Scilab Textbook Companion for Electronic Communication Systems by R. Blake[1]

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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 to communication system

Scilab code Exa 1.1 example 1

```
clc;
// page no 7
// prob no 1.1
//part a) freq= 1MHz(AM radio broadcast band)
// We have the equation c=freq*wavelength
c=3*10^8;
f=1*10^6;
wl=c/f;
disp('m',wl,+'WAVELENGTH IN FREE SPACE IS ');
//part B) freq= 27MHz(CB radio band)
f=27*10^6;
wl=c/f;
disp('m',wl,+'WAVELENGTH IN FREE SPACE IS ');
//part C) freq= 4GHz(used for satellite television)
f=4*10^9;
wl=c/f;
disp('m',wl,+'WAVELENGTH IN FREE SPACE IS ');
```

Scilab code Exa 1.4 `example 4`

```
clc;
// page no 18
// prob no. 1.4
// In given problem noise power bandwidth is 10kHz; resistor temp T(0c)=27
// First we have to convert temperature to kelvins:
T0c=27;
Tk=T0c+273;
// noise power contributed by resistor , Pn= k*T*B
k=1.38*10^(-23);
B=10*10^3;
Pn= k*Tk*B;
disp('W',Pn,'noise power contributed by resistor');
```

Scilab code Exa 1.5 `example 5`

```
clc;
// page no 20
// prob no 1.5
// In the given problem B=6MHz, Tk=293, k=1.38*10^-23
B=6*10^6; Tk=293; k=1.38*10^-23;R=300;
Pn=k*Tk*B;
disp('W',Pn,'The noise power is');
// Th noise voltage is given by Vn=sqrt(4*k*Tk*B*R)
Vn=sqrt(4*k*Tk*B*R);
disp('volts',Vn,'Th noise voltage is');
// only one-half of this voltage is appears across the antenna terminals, the other appears across
```

```
the source resistance. Therefore the actual noise
 voltag at the input is 2.7 uV
```

Scilab code Exa 1.6 `example 6`

```
clc;
// page no 21
// prob no 1.6
// given: FM broadcast receiver :- Vn=10uV, R=75V, B
   =200 kHz
Vn=10;//in uV
R=75; B=200*10^3;
//By Ohm's law
In=Vn/R;
disp('uA',In,'Noise current is');
// Noise votlage is also given as In=sqrt(2*q*Io*B)
q=1.6*10^-19;
// solving this for Io=In^2/2*q*B;
Io=(In*10^-6)^2/(2*q*B);
disp('A',Io,'current through the diode is');
```

Scilab code Exa 1.7 `example 7`

```
clc;
//page no 23
//pro no 1.7
//Given:refer fig.1.12 of page no.23;R1=100ohm,300K;
   R2=200ohm,400k;B=100kHz;Rl=300ohm
R1=100;T1=300;R2=200;T2=400;B=100*10^3;Rl=300;k
   =1.38*10^-23;
//open-ckt noise voltage is given by
//Vn1 =sqrt(Vr1^2 + Vr2^2)
//     =sqrt[sqrt(4kTBR1)^2 + sqrt(4kTBR2)^2]
```

```
//by solving this we get Vn1=sqrt[4kB(T1R1 + T2R2)]
Vn1=sqrt(4*k*B*(T1*R1 + T2*R2));
disp('volts',Vn1,'Open-ckt noise voltage is ');
// since in this case the load is equal in value to the sum of the resistors,
// one-half of this voltage is appear across the load.
// Now the load power is P= Vn1^2/Rl
P= (Vn1/2)^2/Rl;
disp('W',P,'The load power is');
```

Scilab code Exa 1.8 `example 8`

```
clc;
// page no 24
// prob no 1.8
// Given: N=0.2W; S+N=5W; :. S=4.8W
N=0.2; S=4.8;
p=(S+N)/N;
pdB=10*log10(p);
disp('dB',pdB,'The power ratio in dB');
```

Scilab code Exa 1.9 `example 9`

```
clc;
//page no 25
//prob no 1.9
//Given: Si=100uW; Ni=1uW; So=1uW; No=0.03W
Si=100; Ni=1; So=1; No= 0.03// all powers are in uW
r1=Si/Ni;// input SNR
r2=So/No;// output SNR
NF=r1/r2;// Amplifier noise figure
disp(NF,'Te noise figure is');
```

Scilab code Exa 1.10 example 10

```
clc;
//page no 25
//prob no 1.10
//giiven: SNRin=42 dB, NF=6dB
// NF in dB is given as SNRin(dB)-SNRop(dB)
SNRin=42 ; NF=6;
SNRop=SNRin-NF;
disp('dB',SNRop,'SNR at the output is ');
```

Scilab code Exa 1.11 example 11

```
clc;
//page no 27
// prob no 1.11
//Given NFdB=2dB,:.NF=antilog(NFdB)/10=1.585
NF=1.585;
Teq=290*(NF-1);
disp('K',Teq,'The noise temperature is ');
```

Scilab code Exa 1.12 example 12

```
clc;
//page no 29
//prob no 1.12
//Given:
A1=10;A2=25;A3=30;NF1=2;NF2=4;NF3=5;
At=A1*A2*A3;
```

```
disp(At,'The power gain is');
// The noise figure is given as
NFt=NF1+((NF2-1)/A1) + ((NF3-1)/(A1*A2));
disp(NFt,'The noise figure is');
// Noise temp can be found as
Teq=290*(NFt-1);
disp('K',Teq,'The noise temperature is');
```

Scilab code Exa 1.13 example 13

```
clc;
// page no 34
// prob no1.13 refer fig 1.20 of page no 34
// part A) The signal frequency is f1=110MHz.
f=110;// in MHz
disp('MHz',f,'A)The freq is');
//The signal peak is two divisions below the reference level of -10dBm, with 10dB/division ,so its -30dBm.
PdBm=-30;
disp('dBm',PdBm,'The power in dBm');
// The equivalent power can be found from P(dBm)=10 logP/1 mW
//P(mW)=antilog dBm/10= antilog -30/10=1*10^-3mW=1uW
//the voltage can be found from the graph but it is more accurately from P=V^2/R
P=10^-6; R=50;
disp('W',P,'The power is');
V=sqrt(P*R);
disp('volts',V,'The voltage is');

// part B)The signal is 1 division to theleft of center, with 100kHz/div. The freq is 100kHz less than the ref freq of 7.5MHz
f=7.5-0.1;// in MHz
```

```
disp('MHz',f,'B)The freq is');
// With regards to the amplitude, the scale is 1dB/div & the signal is 1 div below the reference level. Therefore the signal has a power level given as
PdBm=10-1;// in dBm
// This can be converted to watts & volts as same in part A
//P(mW)=antilog dBm/10= antilog 9/10=7.94mW
P=7.94*10^-3; R=50;
disp('W',P,'The power is');
disp('dBm',PdBm,'The power in dBm');
V=sqrt(P*R);
disp('volts',V,'The voltage is');

//part C) The signal is 3 divisions to the right of the center ref freq of 543MHz, with 1MHz/div. Therefore the freq is
f=543+3*1;// in MHz
disp('MHz',f,'C)The freq is');
// from the spectrum, signal level is
V=22.4*6/8;
disp('mV',V,'The voltage is');
// power is given as
P=V^2/R;
disp('uW',P,'The power is');
PdBm=10*log10(P*10^-6/10^-3);
disp('dBm',PdBm,'The power in dBm');
```

Chapter 2

Radio Frequency Circuits

Scilab code Exa 2.1 example 1

```
clc;
//page no 50
//prob no 2.1
//Refer the fig 2.6 of page 50. L1=25uH;C1=50pF
L1=25*10^-6;C1=50*10^-12;Q=15;
//A) The resonent freqency is given as
fo=(1/(2*%pi*sqrt(L1*C1)));
disp('Hz',fo,'a)The resonent frequency is ');
//B) The bandwidth is given as
B=fo/Q;
disp('Hz',B,'The bandwidth is ');
```

Scilab code Exa 2.2 example 2

```
clc;
//page no 62
// prob no. 2.2
// Given : Hartley oscillators L=10uH; C=100pF
```

```
L=10*10^-6; C=100*10^-12;N1=10;N2=100
// A)The operating frequency is
fo=1/(2*%pi*sqrt(L*C));
disp('Hz',fo,'1)The operating frequency is');
// The feedback fraction is given by
B=-N1/N2;
//Operating gain is given as
A=1/B;
disp(A,'2)Operating gain');
disp('The -ve sign denotes a phase inversion');
//B) The operating frequency is same as in part A)
N1=20;N2=80;
// The feedback fraction is given by
B=(N1+N2)/N1;
//Operating gain is given as
A=1/B;
disp(A,'3)Operating gain');
```

