;
Gdb2=15;
Gdb3=25;
Gdb=Gdb1+Gdb2+Gdb3;   // net gain in dB
G=10^(Gdb/10);
mprintf('Absolute gain G=%i\n',G);
B=10^4;    //Hz
ni=10^-12;   //pW/Hz
No=ni*G*B;
mprintf(' Output Noise power ,No=%i mW',No*10^3);
```

Scilab code Exa 12.10 low noise amplifier

```
clc;
```

```
close();
clear();
//page no 412
//prob no. 12.10
Te=50;   //K
T0=290;   //K
F=1+Te/T0;
mprintf('(a) Noise figure , F=%.3f\n',F);
Fdb=10*log10(F);
mprintf(' (b) Decibel value , Fdb=%.3f dB ',Fdb);
```

Scilab code Exa 12.11 effective noise temperature

```
clc;
close();
clear();
//page no 412
//prob no. 12.11
Fdb=5;
T0=290;  //K
F=10^(Fdb/10);
mprintf('Noise figure , F=%.3f\n',F);
Te=(F-1)*T0;
mprintf(' Noise Temperature , Te=%i K ',Te);
```

Scilab code Exa 12.12 RF amplifier

```
clc;
close();
clear();
//page no 413
//prob no. 12.12
T0=290;  //K
```

```
Fdb=9;
F=10^(Fdb/10);
mprintf('Absolute Noise figure, F=%.3f=8(Approx)\n',F);
F=8;    //Approximate
Te=(F-1)*T0;
mprintf(' Noise Temperature , Te=%i K \n',Te);
Ti=T0;
k=1.38*10^-23;    //Boltzmann's Constant
B=2*10^6;   //Hz
Ni=k*Ti*B;   //W
mprintf(' (a) Input source Noise ratio , Ni=%i fW\n',Ni*10^15);
Pi=8*10^-12;    //W
SNinput=Pi/Ni;
mprintf('(b) Input source signal to noise ratio S:Ninput=%.0f\n',SNinput);
mprintf('  Corresponding dB value S;Ninput(db)=%.0f dB\n',10*log10(SNinput));
Gdb=50;
G=10^(Gdb/10);
Po=G*Pi;   //W
mprintf('(c) The output signal power, Po=%i nW\n',Po*10^9);
Tsys=Ti+Te;
No=G*k*Tsys*B;  //W
mprintf('(d) output noise power No=%.2f nw\n',No*10^9);
SNoutput=Po/No;
mprintf('(e) Output signal to noise ratio S:Noutput=%.0f\n',SNoutput);
mprintf('  Corresponding dB value S;Noutput(db)=%.0f dB\n',10*log10(SNoutput));
```

Scilab code Exa 12.13 output S to ratio

```
clc;
close();
clear();
//page no 414
//prob no. 12.13
//Data from ex-12
T0=290;  //K
Fdb=9;
F=10^(Fdb/10);
F=8;   //Approximate
Te=(F-1)*T0;
Ti=T0;
k=1.38*10^-23;   //Boltzmann's Constant
B=2*10^6;  //Hz
Ni=k*Ti*B;  //W
Pi=8*10^-12;   //W
SNinput=Pi/Ni;
SNinputdb=10*log10(SNinput);
//Ex13 calculation
SNoutputdB=SNinputdb-Fdb;
mprintf('  S:Noutput(db)=%.0f dB\n',SNoutputdB);
```

Scilab code Exa 12.14 Equivalent noise temperature

```
clc;
close();
clear();
//page no 418
//prob no. 12.14
//Absolute gains
G1=20;
G2=15;
G3=12;
//Temp in K
Te1=100;
```

```
Te2=200;
Te3=300;
Te=Te1+Te2/G1+Te3/G1/G2

mprintf('Noise Temperature ,Te=%.0f K\n',Te);
```

Scilab code Exa 12.15 Net noise figure

```
clc;
close();
clear();
//page no 418
//prob no. 12.15
//Absolute gains
G1=20;
G2=15;
G3=12;
//Temp in K
Te1=100;
Te2=200;
Te3=300;
//Noise figures
F1=1+Te1/290;
F2=1+Te2/290;
F3=1+Te3/290;
F=F1+(F2-1)/G1+(F3-1)/G1/G2;
mprintf('Noise figure ,F=%.4f\n',F);
Te=(F-1)*290;

mprintf('Noise Temperature ,Te=%.0f K\n',Te);
```

Scilab code Exa 12.16 Cascaded system

```
clc;
close();
clear();
//page no 419
//prob no. 12.16
Ldb=6.02;  //db
L=10^(Ldb/10);
mprintf('Absloute loss ,L=%.0f\n',L);
Tp=290;  //K
//Noise temp  (K)
TeL=(L-1)*Tp;
Tepre=50;
Terec=200;
Gpre=10^(20/10);
Te=TeL+L*Tepre+L*Terec/Gpre;
mprintf('Noise Temperature ,Te=%.0f K\n',Te);

//Noise figures
F=1+Te/290;
mprintf('Noise figure ,F=%.4f\n',F);
mprintf('Noise figure ,F(dB)=%.3f  dB\n',10*log10(F));
```

Scilab code Exa 12.17 Noise temperature and noise figure

```
clc;
close();
clear();
//page no 419
//prob no. 12.17
Ldb=6.02;  //db
L=10^(Ldb/10);
mprintf('Absloute loss ,L=%.0f\n',L);
Tp=290;  //K
//Noise temp  (K)
```

```
TeL=(L-1)*Tp;
Tepre=50;
Terec=200;
Gpre=10^(20/10);
Te=Tepre+TeL/Gpre+L*Terec/Gpre;
mprintf(' (a) Noise Temperature ,Te=%.1f K\n',Te);

//Noise figures
F=1+Te/290;
mprintf(' (b) Noise figure ,F=%.2f\n',F);
mprintf('Noise figure ,F(dB)=%.3f  dB\n',10*log10(F));
```

Chapter 13

Performance of Modulation systems with noise

Scilab code Exa 13.1 AC system comparison