Scilab code Exa 2.3 example 3

```
clc;
// page no 66
//prob no 2.3
C1=10*10^-12; C2=100*10^-12; L=1*10^-6;
// The effective capacitance is
CT=(C1*C2)/(C1+C2);
disp(CT);
// The operating frequency is
f0=1/(2*%pi*sqrt(L*CT));
disp('Hz',f0,'1)The operating frequency is');
// The feedback fraction is given approximately by
B=-C1/C2;
disp(B,'The feedback fraction is');
// For the common-base ckt, the op-freq is same but
   the feedback fraction willbe different.
```

```
C1=100*10^-12; C2=10*10^-12;
// It is given by
B=C2/(C1+C2);
disp(B,'The feedback fraction is');
```

Scilab code Exa 2.4 example 4

```
clc;
// page no 68
//prob no 2.4
//Refer fig 2.22
c1=1000;c2=100;c3=10;//all values are in pf
//The effective total capacitance
Ct=1/((1/c1)+(1/c2)+(1/c3));
disp('pF',Ct,'The effective total capacitance is');
CT=Ct*10^-12;L=10^-6;
//The operating freq is
f0=1/(2*%pi*sqrt(L*CT));
disp('Hz',f0,'The operating freq is');
```

Scilab code Exa 2.5 example 5

```
clc;
// page no 70
//prob no 2.5
C=80*10^-12; L= 100*10^-6;
//Part a) The resonent frequency is
f0=1/(2*%pi*sqrt(L*C));
disp('Hz',f0,'The resonent freq is');
// Part b) In this part the circuit is resonate on
    doubling the frequency,therefore
f1=2*f0;
// from the equation of resonent frequency
```

```
C1=1/(4*(%pi*f1)^2*L);
// Now for tuning voltage  we have to use equation
   C1=Co/sqrt(1+2V)
Co=C;
// after solving the expression
v=((Co/C1)^2 -1)/2;
disp('V',v,'The tuning voltage is ');
```

Scilab code Exa 2.7 example 6

```
clc;
//page no 76
//problem 2.7
// all frequencies are in MHz
f1=11;f2=10;
// output frequencies at the output of square-law
   mixer
a=f1+f2;
b=f1-f2;
disp('MHz',b,'MHz',a,'The output frequencies at the
   output of square-law mixer are :');
```

Scilab code Exa 2.8 example 7

```
clc;
//page no 85
//problem no. 2.8
// all the frequencies are in MHz
freq_free_run =12;
freq_lock1 =10;
freq_lock2 =16;
```

```
// capture range is approximately twice the difference between the free-running freq and the freq at which lock is first achieved
capture_range =2*(freq_free_run - freq_lock1 );
disp('MHz',capture_range,'The capture range is ');
// lock range is approximately twice the the difference between the freq where lock is lost and free-running freq
lock_range = 2*(freq_lock2 - freq_free_run);
disp('MHz',lock_range,'The lock range is ');
// The PLL freq response id approximate symmetrical. This means the free-running freq is in the center of the lock range and capture range. Therefore
freq_lock_acquired = freq_free_run + (capture_range/2);
freq_lock_lost = freq_free_run - capture_range
disp('MHz',freq_lock_acquired,'The freq at which the lock is acquired, moving downward in freq is ');
disp('MHz',freq_lock_lost,'Lock will be lost on the way down at');
```

Scilab code Exa 2.9 example 8

```
clc;
//page no 86
// prob no 2.9
// refer fig 2.38
//Here we are using a 10MHz crystal, it will be necessar to devide it by a factor to get 10kHz
f_osc = 10*10^6; f_ref=10*10^3;f0_1=540*10^3;f0_2=1700*10^3;
Q=f_osc/f_ref;
// we have to specify the range of values of N. Find N at each and of the tuning range
N1=f0_1/f_ref;
```

```
N2=f0_2/f_ref;
disp(N2,'The values of N at high end is',N1,'The values of N at low end is');
```

Scilab code Exa 2.10 example 9

```
clc;
//page no 89
// prob no 2.10
// refer fig 2.40
P=10;f_ref=10*10^3;M=10;
//consider
N=1;
// With a fixed-modulus prescalar, the min freq step is
step_size=M*f_ref;
// With the two-modulus system, let the main divider modulus N remain constant & increase the modulus m to (m+1) to find how much the freq changes.
// for 1st case, o/p freq
fo=(M+N*P)*f_ref;
// for 2nd case where leave N alone but changes M to M+1, new o/p freq
fo_=(M+1+N*P)*f_ref;
// The difference is
f= fo_-fo;
disp('Hz',f,'The step size that would have been obtained without prescaling');
```

Scilab code Exa 2.11 example 10

```
clc;
//page no 91
```

```
//prob no 2.11
//refer fig 2.42
f_ref= 20*10^3;
f_osc= 10*10^6;
N1=10;N2=100;
f0=(N1*f_ref) + f_osc;
f1=(N2*f_ref) + f_osc;
disp('Hz',f1,'Hz',f0,'The output frequencies are');
step_size=(f1-f0)/(N2-N1);
disp('Hz',step_size,'The step size is');
```

Chapter 3

The Amplitude Modulation

Scilab code Exa 3.1 example 1

```
clc;
// page no 105
// prob no 3.1
Erms_car=2; f_car=1.5*10^6;f_mod=500;Erms_mod=1;//
    given
// Equation requires peak voltages & radian
    frequencies
Ec=sqrt(2)*Erms_car; Em=sqrt(2)*Erms_mod;
wc=2*%pi*f_car; wm=2*%pi*f_mod;t=1;
// Therefore the equation is
disp('v(t) = (2.83+1.41*sin(3.14*10^3*t))*sin
    (9.42*10^6*t) V');
```

Scilab code Exa 3.2 example 2

```
clc;
//page no 106
//prob no 3.2
```

```
// To avoid the round-off errors we should use the
    original voltage values
Em=1;Ec=2;
m=Em/Ec;
disp(m,'m=');
disp('v(t) = 2.83(1+0.5*sin(3.14*10^3*t))*sin
    (9.42*10^6*t) V','The equation can be obtained as
    ');
```

Scilab code Exa 3.3 example 3

```
clc;
//page no 109
//prob no 3.3
E_car=10;E_m1=1;E_m2=2;E_m3=3;
m1=E_m1/E_car;
m2=E_m2/E_car;
m3=E_m3/E_car;
mT=sqrt(m1^2+m2^2+m3^2);
disp(mT,'The modulation index is');
```

Scilab code Exa 3.4 example 4

```
clc;
//page no 110
//prob no 3.4
//refer fig 3.2
E_max=150; E_min=70;// voltages are in mV
m=(E_max-E_min)/(E_max+E_min);
disp(m,'The modulation index is');
```

Scilab code Exa 3.6 example 5

```
clc;
//page no 114
//prob no 3.6
B=10*10^3;
// maximum modulation freq is given as
fm=B/2;
disp('Hz',fm,'The maximum modulation freq is');
```

Scilab code Exa 3.7 example 6

```
clc;
//page no 116
//prob no 3.7
// AM broadcast transmitter
Pc=50;m=0.8;//power is in kW
Pt=Pc*(1+m^2 /2);
disp('kW',Pt,'The total power is');
```

Scilab code Exa 3.8 example 7

```
clc;
// page no 328
// prob no 8.6
//2 kHz tone is present on channel 5 of group 3 of
   supergroup
//signal is lower sided so
fc_channel_5=92*10^3;
fg=fc_channel_5 - (2*10^3);// 2MHz baseband signal
// we know group 3 in the supergroup is moved to the
    range 408-456 kHz with a suppressed carrier
   frequency of 516kHz
```

```
f_s_carr=516*10^3;
fsg=f_s_carr - fg;
disp(fsg);
```

Scilab code Exa 3.9 `example 8`

```
clc;
//page no 122
//prob no. 3.9
// refer fig 3.14
// from spectrum we can see that each of the two sidebands is 20dB below the ref level of 10dBm. Therefore each sideband has a power of −10dBm i.e. 100uW.
power_of_each_sideband = 100;
Total_power = 2* power_of_each_sideband;
disp('uW',Total_power,'The total power is');
div=4; freq_per_div=1;
sideband_separation = div * freq_per_div;
f_mod= sideband_separation/2;
disp('kHz',f_mod,'The modulating freq is ');
// Even if this siganl has no carrier , it still has a carrier freq which is midway between the two sidebands. Therefore
carrier_freq = 10;
disp('MHz',carrier_freq,'The carrier freq');
```

Scilab code Exa 3.10 `example 9`

```
clc;
// page no 126
// prob no 3.10
f_car=8*10^6;f_mod1=2*10^3;f_mod2=3.5*10^3;
```

```
//Signal is LSB hence o/p freq is obtained by subtracting f_mod from f_car
f_out1=f_car-f_mod1;
disp('MHz',f_out1/(10^6),'The o/p freq f_out1 is ');
f_out2=f_car-f_mod2;
disp('MHz',f_out2/(10^6),'The o/p freq f_out1 is ');
```

Scilab code Exa 3.11 `example 10`

```
clc;
// page no 127
// prob no 3.11
//Refering the fig. 3.17
//From fig it is clear that thee waveform is made from two sine waves
Vp=12.5;//Since Vp-p is 25V from fig hence individual Vp is half of Vp-p
Rl=50;//Load resistance is 50 ohm
//Determination of average power
Vrms=Vp/sqrt(2);
P=((Vrms)^2)/Rl;
disp('W',P,'The value of average power of signal is ');
```

Chapter 4

Angle Modulation

Scilab code Exa 4.1 example 1

```
clc;
//page no 139
//prob no. 4.1
//An FM modulator is given with kf=30kHz/V operate at carrier freq 175MHz
fc=175*10^6;kf=30*10^3;
//a)Determination of o/p freq for modulating signal value em1=150mV
em1=150*10^-3;
fsig1=fc+(kf*em1);
disp('MHz',fsig1/(10^6),'a)The value of o/p freq is ');
//b)Determination of o/p freq for modulating signal value em2=-2V
em2=-2;
fsig2=fc+(kf*em2);
disp('MHz',fsig2/(10^6),'b)The value of o/p freq is ');
```

Scilab code Exa 4.2 example 2

```
clc;
//page no 140
//prob no. 4.2
//An FM modulator is given which is modulated by sine wave 3V
v=3;
kf=30*10^3;
//Determination of peak value
Em=v*sqrt(2);
//Determination of deviation delta
delta=kf*Em;
disp('kHz',delta/1000,'The value of deviation is ');
```

Scilab code Exa 4.3 example 3

```
clc;
//page no 140
//prob no. 4.3
//An FM broadcaster transmitter operate at max deviatn of 75kHz
delta=75*10^3;
//a)Determination of modulation index with modulating freq of signal =15kHz
fm1=15*10^3;
mf1=delta/fm1;
disp(mf1,'a)The value of modulation index for fm=15 kHz is ');
//b)Determination of modulation index with modulating freq of signal =50Hz
fm2=50;
mf2=delta/fm2;
disp(mf2,'b)The value of modulation index for fm=50 Hz is ');
```

Scilab code Exa 4.4 example 4

```
clc;
//page no 141
//prob no. 4.4
//A phase modulator is given with kp=2rad/V
kp=2;
//Peak phase deviation of 60 degree
//Converting degree in radian
phi=(2*%pi*60)/360;
//Determination of peak voltage that cause that
   deviation
Vp=phi/kp;
//Determination of rms voltage
Vrms=Vp/(sqrt(2));
disp('V',Vrms,'The rms voltage that cause deviation
   is ');
```

Scilab code Exa 4.6 example 5

```
clc;
//page no 145
//prob no. 4.6
//Phase modulator with sensitivity kp=3rad/V & sine
   wave i/p 2 V peak at 1kHz
kp=3;Vp=2;f=1*10^3;
//As max value of sine functn is 1, hence max value
   of phi is kp*Vp
phi_max=kp*Vp;
//phi_max is nothing but mp
mp=phi_max;
```

```
//value of mf is same as mp if signal is considered as freq modulation
//Determination of freq deviation
dev=mp*f;
disp('kHz',dev/1000,'The freq deviation produce is');
```

Scilab code Exa 4.7 example 6

```
clc;
//page no 149
//prob no. 4.7
//An FM signal has deviation 3kHz & modulating freq 1kHz with total power Pt=5W developed across 50 ohm with fc=160 MHz
dev=3*10^3;fm=10^3;Pt=5;Rl=50;fc=160*10^6;
//a)Determination of RMS signal voltage
Vt=sqrt(Pt*Rl);
disp('V',Vt,'a)The rms signal voltage is');
/////////////b)Determination of rms voltage at carrier freq
//for that modulation index needs to be found out
mf=dev/fm;
//From bessel function table, the coeff for the carrier first 3 side bands
J=[0.26,0.34,0.49,0.31];
disp('b)The rms voltage of side bands are')
for i=1:4,
    V(i)=J(i)*Vt;
end;
disp('V',V(4),'V3=','V',V(3),'V2=','V',V(2),'V1=','V',V(1),'Vc=');
///////////c)Determination of freq of each side bands////////////////
disp('c)The 3 side bands at different freq. are ')
```

```
for j=1:3,
    f_usb(j)=fc/10^6+(fm*j/10^6);
end
disp('MHz',f_usb(3),'f_usb3=','MHz',f_usb(2),'f_usb2=','MHz',f_usb(1),'f_usb1=');

for j=1:3,
    f_lsb(j)=fc/10^6-(fm*j/10^6);
end
disp('MHz',f_lsb(3),'f_lsb3=','MHz',f_lsb(2),'f_lsb2=','MHz',f_lsb(1),'f_lsb1=');
////////////d)Determination of power of each side band/////////////////
for i=1:4,
    P(i)=((V(i))^2)/Rl;
    a(i)=(P(i))/(10^-3);
end;
disp('d)The power of each side band is');
disp('W',P(4),'P3=','W',P(3),'P2=','W',P(2),'P1=','W',P(1),'Pc=',);
//////////e)Determination of power that is uncounted
P=P(1)+2*(P(2)+P(3)+P(4));
//As total power is 5 W
P_x=Pt-P;
//Percentage of total power uncounted
Px=(P_x/P)*100;
disp('%',Px,'e)Percentage total power which is uncounted is');
//////////f)Ploting the signal in freq domain/////////////////////
//Converting power in dBm
for i=1:4,
    //a(k)=(P(k))/(10^-3);
   P_dBm(i)=10*log10(a(i));
end;
disp('f)Power of each side bands in dBm is')
disp('dBm',P_dBm(4),'P3(dBm)=','dBm',P_dBm(3),'P2(dBm)=','dBm',P_dBm(2),'P1(dBm)=','dBm',P_dBm(1),'
```

```
    Pc(dBm)',);
x=[159.997:0.001:160.003];
y=[26.8,30.8,27.6,25.3,27.6,30.8,26.8];
plot(x,y);
```

Scilab code Exa 4.9 example 7

```
clc;
//page no 157
//prob no. 4.9
//An FM signal has freq deviation of 5kHz modulating
    freq fm=1kHz with SNR at i/p is 20 dB
//Converting dB in voltage ratio
fm=1*10^3;dev_s=5*10^3;snr=20;
Es_En=10^(snr/20);
//Since Es>>En then
phi=1/(Es_En);
m_fn=phi;//modulation index equal to phi_n
dev_n=(m_fn)*fm;//Equivalent freq deviation due to
    noise
//SNR as a voltage ratio is given as
SNR=(dev_s)/(dev_n);
//Converting this voltage ration in dB
SNR_dB=20*(log10(SNR));
disp('dB',SNR_dB,'The SNR at detecttor o/p is');
```

Scilab code Exa 4.10 example 10

```
clc;
//page no 163
//prob no. 4.10
//Refer the fig. 4.19
```

```
// We know this transmitter is designed for voice frequencies,so we have to use trial and error method to produce a carrier null for a deviation of 5kHz
mf=2.4;// starting with the first null for mf=2.4
dev=5;//in kHz
fm=dev/mf;
if (0.3<=fm & 3>=fm) then
    disp('kHz',fm,'The freq is widin the acceptable range');
else
    mf=5.5;
    fm=dev/mf;
    disp('kHz',fm,'The freq is widin the acceptable range');
end
// for this calculated fm, set the function generator to the value of fm so that the deviation is 5kHz
```

Chapter 5

Transmitters

Scilab code Exa 5.2 example 1

```
clc;
//page no 179
//prob no. 5.2
//A transmitter  with carrier power o/p 10W at
   efficiency 70% at 100% modulatn
Po=10;eta=0.7;
//Determination of dc power o/p
Ps=Po/eta;
disp('W',Ps,'The value of dc power input is');
//Determination of audio power
Pa=0.5*Ps;
disp('W',Pa,'The value of audio power is');
```

Scilab code Exa 5.3 example 2

```
clc;
//page no 181
//prob no. 5.3
```

```
//A transmitter operates at 12V, with collector current 2A.Modulatn transformer has turn ratio 4:1
//Determination of impedance at transformer secondary
Vcc=12;Ic=2;N1=4;N2=1;
Za=Vcc/Ic;
disp('ohm',Za,'The impedance of transformer secondary is');
//Determination of impedance of transformer primary
Zp=Za*(N1/N2)^2;
disp('ohm',Zp,'The impedance of transformer primary is');
```

Scilab code Exa 5.4 `example 3`

```
clc;
//page no 182
//prob no. 5.4
//Class C amplifier with carrier o/p power of 100W with efficiency of 70% & with 100% modulation
Pc=100;eta=0.7;
//Determination of o/p power
Po=1.5*Pc;
disp('W',Po,'The o/p power with 100% modulation is');
//Determination of supply power
Ps=Po/eta;
disp('W',Ps,'The value of supply power is');
//Determination of power dissipated Pd
Pd=Ps-Po;
disp('W',Pd,'Power dissipated is');
```

Scilab code Exa 5.5 example 4

```
clc;
//page no 184
//prob no. 5.5
//An FM transmitter produce 10W of carrier power
   operating at 15V
Vcc=15;Pc=10;
//Determination of load impedance  seen from
   collector
Rl=((Vcc)^2)/(2*Pc);
disp('ohm',Rl,'The load impedance is');
```