```
clc;
close();
clear();
//page no 442
//prob no. 13.1
Gb=1;
mprintf('(a) SSB:   Gb=%i   \n',Gb);
mprintf('    GbdB=%i   dB\n',10*log10(Gb));
mprintf('(b) DSB:   Gb=%i   \n',Gb);
mprintf('    GbdB=%i   dB\n',10*log10(Gb));
m=0.5;
Gb=m^2/(2+m^2);
mprintf('(c) AM(m=.5):   Gb=%.3f   \n',Gb);
mprintf('    GbdB=%.3f   dB\n',10*log10(Gb));
m=1;
Gb=m^2/(2+m^2);
mprintf('(d) AM(m=1):   Gb=%.3f   \n',Gb);
mprintf('    GbdB=%.3f   dB\n',10*log10(Gb));
delta_phi=5;
```

```
Gb=delta_phi^2/2;
mprintf('(e) FM(delta phi=5)):  Gb=%.1f  \n',Gb);
mprintf('    GbdB=%.3f  dB\n',10*log10(Gb));
D=5;
Gb=3*D^2/2;
mprintf('(f) FM(D=5):  Gb=%.1f  \n',Gb);
mprintf('    GbdB=%.3f  dB\n',10*log10(Gb));
Wf1=7.07;
Gb=3/2*D^2*%pi/6*Wf1;
mprintf('(g) FM(D=5, W/f1=7.07):  Gb=%.1f  \n',Gb);
mprintf('    GbdB=%.2f  dB\n',10*log10(Gb));
```

Scilab code Exa 13.2 Receiver processing gain

```
clc;
close();
clear();
//page no 443
//prob no. 13.2
GR=1;
mprintf('(a) SSB:  GR=%i  \n',GR);
mprintf('    GRdB=%i  dB\n',10*log10(GR));
GR=2;
mprintf('(b) DSB:  GR=%i  \n',GR);
mprintf('    GRdB=%.2f  dB\n',10*log10(GR));
m=0.5;
GR=2*m^2/(2+m^2);
mprintf('(c) AM(m=.5):  GR=%.4f  \n',GR);
mprintf('    GRdB=%.3f  dB\n',10*log10(GR));
m=1;
GR=2*m^2/(2+m^2);
mprintf('(d) AM(m=1):  GR=%.3f  \n',GR);
mprintf('    GRdB=%.2f  dB\n',10*log10(GR));
delta_phi=5;
GR=(1+delta_phi)*delta_phi^2;
```

```
mprintf('(e) FM(delta phi=5)):  GR=%.1f  \n',GR);
mprintf('   GRdB=%.3f  dB\n',10*log10(GR));
D=5;
GR=3*D^2*(1+D);
mprintf('(f) FM(D=5):  GR=%.1f  \n',GR);
mprintf('   GRdB=%.3f  dB\n',10*log10(GR));
Wf1=7.07;
GR=3*(1+D)*D^2*%pi/6*Wf1;
mprintf('(g) FM(D=5, W/f1=7.07):  GR=%.1f  \n',GR);
mprintf('   GRdB=%.2f  dB\n',10*log10(GR));
```

Scilab code Exa 13.3 signal to noise ratio

```
clc;
close();
clear();
//page no 447
//prob no. 13.3
k=1.38*10^-23;    //Boltzmann's const
//Temperatures in K
Ti=150;
Te=325;
Tsys=Ti+Te;
mprintf(' Tsys=%i K \n',Tsys);
D=5;
W=15;    //kHz
B=2*(1+D)*W;
mprintf('  B=%i  kHz\n',B);
Nsys=k*Tsys*B*10^3;    //W
mprintf('  Nsys=%.3f fW\n',Nsys*10^15);
PR=50*10^-12;    //W
SNsys=PR/Nsys;
mprintf('  (S/N)sys=%i  \n',SNsys);
GR=3*(1+D)*D^2
mprintf('  GR=%.0f  \n',GR);
```

```
SNoutput=GR*SNsys;
mprintf('  (S/N)output=%.0f  \n',SNoutput);
mprintf('  (S/N)out,dB=%.2f  dB\n',10*log10(SNoutput));
mprintf('  (S/N)sys,dB=%.2f  dB\n',10*log10(SNsys));
GRdb=10*log10(GR);
mprintf('  GR,dB=%.2f dB \n',GRdb);
mprintf('  (S/N)output,dB=%.2f  dB\n',10*log10(SNoutput));
```

Scilab code Exa 13.4 signal to noise ratio

```
clc;
close();
clear();
//page no 450
//prob no. 13.4
N=16;  //bit
SNoutdB=1.76+6.02*N;
mprintf(' (S/N)output,dB=%.2f dB \n',SNoutdB);
```

Scilab code Exa 13.5 Minimum number of bits

```
clc;
close();
clear();
//page no 450
//prob no. 13.5
SNoutdB=53;
N=(SNoutdB-1.76)/6.02;
mprintf(' N=%.2f bits \n',N);
N=9;   //roundup
mprintf(' N=%i bits \n',N);
```

Scilab code Exa 13.6 Binary digital communication system

```
clc;
close();
clear();
//page no 453
//prob no. 13.6
N=6;    //bits per word
M=2^N;
mprintf(' M=%i  \n',M);
Pr=200*10^-15;    //W
R=2*10^6;    //bits/s
Eb=Pr/R;
mprintf(' Bit energy ,Eb=%.0f*10^-21  \n',Eb*10^21);
k=1.38*10^-23;    //Boltzmann cons
Ti=300;   //K
Te=425;   //K
Tsys=Ti+Te;
nsys=k*Tsys;
mprintf('  Noise power spectral density ,nsys=%.0f*10^-20 W/Hz \n',nsys*10^20);
rho=Eb/nsys;
mprintf(' Bit energy , rho=%.0f  \n',rho);
rhodB=10*log10(rho);
mprintf(' Bit energy in db, rho,dB=%.0f dB \n',rhodB);
//part a
Pe=4*10^-6;
SNout=1.5*M^2/(1+4*M^2*Pe);
mprintf(' \n(a) (S/N)output=%.0f (or %0.2f  dB) \n',SNout,10*log10(SNout));
//part b
Pe=2.3*10^-5;
SNout=1.5*M^2/(1+4*M^2*Pe);
```