Scilab code Exa 5.6 example 5

```
clc;
//page no 193
//prob no. 5.6
//Refer fig. 5.13
//Filter method SSB generator
fc=5*10^6;//filter centre freq.
BW=3*10^3;//Filter bandwidth
foc=4.9985*10^6;//carrier oscillator freq.
disp('a)The USB will be passed');//Since carrier
   freq is at low end of passband
disp('b)The carrier freq should be moved to the high
    end of filter at 5.0015MHz');//To generate the
   LSB
```

Scilab code Exa 5.7 example 6

```
clc;
//page no 196
```

```
//prob no. 5.7
//SSB transmitter refering fig.5.17 to transmit USB
    signal at carrier freq 21.5MHz
fo=21.5;//carrier freq in MHz
foc=8.9985;//carrier oscillator freq. in MHz
//Determination of freq of local oscillator
flo=fo-foc;
disp('MHz',flo,'The freq of local oscillator');
```

Scilab code Exa 5.8 example 7

```
clc;
//page no 199
//prob no. 5.8
//LSB transmitter refering fig.5.14 with new carrier
     freq 9.0015 MHz & local oscillator freq 12.5015
    MHz
fco=9.0015;//carrier oscillator freq
flo=12.5015;//local oscillator freq
//Determination of new o/p freq
fo=fco+flo;
disp('MHz',fo,'The o/p carrier freq');
```

Scilab code Exa 5.9 example 8

```
clc;
//page no 204
//prob no. 5.9
//A direct FM transmitter with kf=2kHz/V & max
    deviatn of 300Hz.
kf=2*10^3;tx_dev=300;
disp('a)See fig.5.23 for this block diagram');
```

```
f_mul=3*2*3;//3 stage freq multiplier with tripler doubler and tripler
//b)Determination of max dev at oscillator
dev_o=5*10^3;//Deviation at o/p
dev_osc=dev_o/f_mul;
if  dev_osc < tx_dev then
    disp('b)Transmitter is capable of 5kHz deviation');
else
    disp('b)Transmitter is not capable of 5kHz deviation')
end;
//c)Determination of oscillator freq
fo=150;//carrier freq in MHz
fosc=fo/f_mul;
disp('MHz',fosc,'c)The oscillator freq is');
//d)Determination of audio voltage for full deviation
Vi_peak=dev_osc/kf;//dev at oscillator of 278Hz causes full 5kHz deviation
//converting peak voltage to rms voltage
Vi_RMS=Vi_peak/sqrt(2);
disp('mV',Vi_RMS*10^3,'The audio RMS voltage is')
```

Scilab code Exa 5.10 example 9

```
clc;
//page no 206
//prob no. 5.10
//Refer fig.5.24
//Till the antenna there are 2 doubler and 4 tripler
f_mul=18*18;
dev_o=75*10^3;//o/p freq deviation is 75kHz
//Determiantion of reqd freq deviation of oscillator
dev_osc=dev_o/f_mul;
```

```
disp('Hz',dev_osc,'Freq deviation of oscillator is')
    ;
```

Scilab code Exa 5.11 example 10

```
clc;
//page no 207
//prob no. 5.11
//A PLL FM generator refering fig.5.25 with
f_ref=100*10^3;N=200;kf=50*10^3;//in Hz/V
//a)Determination of carrier freq of o/p signal
fc=N*f_ref;
disp('MHz',fc/10^6,'The carrier freq of o/p signal')
    ;
//b)Determination of RMS modulating voltage for 10
    kHz deviation
dev=10*10^3;
Vp=dev/kf;
//Converting peak voltage to RMS voltage
V_RMS=Vp/sqrt(2);
disp('mV',V_RMS*1000,'The RMS voltage for needed
    deviation is ');
```

Chapter 6

Receivers

Scilab code Exa 6.1 example 1

```
clc;
//page no 227
//prob no. 6.1
//A tuned ckt with broadast band (540 to 1700 kHz).
   Bw=10kHz at 540 kHz
BW1=10*10^3;f1=540*10^3;f2=1700*10^3;//all in Hz
//Determination of BW at 1700kHz
BW2=BW1*sqrt(f2/f1);
disp('kHz',BW2/1000,'The Bandwidth at 1700kHz');
```

Scilab code Exa 6.4 example 2

```
clc;
//page no 236
//prob no. 6.4
//A receiver with sensitivity 0.5uV & blocking
   dynamic range 70dB.
//Determination of vpltage signal V1
```

```
P1_P2=70;V2=0.5*10^-6;//let
V1=V2*10^(P1_P2/20);
 disp('mV',V1*1000,'The voltage value of signal is')
    ;
```

Scilab code Exa 6.5 example 3

```
clc;
//page no 238
//prob no. 6.5
//Refer the fig 6.5
//A receiver tuned to station at 590kHz
f_if=455*10^3;//Intermediate freq
f_sig=590*10^3;
//a)Determintion of image freq
f_image=f_sig+2*f_if;
disp('kHz',f_image/1000,'a)The image freq is');
Q=40;//Q_factor
//b)Determination of image rejection
x=(f_image/f_sig)-(f_sig/f_image);
Asig_Aimage=sqrt(1+(Q*x)^2);//image rejection
//converting in dB
IR_dB=20*log10(Asig_Aimage);
disp('dB',IR_dB,'b)The image rejection is');
```

Scilab code Exa 6.6 example 4

```
clc;
//page no 239
//prob no. 6.6
//An AM high-freq receiver with IF=1.8MHz tuned at
   freq 10MHz
f_sig=10;f_if=1.8;//All freq in MHz
```

```
//Determination of local oscillator freq f_lo
f_lo=f_sig+f_if;
//determination of freq. that cause IF response
m=[1 1 2 2];//values of m that are integer
n=[1 2 1 2];//values of n that are integer
for i=1:4
    fs1(i)=((m(i)/n(i))*(f_lo))+((f_if)/n(i));
end;
for i=1:4
    fs2(i)=((m(i)/n(i))*(f_lo))-((f_if)/n(i));
end;
disp('All freqs are in MHz',fs2,fs1,'The different
    freqs are');
```

Scilab code Exa 6.7 `example 5`

```
clc;
//page no 245
//prob no. 6.7
//An FM detector produce Vpp=1.2V with dev=10kHz
Vpp=1.2;dev=10*10^3;
//Determination of detector sensitivity
Vp=Vpp/2;//Peak voltage
kd=Vp/dev;
disp('uV/Hz',kd*10^6,'the sensitivity of detector is
    ');
```

Scilab code Exa 6.8 `example 6`

```
clc;
//page no 249
//prob no. 6.8
//A PLL FM detector with kf=100kHz/V & dev=75kHz
```

```
kf=100*10^3;dev=75*10^3;
//Determination of RMS voltage
Vp_op=dev/kf;
//Converting peak voltage in RMS voltage
V_RMS=Vp_op/sqrt(2);
disp('V',V_RMS,'The RMS voltage is');
```

Scilab code Exa 6.9 `example 7`

```
clc;
//page no 258
//prob no. 6.9
//An IF transformer at 455kHz & primary ckt has Qp
   =40 & secondary Q=30
fo=455*10^3;Qp=40;Qs=30;
//a)Determination of critical coupling factor
kc=1/sqrt(Qp*Qs);
disp(kc,'a)The critical coupling factor is');
//b)Determination of optimum coupling factor
Kopt=1.5*kc;
disp(Kopt,'b)The optimum coupling factor is');
//c)Determination of optimum coupling factor
B=Kopt*fo;
disp('kHz',B/1000,'c)The BW using optimum coupling
   factor is');
```

Scilab code Exa 6.10 `example 8`

```
clc;
//page no 261
//prob no. 6.10
//Receiver refering in fig.6.28
f_sig=25*10^6;//signal i/p freq
```

```
f_lo1=29.5*10^6;//Ist local oscillator freq
//determination of Ist IF which uses high side injection
f_IF1=f_lo1-f_sig;//high side injection
disp('MHz',f_IF1/10^6,'The first IF is');
//Determination of IInd IF which uses low side injection
f_lo2=4*10^6;//IInd local oscillator freq
f_IF2=f_IF1-f_lo2;
disp('kHz',f_IF2/10^3,'The second IF is');
```

Scilab code Exa 6.11 `example 9`

```
clc;
//page no 265
//prob no. 6.11
//An S-meter is given
V1=50*10^-6;//signal strength at transmitter in V
P=18;//18 dB power
V2=V1/(10^(P/20));
disp('uV',V2*10^6,'Signal strength at receiver i/p is');
```

Chapter 7

Digital communication

Scilab code Exa 7.1 example 1

```
clc;
//page no 285
//prob no 7.1
// In the given problem a signal is transmitted
   using a four level code
M=4;
B=3.2;// in KKz
SNR=35;//in dB
//By using Shannon-Hartley theorem, ignoring noise
   we have
c=2*B*log2 (M);
disp('kb/s',c,'maximum data rate for four-level code
    in the available bandwidth');
//Now we have to use Shannon limit to find the
   maximum data rate for any code
//SNR in power ratio is
SNR1=10^(35/10);
C=B*log2(1+SNR1);
disp('kb/s',C,'maximum data rate for four-level code
    in the available bandwidth');
// Both results are maxima, we have to choose lesser
```

```
of the two.
// Therefore we choose c=12.8kp/s
```