```
mprintf(' \n(b) (S/N)output=%.0f (or %0.2f dB) \n',SNout,10*log10(SNout));
//part c
Pe=8*10^-4;
SNout=1.5*M^2/(1+4*M^2*Pe);
mprintf(' \n(c) (S/N)output=%.1f (or %0.2f dB) \n',SNout,10*log10(SNout));
//part d
Pe=3.5*10^-3;
SNout=1.5*M^2/(1+4*M^2*Pe);
mprintf(' \n(d) (S/N)output=%.1f (or %0.2f dB) \n',SNout,10*log10(SNout));
```

Scilab code Exa 13.7 PSK signal to noise ratio

```
clc;
close();
clear();
//page no 455
//prob no. 13.7
//data from ex 13.6
M=2^6;
Pr=200*10^-15;   //W
R=8*10^6;   //bits/s     (changed)
Eb=Pr/R;

k=1.38*10^-23;   //Boltzmann cons
Ti=300;  //K
Te=425;  //K
Tsys=Ti+Te;
nsys=k*Tsys;
//mprintf('  Noise power spectral density ,nsys=%.0f *10^-20 W/Hz \n',nsys*10^20);
rho=Eb/nsys;
mprintf(' Bit energy , rho=%.1f  \n',rho);
```

```
rhodB=10*log10(rho);
mprintf(' Bit energy in db, rho,dB=%.2f dB \n',rhodB);

Pe=1.3*10^-2;
SNout=1.5*M^2/(1+4*M^2*Pe);
mprintf(' \n (S/N)output=%.2f (or %0.2f  dB) \n',SNout,10*log10(SNout));
```

Scilab code Exa 13.8 input average carrier power

```
clc;
close();
clear();
//page no 455
//prob no. 13.8
Pe=10^-5;
R=1*10^6;  //bits/s
k=1.38*10^-23;   //Boltzmann cons
Ti=475;  //K
Te=250;  //K
Tsys=Ti+Te;
nsys=k*Tsys;  //W/Hz
function Eb=E(rhodb)    //function for Eb
    rho=10^(rhodb/10);
    Eb=nsys*rho;
endfunction
function Pr=P(E)      //function for Pr
    Pr=R*Eb;
endfunction
function display(rhodb,pt)
    Eb=E(rhodb);
    Pr=P(E);
mprintf('\n(%c)Bit energy , Eb=%.2f*10^-21 J \n',pt,Eb*10^21);
mprintf(' Required reciver carrier power , Pr=%.2f fW \n',Pr*10^15);

endfunction
//Part a
rhodb=9.6;
display(rhodb,'a');

//Part b
rhodb=10.3;
display(rhodb,'b');

//Part c
rhodb=12.6;
display(rhodb,'c');

//Part d
rhodb=13.4;
display(rhodb,'d');
```

Scilab code Exa 13.9 PSK required reciever power

```
clc;
close();
clear();
//page no 456
//prob no. 13.9

//Data form ex13.8
Pe=10^-5;
R=2*10^6;  //bits/s  (changed)
k=1.38*10^-23;   //Boltzmann cons
Ti=475;  //K
Te=250;  //K
Tsys=Ti+Te;
```

```
nsys=k*Tsys;  //W/Hz
function Eb=E(rhodb)     //function for Eb
    rho=10^(rhodb/10);
    Eb=nsys*rho;
endfunction
function Pr=P(E)       //function for Pr
    Pr=R*Eb;
endfunction

rhodb=9.6;
 Eb=E(rhodb);
 Pr=P(E);
mprintf('\nBit energy , Eb=%.2f*10^-21 J \n',Eb*10^21);
mprintf(' Required reciver carrier power , Pr=%.2f fW \n',Pr*10^15);
```

Chapter 14

Transmission lines and waves

Scilab code Exa 14.1 Length of line

```
clc;
close();
clear();
//page no 471
//prob no. 14.1
f=1*10^6;  //Hz
lembda=3*10^8/f;   //m
mprintf('The free space wavelength is = %i m \n',lembda);
l=.1*lembda;
mprintf(' Length ,l= %i m',l);
```

Scilab code Exa 14.2 Length of line

```
clc;
close();
clear();
//page no 471
```

```
//prob no. 14.2
f=1*10^8;  //Hz
lembda=3*10^8/f;   //m
mprintf('The free space wavelength is = %i m \n',lembda);
l=.1*lembda;
mprintf(' Length ,l= %.1f m',l);
```

Scilab code Exa 14.3 Length of line

```
clc;
close();
clear();
//page no 472
//prob no. 14.3
f=1*10^9;  //Hz
lembda=3*10^8/f;   //m
mprintf('The free space wavelength is = %i cm \n',lembda*100);
l=.1*lembda;
mprintf(' Length ,l= %i cm',l*100);
```

Scilab code Exa 14.4 Characteristic impedance

```
clc;
close();
clear();
//page no 474
//prob no. 14.4
L=320*10^-9;   //H/m
C=90*10^-12;   //F/m
R0=sqrt(L/C);
```

```
mprintf('The characteristc impedance, R0 = %.2f ohm \n',R0);
```

Scilab code Exa 14.5 Velocity of propagation

```
clc;
close();
clear();
//page no 476
//prob no. 14.5
L=320*10^-9;    //H/m
C=90*10^-12;    //F/m
v=1/sqrt(L*C);
mprintf('The velocity of propagation is, v = %.3f 10^8 m/s \n',v*10^-8);
```

Scilab code Exa 14.6 Dielectric costant

```
clc;
close();
clear();
//page no 476
//prob no. 14.6
L=320*10^-9;    //H/m
C=90*10^-12;    //F/m
v=1/sqrt(L*C);    //from Ex14.5
Er=(3*10^8/v)^2;
mprintf('The dielectic constant is, Er = %.2f  \n',Er);
```

Scilab code Exa 14.6.1 Coaxial cable