Scilab code Exa 7.2 example 2

```
clc;
//page no. 289
// prob no. 7.2
// In the given problem
fm=30;// in KHz
fs=44.1;//sampling rate in KHz
fa=fs-fm;// audible frequency
disp('KHz',fa,'The audible frequency is');
```

Scilab code Exa 7.3 example 3

```
clc;
//page no 291
//prob no 7.3
//part a: no of samples,
m=8;
N=2^m;// the number of levels
disp('levels',N,'a) The number of levels with m=8
   are');
// part b:
m=16;
N=2^m;// the number of levels
disp('levels',N,'b) The number of levels with m=16
   are');
```

Scilab code Exa 7.4 `example 4`

```
clc;
// page no 292
// prob no 7.4
//In the given problem
m=16;
DR=1.76 +6.02*m ; //Dynamic range for a linear PCM in dB
disp('dB',DR,'Dynamic range for a linear PCM');
```

Scilab code Exa 7.5 `example 5`

```
clc;
//page no 295
// prob no 7.5
// in the given problem
fs=40; m=14;
// the minimum data rate needed to transmit audio is given by
D=fs*m;
disp('Kb/s',D,'The minimum data rate needed to transmit audio is ');
```

Scilab code Exa 7.6 `example 6`

```
clc;
// page no 294
// prob no 7.6
// In the given problem, input to a mu-law compresser is +ve,
// with its voltage one-half the max value
u=255;
```

```
Vi=1;//maximum input value is considered as unity volts
vi=0.5;
V0=1;//consider maximum output voltage as unity volts
vo=V0* log(1+u*vi/Vi)/log(1+u);
disp('volts',vo,'The maximum output voltage produced is');
```

Chapter 8

The Telephone System

Scilab code Exa 8.3 `example 1`

```
clc;
// page no 323
// prob no 8.3
//A telephone signal takes 3 ms to rreaach its
   destination
t=2;
//Determination of net loss VNL reqd for acceptable
   amount of echo.
VNL=(0.2*t)+0.4;
disp('dB',VNL,'The net loss is');
```

Scilab code Exa 8.5 `example 2`

```
clc;
// page no 326
// prob no 8.5
//Refering the fig.8.15 channel 12 has lowest
   carrierr freq 64 kHz
```

```
F=64;
c_total=12;
//Carrier freq goes up 4kHz per channel
f_up=4;
//Determination of carrier freq for channel 5
c=5;
fc=F+(f_up*(c_total-c));
disp('kHz',fc,'The value of carrier freq for channel
    5 is');
```

Scilab code Exa 8.6 `example 3`

```
clc;
//page no 328
//prob no 8.6
// 2kHz tone is present on channel 5 of group 3 of a
    supergroup
// refer to example 8.5, calculated fc=92kHz
fc=92;//in kHz
// Here signal is lower sideband,the 2kHz baseband
   signal therefore will be
fg=fc-2;
//from fig 10.15,group 3 in the supergroup is moved
   to the range 408-456 kHz, with a suppressed
   carrier frequency of 516kHz.
fsc=516;// in kHz
//the modulation is lower sideband,so the supergroup
    o/p freq will be 90kHz lower than carrier freq
fsg=fsc-fg;
disp('kHz',fsg,'The tone appear in the supergroup
   output at frequency of');
```

Chapter 9

Data Transmission

Scilab code Exa 9.2 example 1

```
clc;
// page no 349
// prob no 9.2
Nd=7; N_start=1; N_stop=1; N_parity=1;
Nt= Nd + N_start+ N_stop + N_parity;
efficiency=Nd/Nt *100;
disp('%',efficiency,'The efficiency is');
```

Scilab code Exa 9.6 example 2

```
clc;
// page no 358
// prob no 9.6
m=21;
// The correct number of check bits is the smallest number that satisfy the equation 2^n >= m+n+1;
for n=1:1:10 // we choose range of 1 to 10
    a=m+n+1;
```

```
    b=2^n;
    if(b>=a)
        disp(n,'hammming bits are required')
        break;
    end
end
```

Chapter 12

Digital Modulation and Modems

Scilab code Exa 12.1 example 1

```
clc;
// page no 407
// prob no 12_1
//A radio channel with BW=10KHz and SNR=15 dB
B=10*10^3;
snr=15;
//converting dB in power ratio
SNR=10^(snr/10);
//a)Determination of theoretical max data rate
C1=B*log2(1+SNR);
disp('kb/s',C1/1000,'a)The theoretical max data rate
    is');
//b)Determination of data rate with 4 states i.e M=4
M=4;
C2=2*B*log2(M);
disp('kb/s',C2/1000,'b)The data rate for 4 states is
    ');
```

Scilab code Exa 12.2 `example 2`

```
clc;
// page no 408
// prob no 12_2
//A modulator transmit symbol with symbol rate=10k/sec with 64 states
M=64;
S=10000;
//Baud rate is simply symbol rate
disp('kbaud',S/1000,'The baud rate is ');
//Determination of bit rate
C=S*log2(64);
disp('kb/s',C/1000,'The bit rate is ');
```

Scilab code Exa 12.3 `example 3`

```
clc;
// page no 411
// prob no 12_3
f=200*10^3;
fb=270.833 *10^3;
data_rate=270.833 *10^3
fc=880*10^6;
bandwidth=200*10^3;
freq_shift=0.5*fb;
disp('Hz',freq_shift,'a)The frequency shift is');
// The shift each way from the carrier frequency is half the freq_shift
f_max=fc+0.25*fb;
disp('Hz',f_max,'b)The maximum frequency is');
f_min=fc-0.25*fb;
```

```
disp('Hz',f_min,'The minimum frequency is');
bandwidth_efficiency=data_rate/bandwidth;
disp('b/s/Hz',bandwidth_efficiency,'The bandwidth
   efficiency in b/s/Hz is');
```

Scilab code Exa 12.4 `example 4`

```
clc;
// page no 412
// prob no 12_4
baud_rate=24.3;// in kilobaud
// In this problem dibit system is used.
//Therefore symbol_rate=baud_rate=0.5*bit_rate
bit_rate=2*baud_rate;
disp('kb/s',bit_rate,'The channel data rate is');
```

Scilab code Exa 12.5 `example 5`

```
clc;
// page no 413
// prob no 12_5
no_of_phase_angles=16;
no_of_amplitudes=4;
no_of_states_per_symbol=no_of_phase_angles*
   no_of_amplitudes;
bit_per_symbol=log2(no_of_states_per_symbol);
disp(bit_per_symbol,'The no. of bits per symbol is')
   ;
```

Scilab code Exa 12.6 `example 6`

```
clc;
// page no 415
// prob no 12_6
B=3*10^3;SNR_dB=30;
SNR_power=10^(30/10);
C=B*log2(1+SNR_power);
disp('b/s',C,'Shannon limit');
```

Chapter 13

Multiplexing and Multiple Access Techniques

Scilab code Exa 13.1 example 1

```
clc;
// page no 437
// prob no 13_1
freq_band=1*10^6;
// A)For SSBSC AM, the bandwidth is the same as the maximunm modulating freq.
fmax=4*10^3;
B=fmax;
no_of_signal=freq_band/B;
disp(no_of_signal,'a)The number of signals are');
// B)For DSB AM, the bandwidth is twice the maximunm modulating freq.
B=2*fmax;
no_of_signal=freq_band/B;
disp(no_of_signal,'b)The number of signals are');
// C)Using Carson's Rule to approximate the bandwidth
f_max=15*10^3; deviation=75*10^3;
B=2*(deviation + f_max);
```

```
no_of_signal=freq_band/B;
disp(no_of_signal,'c)The number of signals are');
// D)Use Shannon-Hartley theorem to find the
   bandwidth
C=56*10^3;M=4;//for QPSK
B=C/(2*log2(M));
no_of_signal=freq_band/B;
disp(no_of_signal,'d)The number of signals are');
```

Scilab code Exa 13.2 example 2

```
clc;
// page no 444
// prob no 13_2
//Voice transmisssion occupies 30 kHz.Spread
   spectrum is used to increase BW to 10MHz
B1=30*10^3;//BW is 30 kHz
B2=10*10^6;//BW is 10 MHz
T=300;//noise temp at i/p
PN=-110;//signal has total signal power of -110 dBm
   at receiver
k=1.38*10^-23;//Boltzmann's const in J/K
//Determination of noise power at B1=30kHz
PN1=10*(log10(k*B1*T/10^-3));
disp('dBm',PN1,'The noise power at BW=30 kHz is');
//Determination of noise power at B2=10MHz
PN2=10*(log10(k*B2*T/10^-3));
disp('dBm',PN2,'The noise power at BW=10 MHz is');
//Determination of SNR for 30kHz BW
SNR1=PN-PN1;
disp('dB',SNR1,'The value of SNR for BW=30 kHz is');
//Determination of SNR for 10MHz BW
SNR2=PN-PN2;
disp('dB',SNR2,'The value of SNR for BW=10 MHz is');
```