```
clc;
close();
clear();
//page no 479
//prob no. 14.6;    //misprinted example no
d=.3;  //cm
D=1.02;  //cm
Er=2.25;
x=log(D/d);   //variable
L=2*10^-7*x;
mprintf('(a)The inductance per unit length is, L = %.1f nH/m \n',L*10^9);
C=55.56*10^-12*Er/x;
mprintf(' (b)The capacitance per unit length is, C = %.2f nH/m \n',C*10^12);
R0=60/sqrt(Er)*x;
mprintf(' (c)The characteristic impedance is, R0 = %.3f ohm \n',R0);
c=3*10^8;
v=c/sqrt(Er);
mprintf(' (d)The velocity of propagation is, v = %i*10^8 m/s \n',v*10^-8);
```

Scilab code Exa 14.7 mismached load impedance

```
clc;
close();
clear();
//page no 480
//prob no. 14.7;
Rin=50   //ohm
Rout=50;   //ohm
Vrms=400;  //V
```

```
Zin=Rin;
mprintf('(a)The input impedance is, Zin = %i ohm\n',Zin);
Irms=Vrms/(Rin+Rout);  //A
mprintf(' (b)The rms current , Irms = %i A \n',Irms);
Pin=Irms^2*Rin;
mprintf(' (c)The input power is, Pin = %i W \n',Pin);
Pl=Pin;
mprintf(' (d)The load power is, Pl = %i W \n',Pl);
```

Scilab code Exa 14.8 Load power

```
clc;
close();
clear();
//page no 481
//prob no. 14.8
Rin=50   //ohm
Rout=50;   //ohm
Vrms=400;  //V

l=50;       //m
Ldb=.01*l;    //dB
L=10^(Ldb/10);
mprintf('The abslute loss is, L = %f \n',L);
Irms=Vrms/(Rin+Rout);  //A
Pin=Irms^2*Rin;

PL=Pin/L;
mprintf(' The actual Power reaching the load is, PL = %.1f W \n',PL);
```

Scilab code Exa 14.9 Lossless transmission line

```
clc;
close();
clear();
//page no 484
//prob no. 14.9
ZL=complex(50,100);
R0=50;
TauL=(ZL-R0)/(ZL+R0);

mprintf('(a)The reflection coefficient at load is,')
    ;
disp(TauL);
[R,theta]=polar(TauL);
mprintf('OR , %.4f angle %i',R,theta*(180/%pi));

S=(1+R)/(1-R);
mprintf('\n (b) The standing wave ratio is, S = %.3f
    \n',S);
```

Scilab code Exa 14.10 Loss less transmission line

```
clc;
close();
clear();
//page no 484
//prob no. 14.10
ZL=100;    //ohm
RL=ZL;
R0=300;     //ohm
TauL=(RL-R0)/(RL+R0);
```

```

mprintf('(a)The reflection coefficient at load is=%0.2f,',TauL);

S=R0/RL;
mprintf('\n (b) The standing wave ratio is, S = %.0f\n',S);
```

Scilab code Exa 14.11 Lossless transmission line

```
clc;
close();
clear();
//page no 485
//prob no. 14.11
ZL=100;    //ohm
RL=ZL;
R0=300;     //ohm
TauL=(RL-R0)/(RL+R0);
mismatch_loss_dB=-10*log10(1-TauL^2);
mprintf(' The mismatch loss (dB), S = %.2f dB\n',mismatch_loss_dB);
```

Scilab code Exa 14.12 Plane wave propagation

```
clc;
close();
clear();
//page no 487
//prob no. 14.12
Ex=3 //V/m
n0=377;
Hy=Ex/n0;
```

```
mprintf('(a) The vaulue of Hy is, Hy = %.3f * 10^-3 A/m\n',Hy*10^3);

Px=Ex^2/n0;
mprintf(' (b) The power density Px is, Px = %.3f * 10^-3 W/m^2\n',Px*10^3);
A=10*30;
P=Px*A;
mprintf(' (c) The net power transmitted is, P = %.3f W \n',P);
```

Chapter 15

Introduction to Antennas

Scilab code Exa 15.2 Distance of boundary

```
clc;
close();
clear();
//page no 500
//prob no. 15.2
c=3*10^8;  //speed of light
f=2*10^9;   //frequency
lembda=c/f;   //wavelength
mprintf('The wavelength of 2GHz is , = %.2f m\n',
   lembda);
D=15;  //m
Rff=2*D^2/lembda;
mprintf(' The distance to the far field is , Rff = %i
    m\n',Rff);
```

Scilab code Exa 15.3 max dB gain

```
clc;
```

```
close();
clear();
//page no 502
//prob no. 15.3
Gmax=10^5;
Gmax_dB=10*log10(Gmax);
mprintf('Gmax,dB= %i dB',Gmax_dB);
```

Scilab code Exa 15.4 Power gain

```
clc;
close();
clear();
//page no 504
//prob no. 15.4
d=10^5;  //m
Pt=100;  //W
Pd=Pt/(4*%pi*d^2);
mprintf('The power density is ,Pd= %.1f pW/m^2',Pd
   *10^12);
```

Scilab code Exa 15.5 Power density

```
clc;
close();
clear();
//page no 504
//prob no. 15.5
d=10^5;  //m
Pt=100;  //W
Gt=50;
Pd=Gt*Pt/(4*%pi*d^2);
```

```
mprintf('The power density is ,Pd= %.2f nW/m^2',Pd*10^9);
```

Scilab code Exa 15.6 satellite system

```
clc;
close();
clear();
//page no 504
//prob no. 15.6
c=3*10^8;  //speed of light
f=15*10^9;   //frequency
lembda=c/f;   //wavelength
mprintf('The wavelength of 15 GHz is, = %.2f m\n',lembda);

d=41*10^6;  //m
Pt=50;  //W
Gt=10^4;
Gr=10^5
Pr=lembda^2*Gr*Gt*Pt/((4*%pi)^2*d^2);
mprintf('The power density is ,Pr= %.1f pW',Pr*10^12);
```

Scilab code Exa 15.7 Radiation resistance

```
clc;
close();
clear();
//page no 506
//prob no. 15.7

Pt=2000;  //W
```

```
Irms=5;
Rrad=Pt/Irms^2;
mprintf('The radiation resistance is ,Rrad= %i ohm',Rrad);
```

Scilab code Exa 15.11 Parabolic reflector

```
clc;
close();
clear();
//page no 511
//prob no. 15.1
//misprinted example number
c=3*10^8;  //speed of light
f=10*10^9;   //frequency
lembda=c/f;   //wavelength
mprintf('The wavelength of 2GHz is , = %.2f m\n',lembda);
D=12;  //m
Ap=%pi*D^2/4;
mprintf(' (a)The physical area is ,Ap= %.2f m^2  \n',Ap);
n1=.7;   //efficiency
Ae=n1*Ap;
mprintf('  The effective capture area is ,Ae= %.2f m^2',Ae);
G=4*%pi*Ae/lembda^2;
mprintf('\n (b) The gain is ,G= %i',G);
GdB=10*log10(G);
mprintf('\n The gain(dB) is ,GdB= %.1f dB',GdB);
theta_3dB=70*lembda/D;
mprintf('\n (c) The 3 dB beamwidth = %.3f degrees',theta_3dB);
```

Scilab code Exa 15.12 Effective area

```
clc;
close();
clear();
//page no 507
//prob no. 15.12
//misprinted example number
c=3*10^8;  //speed of light
f=100*10^6;   //frequency
lembda=c/f;   //wavelength
mprintf('The wavelength of 2GHz is, = %i m\n',lembda
   );
Ac=0.13*lembda^2;
mprintf('The capture area is ,Ac= %.2f m^2',Ac);
```

Chapter 16

Communication link analysis and Design

Scilab code Exa 16.1 Recieived power

```
clc;
close();
clear();
//page no 518
//prob no. 16.1
c=3*10^8;  //speed of light
Pt=5     //W
GtdB=13;  //dB
GrdB=17;  //dB
d=80*10^3;  //metre
f=3*10^9;   //frequency
lembda=c/f;   //wavelength
mprintf('The wavelength is , = %.1f m\n',lembda);

Gt=10^(GtdB/10);
Gr=10^(GrdB/10);
mprintf(' Gt=%.2f  \n',Gt);
mprintf(' Gr=%.2f  \n',Gr);
Pr=lembda^2*Gt*Gr*Pt/((4*%pi)^2*d^2);
```

```
mprintf(' Pr=%.1f pW \n',Pr*10^12);
```

Scilab code Exa 16.2 dB approach

```
clc;
close();
clear();
//page no 520
//prob no. 16.2
c=3*10^8;  //speed of light
Pt=5    //W
GtdB=13;  //dB
GrdB=17;  //dB
d=80;  //in km
f=3;   //frequency in GHz

PtdBW=10*log10(Pt);
alfa1_dB=20*log10(f)+20*log10(d)+92.44;  //dB
mprintf('The path loss is ,  alfa_1(dB) = %.2f dB\n',
   alfa1_dB);

PrdBW=PtdBW+GtdB+GrdB-alfa1_dB;   //calculation of
   recieved power in dB
mprintf(' Pr(dBW)=%.2f  dBW\n',PrdBW)

Pr=10^(PrdBW/10);   //recieved power in Watts
mprintf(' Pr=%.1f pW ',Pr*10^12);
```

Scilab code Exa 16.3 Path loss

```
clc;
close();
clear();
```

```
//page no 521
//prob no. 16.3
d=240000*1.609;   //in km
//part a
f=100;   //frequency in MHz
alfa1_dB=20*log10(f)+20*log10(d)+32.44;   //dB
mprintf('(a) The path loss is %.2f dB\n',alfa1_dB);
//part b
f=1;   //frequency in GHz
alfa1_dB=20*log10(f)+20*log10(d)+92.44;   //dB
mprintf(' (b) The path loss is %.2f dB\n',alfa1_dB);
//part c
f=10;   //frequency in GHz
alfa1_dB=20*log10(f)+20*log10(d)+92.44;   //dB
mprintf(' (c) The path loss is %.2f dB\n',alfa1_dB);
```

Scilab code Exa 16.4 path loss

```
clc;
close();
clear();
//page no 522
//prob no. 16.4
f=1;   //in GHz
//part a
d=1;   //in Km
alfa1_dB=20*log10(f)+20*log10(d)+92.44;   //dB
mprintf('(a) The path loss is %.2f dB\n',alfa1_dB);
//part b
d=10;   //in km
alfa1_dB=20*log10(f)+20*log10(d)+92.44;   //dB
mprintf(' (b) The path loss is %.2f dB\n',alfa1_dB);
//part c
d=100;   //in km
alfa1_dB=20*log10(f)+20*log10(d)+92.44;   //dB
```

```
mprintf(' (c) The path loss is %.2f dB\n',alfa1_dB);
```

Scilab code Exa 16.5 Minimum transmitted power required

```
clc;
close();
clear();
//page no 522
//prob no. 16.5
Pr=50*10^-12;  //in Watts
GtdB=3;  //dB
GrdB=4;  //dB
d=80;  //kilo-metre
f=500;   //frequency in MHz
PrdBW=10*log10(Pr);   //in dB conversion
mprintf('Pr(dBW)=%.2f  dBW\n',PrdBW)
alfa1_dB=20*log10(f)+20*log10(d)+32.44;  //path loss in dB
mprintf(' The path loss is , %.2f dB\n',alfa1_dB);
PtdBW=PrdBW+alfa1_dB-GtdB-GrdB;   //calculation of transmitted  power in dB
mprintf(' Pt(dBW)=%.2f  dBW\n',PtdBW)
Pt=10^(PtdBW/10);   //transmitted power in Watts
mprintf(' Pt=%.1f W ',Pt);
```

Scilab code Exa 16.6 Required transmitted power

```
clc;
close();
clear();
//page no 523
//prob no. 16.6
Pr=200;  //in f-Watts
```