Scilab code Exa 13.3 example 3

```
clc;
// page no 445
// prob no 13_3
no_of_freq_hops =100; total_time_req=10;
time_for_each_freq = total_time_req  /
   no_of_freq_hops;
disp('sec/hop',time_for_each_freq,'Time required for
    each freq');
```

Scilab code Exa 13.4 example 4

```
clc;
// page no 446
// prob no 13_4
bit_rate=16*10^3;//in bps
chip_rate =10:1;
no_of_chip=10;
total_bit_rate=no_of_chip*bit_rate;
m=4;n=log2(m);
symbol_rate = total_bit_rate/n;
disp('baud',symbol_rate,'The no of signal changes i.
   e. symbol rate is ');
```

Scilab code Exa 13.5 example 5

```
clc;
// page no 447
```

```
// prob no 13_5
//signal with bandwidth Bbb=200 kHz & SNR=20 dB spred at chip rate 50:1
Bbb=200*10^3;//Bandwidth
Gp=50;//chip rate
SNR_in=20;//SNR is 20 dB without spreading
//Determination of BW after spreading
Brf=Gp*Bbb;
disp('MHz',Brf,'The value of BW after spreading');
//Converting into dB
Gp_dB=10*log10(Gp);
disp('dB',Gp_dB,'The value of processing gain');
//Determination of SNR after spreadng
SNR_out=SNR_in-Gp_dB;
disp('dB',SNR_out,'The value of SNR after spreading in dB');
```

Chapter 14

Transmission Lines

Scilab code Exa 14.1 example 1

```
clc;
//page no 461
//prob no. 14.1
//A coaxial cable with capacitance=90pF/m &
   characteristic impedance=50 ohm
C=90*10^-12;Zo=50;
//Determination of inductance of 1m length
L=(Zo^2)*C;
disp('nH/m',L*10^9,'The inductance of 1m length is')
   ;
```

Scilab code Exa 14.2 example 2

```
clc;
//page no 462
//prob no. 14.2
//a)Determination of impedance of open wire with
   diameter 3mm & r=10mm
```

```
D=3/2;r=10;//All values are in mm
Zo1=276*log10(r/D);
disp('ohm',Zo1,'a)The characteristic impedance of
    conductor is');
//b)Determination of impedance of coaxial with er
    =2.3,inner diameter=2mm & outer diameter=8mm
er=2.3;D=8;d=2;//All diameter values in mm
Zo2=(138/sqrt(er))*log10(D/d);
disp('ohm',Zo2,'b)The characteristic impedance of
    coaxial cable is');
```

Scilab code Exa 14.3 `example 3`

```
clc;
//page no 463
//prob no. 14.3
//Cable with teflon dielectric er=2.1
er=2.1;c=3*10^8;//Velocity of light
//Determination of velocity factor
Vf=1/sqrt(er);
disp(Vf,'The value of velocity factor is');
//Determination of propagation velocity
Vp=Vf*c;
disp('m/s',Vp,'The value of propagation velo. is');
```

Scilab code Exa 14.4 `example 4`

```
clc;
//page no 468
//prob no. 14.4
//Refer fig. 14.13(a)
vs=1;//source voltage
Rs=50;//source resistance
```

```
Zo=50;//line impedance
RL=25;//load resistance
l=10;//length of line
vf=0.7;//velocity factor
Vi=0.5;
c=3*10^8;//velo of light
//Vs will divide between Rs and Zo of the line.Since two resistors are equal,the voltage will divide equally.
//Therefore at t=0,the voltage at the source end of the line will rise from zero to 0.5V. The voltage at the load will remain zero untill the surge reaches it.The time for this is
T=l/(vf*c);
// After T sec, the voltage at the load will rise. The reflection coefficient is given as
refl_coeff=(RL-Zo)/(RL+Zo)
//Now reflection voltage is
Vr=refl_coeff * Vi;
//The total voltage at the load is
Vt=Vr+Vi;
disp('V',Vt,'The total voltage at the load is');
// The reflected voltage will propogate back along the line,reaching the source at time 2T.After this the voltage will be 0.3335V all along the line
//The voltage across the line, and the load will be
VL=vs*(RL/(RL+Zo));
disp('V',VL,'The voltage across the line,');
```

Scilab code Exa 14.5 `example 5`

```
clc;
//page no 472
//prob no. 14.5
```

```
//Standard coaxial cable RG-8/U with 45 degree phase shift at 200MHz
p=45;f=200*10^6;c=3*10^8;//Speed of light in m/s
vf=0.66;//velo. factor for this line
vp=vf*c;//Determination of propagation velo.
wav=vp/f;//Determination of wavelength of signal
//Determination of reqd length for 45 degree phase shift
L=wav*(p/360);
disp('m',L,'The length reqd for phase shift is');
```

Scilab code Exa 14.6 example 6

```
clc;
//page no 476
//prob no. 14.6
//A 50ohm line terminated in 25ohm resistance
Zo=50;Zl=25;
//Determination of SWR
SWR=Zo/Zl;//In this case Zo>Zl
disp(SWR,'The value of SWR is');
```

Scilab code Exa 14.7 example 7

```
clc;
//page no 477
//prob no. 14.7
//A generator sends 50mW at 50ohm line & reflection coeff I=0.5
Pi=50;I=0.5;
//Determination of amount of power reflected
Pr=(I^2)*Pi;
disp('mW',Pr,'The amount of power reflected is');
```

```
//Determination of remainder power that reaches load
Pl=Pi-Pr;
disp('mW',Pl,'The power dissipated in load is');
```

Scilab code Exa 14.8 example 8

```
clc;
//page no 478
//prob no. 14.8
//A transmitter supplies 50W with SWR 2:1
Pi=50;SWR=2;
//Determination of power absorbed by load
Pl=(4*SWR*Pi)/(1+SWR)^2;
disp('W',Pl,'The power absorbed by load is');
```

Scilab code Exa 14.9 example 9

```
clc;
// page no 545
// prob no 14.9
Zo=50;// line impedence in ohm
ZL=100;// load impedance in ohm
vf=0.8;//velocity factor
l=1;//length of line
f=30*10^6;// freq of operation
c=3*10^8;//velo of light
// we have to find the length of line in degree
wl=vf*c/f//wavelength
// Then the length of line in degree is
ang=l/wl*360
// calculation of impedance
Z=Zo*(ZL+(%i*Zo*tand(ang)))/(Zo+(%i*ZL*tand(ang)));
```

```
disp('ohm',Z,'The impedance looking toward the load'
    );
```

Scilab code Exa 14.10 `example 10`

```
clc;
//page no 481
//prob no. 14.10
//A series tuned ckt tuned at 1GHz
vf=0.95;c=3*10^8;f=10^9;
vp=vf*c;//determination of propagation velo.
wav=vp/f;//Determination of wavelength
//Determination of length
L=wav/2;//Since half wavelength section wiil be
    series resonant
disp('m',L,'The length should be');
```

Scilab code Exa 14.11 `example 11`

```
clc;
//page no 481
//prob no. 14.10
//A Tx deliver 100W to antenna through 45m coaxial
    cable  with loss=4dB/100m
loss=4/100;L=45;Pout=100;
loss_dB=L*loss;//Determination of loss in dB
Pin_Pout=10^(loss_dB/10);
//Determination of Tx power
Pin=Pout*Pin_Pout;
disp('W',Pin,'The transmitter power must be');
```

Scilab code Exa 14.13 `example 12`

```
clc;
//page no 490
//prob no. 14.13
Zo=50;//line impedance in ohm
f=100*10^6;//operating freq
vf=0.7;//velocity factor
L=6;//length in m
c=3*10^8;//velo of light
ZL=50+%i*50;//load impedance in ohm
// we have to calculate length in degree,so for this
    first find wl
wl=vf*c/f;//wavength in m
ang=360*L/wl;
// now from the graph input impedance is 19.36+%i5
   .44;
Zi=19.36+%i*5.44;
disp('ohm',Zi,'Input impedance is');
```

Scilab code Exa 14.14 `example 13`

```
clc;
//page no 492
//prob no. 14.14
Zo=50;//line impedance in ohm
ZL=75+%i*25;
// the requirment of this is simply to match the 50
   ohm line to the impedsnce at this point on the
   line,which is 88.38 ohm,resistive.
Z2=88.38;//in ohm
//The required turn ratio is
N1_N2=sqrt(Zo/Z2);
disp(N1_N2,'The required turn ratio is');
```

Scilab code Exa 14.15 `example 14`

```
clc;
//page no 494
//prob no. 14.15
// refer prob no 14.14
Zo=50;//line impedance in ohm
Z2=88.38;//in ohm
Zo_=sqrt(Zo*Z2);
disp(Zo_');
```

Scilab code Exa 14.16 `example 15`

```
clc;
//page no 494
//prob no. 14.16
Zo=50;//line impedance in ohm
f=100*10^6;//operating freq in Hz
ZL1=50+%i*75;// load impedance with Xc=75
Xc=75;
// Capacitance in farads is given as
C=1/(2*%pi*f*Xc);
disp('F',C,'Capacitance is');
```