```
GtdB=30;  //dB
GrdB=20;  //dB
d=40000;  //kilo-metre
f=4;   //frequency in GHz
PrdBf=10*log10(Pr);   //in dBf conversion
mprintf('Pr(dBf)=%.2f  dBf\n',PrdBf)
alfa1_dB=20*log10(f)+20*log10(d)+92.44;  //path loss in dB
mprintf(' The path loss is, %.2f dB\n',alfa1_dB);
PtdBf=PrdBf+alfa1_dB-GtdB-GrdB;   //calculation of transmitted  power in dBf
PtdBW=PtdBf-150;   //calculation of transmitted power in dBW
mprintf(' Pt(dBf)=%.2f  dBf OR %.2f dBW\n',PtdBf,PtdBW)
Pt=10^(PtdBW/10);   //transmitted power in Watts
mprintf(' Pt=%.2f W ',Pt);
```

Scilab code Exa 16.7 range of transmission

```
clc;
close();
clear();
//page no 525
//prob no. 16.7
hT=50;  //m
hR=5;   //m
d_km=sqrt(17*hT)+sqrt(17*hR);   //in km
mprintf(' d(km)=%.2f Km ',d_km);
```

Scilab code Exa 16.8 Received power

```
clc;
```

```
close();
clear();
//page no 528
//prob no. 16.8
Pt=10000;  //Watts
Gt=25;     //dB
f=3;         //GHz
d=50;     //km
sigma=20   //radar cross section in m^2
alfa2_dB=20*log10(f)+40*log10(d)+163.43-10*log10(
   sigma);   //alfa2(dB) calculation
mprintf(' The two way path loss is,alfa2(dB)= %.2f
   dB\n',alfa2_dB);
PtdBW=10*log10(Pt);   //transmitted  power in dB
mprintf(' Pt(dBW)=%i  dBW\n',PtdBW)
PrdBW=PtdBW+2*Gt-alfa2_dB   //dBW
mprintf(' Pr(dBW)=%.2f dBW \n',PrdBW);
Pr=10^(PrdBW/10);
mprintf(' Pr=%.2f fW',Pr*10^15);
```

Scilab code Exa 16.9 Distance to the target

```
clc;
close();
clear();
//page no 530
//prob no. 16.9
c=3*10^8;    //speed of light in m/s
Td=400*10^-6      //s
d=c*Td/2        //in m
mprintf(' d=%.0f Km ',d*10^-3);
```

Scilab code Exa 16.10 Pulse radar system

```
clc;
close();
clear();
//page no 530
//prob no. 16.10
c=3*10^8;     //speed of light in m/s
fp=2*10^3;    //Hz
T=1/fp      //s
dmax=c*T/2         //in m
mprintf('(a) d max=%.0f Km \n',dmax*10^-3);
tau=6*10^-6;    //s
dmin=c*tau/2    //m
mprintf('(b) d min=%.0f m ',dmin);
```

Scilab code Exa 16.11 Doppler shift

```
clc;
close();
clear();
//page no 532
//prob no. 16.11
c=3*10^8;     //speed of light in m/s
fc=15*10^9;    //Hz
v=25      // speed in m/s
fD=2*v/c*fc;     //Hz
mprintf('Doppler shift , fD=%.0f Hz \n',fD);
```

Scilab code Exa 16.12 Speed of automobile

```
clc;
close();
clear();
//page no 532
```

```
//prob no. 16.12
c=186000;     //speed of light in mi/s
fc=10*10^9;    //Hz
fD=2*10^3;     //frequency shift in Hz
v=c*fD/(2*fc);  //speed in mi/s
mprintf('Speed of automobile , v=%.2f*10^-3 mi/s \n',v*10^3);
v=3600*v;
mprintf(' v=%.1f mi/hr \n',v);
```

Scilab code Exa 16.13 Angle of refraction

```
clc;
close();
clear();
//page no 535
//prob no. 16.13
n1=1;     //refraction index of air
E2=4      //material dielectric constant
theta_i=50   //angle of incidence in degree (misprinted in the solution)
n2=sqrt(E2);
theta_r=asin(n1/n2*sin(theta_i*%pi/180));
mprintf(' The angle of refraction is %.2f \n (using angle of incidence =50)\n',theta_r*180/%pi);
//misprinted angle
```

Chapter 17

Satellite communication

Scilab code Exa 17.1 Satellite

```
clc;
close();
clear();
//page no 547
//prob no. 17.1
H=10^6;     //meter
v=20*10^6/sqrt(H+6.4*10^6);    //m/s
mprintf('(a)velocity , v=%i m/s\n',v);
R=6.4*10^6;     //data rate in bits per second
C=2*%pi*(H+R);     //circumference in m
mprintf(' (b)circumference , C=%i m\n',C);     //raunded value of C shown in book solution
T=C/v;
mprintf(' (c)The period is , T=%.2f seconds or %.2f minutes',T,T/60);
```

Scilab code Exa 17.2 Declination offset angle

```
clc;
close();
clear();
//page no 548
//prob no. 17.2
L=37;   //latitude in degree
R=6400;  H=36000;  //from the text
del=atan(R*sin(L*%pi/180)/(H+R*(1-cos(L*%pi/180))))    //Declination angle
mprintf('The ange is %.2f degree\n',del*180/%pi);
```

Scilab code Exa 17.3 Satellite transmitter

```
clc;
close();
clear();
//page no 552
//prob no. 17.3
c=3*10^8;   //speed of light in m/s
f=3.7*10^9;   //Hz
lembda=c/f;   //m
mprintf('The wave length is %.4f cm \n',lembda*100)
theta_3dB=8;    //degree
D=70*lembda/theta_3dB     //m
mprintf('The diameter is , D= %.4f m \n',D);
eta_1=.6;     //illumination efficiency
G=eta_1*(%pi*D/lembda)^2;    //gain calculation
mprintf('The Gain is G= %.2f \n',G)
G_dB=10*log10(G);   //dB gain
mprintf('The Gain in dB is G(dB)= %.3f dB \n',G_dB)
```

Scilab code Exa 17.4 Gain required

```
clc;
close();
clear();
//page no 553
//prob no. 17.4
theta_3dB=1.6;     // beamwidth in degree
eta_1=.6;      //illumination efficiency
G=eta_1*48000/(theta_3dB)^2;     //gain calculation
mprintf('The Gain is G= %.0f \n',G)
G_dB=10*log10(G);    //dB gain
mprintf('The Gain in dB is G(dB)= %.1f dB \n',G_dB)
```

Scilab code Exa 17.5 Gain required

```
clc;
close();
clear();
//page no 554
//prob no. 17.5
theta_3dB=.3;     // minimum practical beamwidth in degree
eta_1=.6;      //illumination efficiency
G=eta_1*48000/(theta_3dB)^2;     //gain calculation
mprintf('The Gain is G= %.0f \n',G)
G_dB=10*log10(G);    //dB gain
mprintf('The Gain in dB is G(dB)= %.1f dB \n',G_dB)
```

Scilab code Exa 17.6 Diameter of ground station uplink antenna

```
clc;
close();
clear();
//page no 554
```

```
//prob no. 17.6
c=3*10^8;    //speed of light in m/s
f=5.925*10^9;    //Hz
lembda=c/f;    //m
mprintf('The wave length is %.3f cm \n',lembda*100)
theta_3dB=1.6;     // beamwidth degree
D=70*lembda/theta_3dB      //m
mprintf('The diameter is , D= %.3f m \n',D);
```

Scilab code Exa 17.7 Distance from earth station

```
clc;
close();
clear();
//page no 556
//prob no. 17.7
l=127-70.2;      //Difference in longitude
L=40.5     //Latitude of New York
d_km=35.786*10^3*sqrt(1+0.42*(1-cos(L*%pi/180)*cos(l
   *%pi/180)));
mprintf('The distance is %.0f km \n',d_km)
```

Scilab code Exa 17.8 Determine C to N ratio

```
clc;
close();
clear();
//page no 556
//prob no. 17.8
PtdBW=20
GtdB=55
EIRP_dBW=PtdBW+GtdB;
```

```
mprintf('The EIRP for uplink earth station is %.0f dBW \n',EIRP_dBW)
l=91-70.2;     //Difference in longitude
L=40.5    //Latitude of New York
d_km=35.786*10^3*sqrt(1+0.42*(1-cos(L*%pi/180)*cos(l*%pi/180)));
mprintf('The distance is %.0f km \n',d_km)

f=6.125       //Uplink frequency in GHz
alfa1_dB=20*log10(f)+20*log10(d_km)+92.44;    //Path loss
mprintf('The path loss is %.2f dB \n',alfa1_dB)

FdB=3;    //noise figure in dB
F=10^(FdB/10)   //absolute noise figure   (exact value)
Te=(F-1)*290;   //Noise temperature
mprintf('The Noise temperature of satellite reciever is %.0f K \n',Te)
Ti=300;    //input noise temperature in K
Tsys=Ti+Te
mprintf('The system temperature of satellite reciever is %.0f K \n',Tsys)
G_dB=27       //satellite reciever antwnna gain
GT=G_dB-10*log10(Tsys);      //G/T ratio in dB
mprintf('The G/T ratio for satellite reciever is %.2f dB/K \n',GT)
B=36*10^6  ;//   Bandwidth  in Hz
L_misc=1.6      //atmospheric loss
CN=EIRP_dBW-alfa1_dB+GT+228.6-10*log10(B)-L_misc;     //C/N in dB
mprintf('The carrier power to noise ratio at the satellite reciever is %.2f dB \n',CN)
//  Value of F is rouded to 2 in the text
```

Scilab code Exa 17.9 Determine C to N ratio

```
clc;
close();
clear();
//page no 557
//prob no. 17.9

EIRP_dBW=47.8;    //dBW
l=91-90;      //Difference in longitude
L=32    //Latitude of New York
d_km=35.786*10^3*sqrt(1+0.42*(1-cos(L*%pi/180)*cos(l*%pi/180)));
mprintf('The distance is %.0f km \n',d_km)

f=3.9       //downlink frequency in GHz
alfa1_dB=20*log10(f)+20*log10(d_km)+92.44;     //Path loss
mprintf('The path loss is %.2f dB \n',alfa1_dB)

F=1.778    //absolute noise figure
Te=(F-1)*290;    //Noise temperature
mprintf('The Noise temperature of satellite reciever is %.2f K \n',Te)
Ti=150;     //input noise temperature in K
Tsys=Ti+Te
mprintf('The system temperature of satellite reciever is %.2f K \n',Tsys)
G_dB=42       //satellite reciever antwnna gain
GT=G_dB-10*log10(Tsys);      //G/T ratio in dB
mprintf('The G/T ratio for satellite reciever is %.2f dB/K \n',GT)
B=36*10^6  ;//   Bandwidth  in Hz
L_misc=1       //atmospheric loss
CN=EIRP_dBW-alfa1_dB+GT+228.6-10*log10(B)-L_misc;     //C/N in dB
mprintf('The carrier power to noise ratio at the satellite reciever is %.1f dB \n',CN)
```

Chapter 19

Wireless Network communication

Scilab code Exa 19.2 First 10 channel in hop sequence

```
clc;
close();
clear();
//page no 605
//prob no. 19.2
b=[0 23 62 8 43 16 71 47 19 61]
for i=1:10
    f9(i)=[b(i)+9]+2
    if f9(i)>79 then
        f9(i)=f9(i)-79
    end
    mprintf('\nFor i=%i ,b(i)=%i. Therefore.f9(%i)=[%i+9]mod(79)+2=%i',i,b(i),i,b(i),f9(i))
end
```

Scilab code Exa 19.4 Part of FHSS frame

```
clc;
close();
clear();
//page no 607
//prob no. 19.4
fd=.160;    //in MHz
Fc=2411;
    mprintf('(a)fd=%.2f MHz. a 0 is represented by %.2f MHz\n',fd,Fc-fd)
    mprintf('(b)A 1 is represented by %.2f MHz\n',Fc+fd)
```

Scilab code Exa 19.5 FHSS frame