Scilab code Exa 14.17 `example 16`

```
clc;
//page no 497
//prob no. 14.17
```

```
Zo=72;//line impedance in ohm
ZL=120-%i*100;//load impedance
//The stub must be inserted at a point on the line where the real part of the load admittance is correct. This alue is
s=1/Zo;
disp('S',s,'The value of stude is');
```

Scilab code Exa 14.18 example 17

```
clc;
//page no 501
//prob no. 14.18
//A TDR display shows dscontinuity  at 1.4us & vf=0.8
t=1.4*10^-6;vf=0.8;c=3*10^8;//Speed of light
//Determination of distance of fault
d=(vf*c*t)/2;//One-half time is used to calculate
disp('m',d,'The distance is');
```

Scilab code Exa 14.19 example 18

```
clc;
//page no 503
//prob no. 14.19
//2 adjacent minima on slotted are 23cm apart with velo factor=95%
L=23*10^-2;vf=0.95;c=3*10^8;//Velo. of light in m/s
//Determination of wavelength
wav=2*L;//Minima are seperated by one-half wavelength
disp('cm',wav*100,'The wavelength is');
//Determination of freq.
```

```
f=(vf*c)/wav;//vp=vf*c
disp('MHz',f/10^6,'The freq is');
```

Scilab code Exa 14.20 example 19

```
clc;
//page no 504
//prob no. 14.20
//Frwd power in Tx line is 150W, Reverse power=20W
Pi=150;Pr=20;//All power in watt
//Determination of SWR
SWR=(1+sqrt(Pr/Pi))/(1-sqrt(Pr/Pi));
disp(SWR,'The value of SWR is');
```

Chapter 15

Radio Wave Propogation

Scilab code Exa 15.1 example 1

```
clc;
//page no 517
//prob no. 15.1
//Dielectric constt=2.3
er=2.3;
//Determination of characteristic impedance
Z=377/sqrt(er);
disp('ohm',Z,'The charasteristic impedance of
   polyethylene is');
```

Scilab code Exa 15.2 example 2

```
clc;
//page no 518
//prob no. 15.2
//Dielelectric strength of air=3MV/m
e=3*10^6;//electric field strength
Z=377;//impedance of air
```

```
Pd=(e^2)/Z;//Determination of power density
disp('GW/m2',Pd/10^9,'The max power density is');
```

Scilab code Exa 15.3 example 3

```
clc;
//page no 520
//prob no. 15.3
//An isotropic radiator with power 100W & dist given
    is 10km
Pt=100;r=10*10^3;
//Determination of power density at r=10km
Pd=Pt/(4*%pi*(r^2));
disp('nW/m2',Pd*10^9,'Power density at a point 10km'
    );
```

Scilab code Exa 15.4 example 4

```
clc;
//page no 521
//prob no. 15.4
//An isotropic radiator radiates power=100W at point
    10km
Pt=100;r=10*10^3;
//Determination of electric field strength
e=sqrt(30*Pt)/r;
disp('mW/m',e*1000,'The electric field strength is')
    ;
```

Scilab code Exa 15.5 example 5

```
clc;
//page no 525
//prob no. 15.5
//A transmitter with power o/p=150W at fc=325MHz. antenna gain=12dBi receiver antenna gain=5dBi at 10km away
//considering no loss in the system
d=10;Gt_dBi=12;Gr_dBi=5;fc=325;Pt=150;
//Determination of power delivered
Lfs=32.44+(20*log10(d))+(20*log10(fc))-(Gt_dBi)-(Gr_dBi);
Pr=Pt/(10^(Lfs/10));
disp('nW',Pr*10^9,'The power delivered to receiver is');
```

Scilab code Exa 15.6 `example 6`

```
clc;
//page no 525
//prob no. 15.6
//A transmitter with o/p power=10W at fc=250MHz, connected to Tx 10m line with loss=3dB/100m t0 antenna with gain=6dBi.Rx antenna 20km away with gain=4dBi
//Refer fig.15.6,assuming free space propagation
d=20;fc=250;Gt_dBi=6;Gr_dBi=4;loss=3/100;Zl=75;Zo=50;L=10;Pt=10;
Lfs=32.44+(20*log10(d))+(20*log10(fc))-Gt_dBi-Gr_dBi;//path loss
disp(Lfs);
L_tx=L*loss;//Determination of loss
ref_coe=(Zl-Zo)/(Zl+Zo);//Reflection coefficient
L_rx=1-(ref_coe^2);//Proportion of incident power that reaches load
L_rx_dB=-10*log10(L_rx);//Converting that proportion
```

```
    in dB
//Determination of total loss Lt
Lt=(Lfs)+(L_tx)+(L_rx_dB);
//Determination of power delivered to receiver
Pt_Pr=10^(Lt/10);//Power ratio
Pr=Pt/Pt_Pr;
disp('W',Pr,'The power delivered to receiver is');
```

Scilab code Exa 15.7 example 7

```
clc;
//page no 530
//prob no. 15.7
//A radio wave moves from air(er=1) to glass(er=7.8)
   .angle of incidence=30 deg
theta_i=30;er1=1;er2=7.8;
//determination of angle of refraction
theta_r=asind((sind(theta_i))/(sqrt(er2/er1)));
disp('degree',theta_r,'The angle of refraction is');
```

Scilab code Exa 15.8 example 8

```
clc;
//page no 537
//prob no. 15.8
//A Tx statn with fc=11.6MHz & angle of incidence=70
    degree
theta_i=70;fc=11.6;//in MHz
//determination of max usable freq(MUF)
MUF=fc/(cosd(theta_i));
disp('MHz',MUF,'The max usable freq MUF is');
```

Scilab code Exa 15.9 example 9

```
clc;
//page no 539
//prob no. 15.9
//A taxi compony using central dispatcher with antenna height=15m &amp; taxi antenna height=1.5m
ht=15;hr=1.5;
//a)Determination of max commn dist betn dispatcher and taxi
d1=sqrt(17*ht)+sqrt(17*hr);
disp('km',d1,'a)The max commn dist betn dispatcher &amp; taxi');
//b)Determination of max ommn dist betn 2 taxis
d2=sqrt(17*hr)+sqrt(17*hr);//ht=hr=height of antenna of taxi cab
disp('km',d2,'The max commn dist betn two taxi is');
```

Scilab code Exa 15.11 example 10

```
clc;
// page no 545
// prob no 15.11
// An automobile travels at 60km/hr
v=60*10^3/(60*60);//conversion of car's speedto m/s
c=3*10^8;//speed of light
//part a) calculation of time between fades if car uses a cell phone at 800*10^6Hz
f=800*10^6;
T=c/(2*f*v);
disp('sec',T,'The fading period is');
```

```
//part b) calculation of time between fades if car
    uses a PCS phone at 1900*10^6Hz
f=1900*10^6;
T=c/(2*f*v);
disp('sec',T,'The fading period is');
// Note that the rapidity of the fading increases
    with both the frequency of the transmissions and
    the speed of the vehicle
```

Scilab code Exa 15.12 `example 11`

```
clc;
//page no 550
// problem no 15.12
A=1000;//metropolitian area expressed in sq. km
r=2;//radius of cell in km
// Number of cell sites given as
N=A/(3.464*r^2);
disp(N,'Number of cell sites are');
```

Chapter 16

Antennas

Scilab code Exa 16.1 `example 1`

```
clc;
//page no 564
//prob no. 16.1
//Determination of length of half-wave dipole
f=20;//Operating freq in MHz
L=142.5/f;
disp('m',L,'The length of half-wave dipole is');
```

Scilab code Exa 16.2 `example 2`

```
clc;
//page no 566
//prob no. 16.2
//A dipole antenna with radiatn resistance=67ohm &
   loss resistance 5ohm
Rr=67;Rl=5;
//Determination of efficiency
eta=Rr/(Rr+Rl);
disp('%',eta,'The efficiency of dipole antenna is');
```

Scilab code Exa 16.3 `example 3`

```
clc;
//page no 569
//prob no. 16.3
//Two antennas with gain 5.3dBi & 4.5dBd
//Converting unit dBd in dBi for comparison
G1_dBi=5.3;G2_dBd=4.5;
G2_dBi=2.14+G2_dBd;
if G2_dBi > G1_dBi then
    disp('Second antenna with gain=4.5dBd has higher
        gain');
else
    disp('First antenna with gain=5.3dBi has higher
       gain ');
end;
```

Scilab code Exa 16.4 `example 4`

```
clc;
//page no 571
//prob no. 16.4
//A dipole antenna with efficency=85% given
n=0.85;D_dBi=2.14;//Directivity in dBi
//Determination of gain in dB
D=10^(D_dBi/10);
G=D*n;//Determination of gain
G_dBi=10*log10(G);//Converting to dBi
disp('dBi',G_dBi,'The gain is');
```

Scilab code Exa 16.6 `example 5`

```
clc;
//page no 573
//prob no. 16.6
//ERP of Tx statn=17W
ERP=17;
//Determnation of EIRP
ERP_dBm=10*log10(ERP/10^-3);//Converting ERP in dBm
EIRP_dBm=ERP_dBm+2.14;//Converting ERP in EIRP
disp('dBm',EIRP_dBm,'EIRP in dBm is expressed as');
```