```
clc;
close();
clear();
//page no 607
//prob no. 19.5
fd1=.216;    //in MHz
fd2=.072;    //in MHz
Fc=2400+25 ;   //MHz
    mprintf('(a)fd1=%.2f MHz. a 00 is represented by %.3f MHz\n',fd1,Fc-fd1)
    mprintf('(b)A 01 is represented by %.3f MHz\n',Fc-fd2)
    mprintf('(c)A 10 is represented by %.3f MHz\n',Fc+fd1)
    mprintf('(b)A 11 is represented by %.3f MHz\n',Fc+fd2)
//answer in part a is misprinted in the text
```

Scilab code Exa 19.6 Waveform of DBPSK

```
clc;
close();
clear();
//page no 608
//prob no. 19.6
code=[0 1 0 1 1 0];
t=[0:.01:2]    //for x-axis
a=[sin(2*%pi.*t)]     //for y-axis
y=[]
x=[]
for i=1:length(code)

    if code(i)==1 then
        a=-a;
    end
    y=[y a]
    x=[x 2*%pi.*(t+2*(i-1))]
end

clf
plot(x,y)
a=gca(); // Handle on axes entity
a.x_location = ”origin”;
a.y_location = ”origin”;
xtitle('DPSK used to encode 010110','Time','amplitude')
xgrid
```

Scilab code Exa 19.7 Waveform of DQPSK

```
clc;
close();
clear();
//page no 609
//prob no. 19.7
```

```
code=[0 0 1 1 1 0 0 0 0 0 0 1];
t=[0:.01:2]   //for x-axis
y=[]
x=[]
p=0   //phase shift
for i=1:2:length(code)
    if code(i)==0 then
        if code(i+1)==0 then
            p=p+0
        else
            p=p+%pi/2
        end
    else
        if code(i+1)==1 then
            p=p+%pi
        else
            p=p+3*%pi/2
        end
    end
    y=[y sin(2*%pi.*t+p)];
    x=[x 2*%pi.*(t+(i-1))];
end

clf()
plot(x,y);
a=gca(); // Handle on axes entity
a.x_location = "origin";
a.y_location = "origin";
xtitle('DQPSK used to encode 001110000001','Time','amplitude');
xgrid
```

Chapter 20

Optical communication

Scilab code Exa 20.1 Frequency of the laser

```
clc;
close();
clear();
//page no 616
//prob no. 20.1
lembda=1300*10^-9;    //wavwlength in m
c=3*10^8;             //speed of light in m/s
f=c/lembda            //in Hz
mprintf('frequency of laser is ,f=%.0f  THz',f
   *10^-12);
```

Scilab code Exa 20.2 Angle of refraction

```
clc;
close();
clear();
//page no 619
//prob no. 20.2
```

```
theta_i=30;     //degree
ni=1.00;        //incident refraction index
nr=1.52;        //refeacted ray refraction index
theta_r=asin(ni/nr*sin(theta_i*%pi/180));     //in radians
mprintf('angle of refraction is %.2f  degree',theta_r*180/%pi);
```

Scilab code Exa 20.3 Critical angle

```
clc;
close();
clear();
//page no 620
//prob no. 20.3
theta_r=90;     //degree
ni=1.52;        //refraction index for crown glass
nr=1.00;        //refraction index for air
theta_i=asin(nr/ni*sin(theta_r*%pi/180));     //in radians
mprintf('critical angle is %.2f  degree',theta_i*180/%pi);
//misprinted theta_r in the text
//values are raunded up in the text
```

Scilab code Exa 20.4 Responsivity of photodiode

```
clc;
close();
clear();
//page no 624
//prob no. 20.4
eta=.8;     //efficiency
```

```
lembda=850;   //nm
R=eta*lembda/1234;     //  A/W
mprintf('The responsivity of diode is R= %.2f  A/W',
   R);
```

Scilab code Exa 20.5 Responsivity of photodiode

```
clc;
close();
clear();
//page no 624
//prob no. 20.5
eta=.6;     //efficiency
lembda=1310;   //nm
R=eta*lembda/1234;     //  A/W
mprintf('The responsivity of diode is R= %.2f  A/W',
   R);
```

Scilab code Exa 20.6 Loss in cable

```
clc;
close();
clear();
//page no 627
//prob no. 20.6
L=.4*.8;     //loss in dB
mprintf('The loss usong this cable is L= %.2f  dB',L
   );
```

Scilab code Exa 20.7 Loss of multimode cable

```
clc;
close();
clear();
//page no 627
//prob no. 20.7
L=2.7*.8;     //loss in dB
mprintf('The loss usong multimode cable is L= %.2f
   dB',L);
```

Chapter 21

Consumer communication systems

Scilab code Exa 21.1 difference between stereo FM and monaural FM

```
clc;
close();
clear();
//page no 637
//prob no. 21.1
D1=5;
GR1=3*D1^2*(1+D1);
mprintf('The reciever processing gain is GR1= %.0f \n',GR1);
Bt=200*10^3;       //bandwisth in Hz
W=53*10^3;          //highest modulating frequency in Hz
D2=Bt/(2*W)-1;      //deviation ratio
mprintf('D2=%.3f\n',D2);
GR2=3*D2^2*(1+D2);
mprintf('The reciever processing gain for sterio FM is GR2= %.3f \n',GR2);
mprintf('The ratio of the two gains is GR2/GR1= %.4f dB\n',GR2/GR1);
```

```
dBdiffrence=10*log10(GR2/GR1)
mprintf('dB diffrence= %.0f dB\n',dBdiffrence);
```

Scilab code Exa 21.2 Monochrome TV

```
clc;
close();
clear();
//page no 644
//prob no. 21.2
mprintf('The percentage is %.0f ',483/525*100)
```

Scilab code Exa 21.3 Deviation ratio in TV channel

```
clc;
close();
clear();
//page no 644
//prob no. 21.3
D=25/15;
mprintf('The deviation ratio is D=%.3f ',D)
```

Scilab code Exa 21.4 Transmission bandwidth of monaural television FM

```
clc;
close();
clear();
//page no 644
//prob no. 21.4
delta_f=25  //KHz
```

```
W=15;           //KHz
Bt=2*(delta_f+W)      //bandwidth
mprintf('The bandwidth is Bt=%i KHz',Bt)
```