Scilab code Exa 16.7 `example 6`

```
clc;
//page no 582
//prob no. 16.7
//a helial antenna with 8 turns with freq=1.2GHz given
N=8;f=1.2*10^9;c=3*10^8;//Speed of light in m/s
//a)Determination of optimum diameter of antenna
wav=c/f;
D=wav/%pi;
disp('m',D,'a)1.The optimum diameter for antenna is');
S=wav/4;//Determination of spacing for the antenna
disp('m',S,'a)2.The spacing for the antenna');
L=N*S;//Determination of total length of an antenna\
disp('m',L,'a)3.The total length of an antenna is');
//b)Determination of antenna gain in dBi
G=(15*N*S*(%pi*D)^2)/(wav^3);
G_dBi=10*log10(G);//Converting in dBi
disp('dBi',G_dBi,'b)The antenna gain is');
//c)determination of beamwidth
theta=((52*wav)/(%pi*D))*sqrt(wav/(N*S));
```

```
disp('degree',theta,'The beamwidth is');
```

Scilab code Exa 16.8 `example 7`

```
clc;
//page no 590
//prob no. 16.8
//Design of log periodic antenna to cover freq
   100-300MHz & t=0.7,a=30 degree
t=0.7;a=30;
//For good performance converting range to 90MHz to
   320MHz
f2=90;f1=320;
//Determination of lengths of elements
L1=142.5/f1;//For freq of 320MHz
L2=L1/t;L3=L2/t;L4=L3/t;L5=L4/t;
disp('The length of elements are');
disp('m',L5,'L5=','m',L4,'L4=','m',L3,'L3=','m',L2,'
   L2=','m',L1,'L1=',);
//Determination of spacing betn elements
D1=L1/(2*tand(a/2));
D2=D1/t;D3=D2/t;D4=D3/t;D5=D4/t;
disp('The spacing betn elements are');
disp('m',D5,'D5=','m',D4,'D4=','m',D3,'D3=','m',D2,'
   D2=','m',D1,'D1=',);
```

Scilab code Exa 16.9 `example 8`

```
clc;
//page no 598
//prob no. 16.9
//A parabolic antenna with diameter=3m & efficiency
   =60% operate at 4GHz
```

```
D=3;n=0.6;f=4*10^9;c=3*10^8;//Spped of light
//Determination of gain & beamwidth
wav=c/f;//Determination of free space wavelength
theta=(70*wav)/D;//Calculaing beamwidth
disp('degree',theta,'The beamwidth is');
G=(n*(%pi^2)*(D^2))/wav^2;//Calculating gain
//Converting gain in dBi
G_dBi=10*log10(G);
disp('dBi',G_dBi,'The gain is');
```

Chapter 17

Microwave Devices

Scilab code Exa 17.1 `example 1`

```
clc;
//page no 621
//prob no. 17.1
//TE10 mode in air dielectric mode with inside cross
    sectn=2cm*4cm
//Determination of cut-off freq
a=4*10^-2;//largest dimn is used for calculation
c=3*10^8;//Speed of light in m/s
fc=c/(2*a);
//Determination of dominant mode of propagation over
    2:1
MUF=2*fc;
disp('Hz',MUF,'The max usable freq is');
```

Scilab code Exa 17.2 `example 2`

```
clc;
//page no 624
```

```
//prob no. 17.2
//Determination of group velo for waveguide in example 7.1
f=5*10^9;//freq.in Hz
fc=3.75*10^9;//cut-off freq from eg.7.1
c=3*10^8;//speed of light in m/s
vg=c*sqrt(1-(fc/f)^2);
disp('m/s',vg,'The group velo.is');
```

Scilab code Exa 17.3 `example 3`

```
clc;
//page no 624
//prob no. 17.3
//A waveguide with fc=10GHz.2 signal withfreq 12 & 17GHz propogate down=50m
fc=10*10^9;c=3*10^8;f1=12*10^9;f2=17*10^9;d=50;
//Determination of group velo for 12GHz
vg1=c*sqrt(1-(fc/f1)^2);
disp('m/s',vg1,'The group velo. for 12GHz signal is');
//Determination of group velo for 17GHz
vg2=c*sqrt(1-(fc/f2)^2);
disp('m/s',vg2,'The group velo. for 17GHz signal is');
//Determination of time taken for 50m dist by f1
t1=d/vg1;
//Determination of time taken for 50m dist by f2
t2=d/vg2;
//Determination of diffn in the travel times for 2 signals
del=t1-t2;
disp('sec',del,'The diffn in the travel times for 2 signals is');
```

Scilab code Exa 17.4 `example 4`

```
clc;
//page no 627
//prob no. 17.4
//Determination of phase velo.with given 5GHz freq
f=5*10^9;c=3*10^8;fc=3.75*10^9;//Cut-off freq
   refering eg.17.1
vp=c/sqrt(1-(fc/f)^2);//Calculation of phase velo.
disp('m/s',vp,'The phase velo is');
```

Scilab code Exa 17.5 `example 5`

```
clc;
//page no 628
//prob no. 17.5
//determination of characteristic impedance of
   waveguide with given 5GHz freq
f=5*10^9;fc=3.75*10^9;//Refering in eg. 17.4
Zo=377/sqrt(1-(fc/f)^2);
disp('ohm',Zo,'The characteristic impedance of
   waveguide is');
```

Scilab code Exa 17.7 `example 6`

```
clc;
//page no 631
//prob no. 17.7
//A signal with level of 20dBm &amp; insertion loss
   =1dB &amp; coupling =20dB, directivity=40dB
```

```
sig_in=20;loss=1;couple=20;direct=40;
//Determination of signal level in main guide
sig_level_main=sig_in-loss;
disp('dBm',sig_level_main,'The signal level in main
    guide is');
//Determination of signal level in secondary guide
sig_level_sec=sig_in-couple;
disp('dBm',sig_level_sec,'The signal level in
    secondary guide is');
//If signal dirn in main guide were reveresed,the
    signal level in sec gide would reduced by 40dB to
sig_sec_rev=(sig_level_sec)-(direct);
disp('dBm',sig_sec_rev,'The signal level from sec
    guide when reversed guide is');
```

Scilab code Exa 17.8 example 7

```
clc;
//page no 642
//prob no. 17.8
//A Gunn device with thickness=7um
d=7*10^-6;v=10^5;//Basic velocity of e
t=d/v;//Basic velocity relation
//Determination of freq of oscillation
f=1/t;//Inverse of period is freq
disp('Hz',f,'The freq of oscillation is');
```

Scilab code Exa 17.9 example 8

```
clc;
//page no 648
//prob no. 17.9
```

```
//A pulse magnetron with avg power=1.2kW & peak power=18.5kW & 1 pulse is generated every 10ms
Pavg=1.2*10^3;Pp=18.5*10^3;Tt=10*10^-3;
//Determination of duty cycle
D=Pavg/Pp;
disp(D,'The duty cycle is');
//Determination of length of pulse
Ton=D*Tt;
disp('sec',Ton,'The length of pulse is');
```

Scilab code Exa 17.10 `example 9`

```
clc;
//page no 652
//prob no. 17.10
//A pyramidal horn has aperture=58mm in E-plane & 78 mm in H-plane & operates at 10GHz
f=10*10^9;c=3*10^8;dH=78*10^-3;dE=58*10^-3;
//a)Determination of gain in dB
wl=c/f;//calculation of wavelength
G=(7.5*dE*dH)/(wl^2);
G_dBi=10*log10(G);//Converting to dBi
disp('dBi',G_dBi,'a)The gain is');
//b)Determination of beamwidth in H-palne
theta_H=(70*wl)/dH;
disp('degree',theta_H,'b)The beamwidth in H-plane is');
//c)Determination of beamwidth in E-plane
theta_E=(56*wl)/dE;
disp('degree',theta_E,'c)The beamwidth in H-plane is');
```

Scilab code Exa 17.11 `example 10`

```
clc;
//page no 654
// problem no 17.11
//for a square patch antenna
f=2*10^6;// freq of operation in Hz
Er=2;// relative permittivity
c=3*10^8;// velo of light
//wavelength is given as
wl=c/(f*sqrt(Er));
//The antenna width and length are each
    approximately half of this.
w=wl/2;
l=wl/2;
disp('m',w,'The antenna width','and','m',l,'The
    antenna length');
```

Scilab code Exa 17.12 example 11

```
clc;
//page no 657
//prob no. 17.12
//A radar Tx has power=10kW at freq=9.5GHz & target
    at 15km with cross sectn=10.2 m2 with gain of
    antenna is 20dBi
f=9.5*10^9;Pt=10*10^3;c=3*10^8;G_dBi=20;a=10.2;r
    =15*10^3;
//Determination of received power
wl=c/f;//calculating wavelength
G=10^(G_dBi/10);//Converting to power ratio
Pr=((wl^2)*Pt*(G^2)*a)/(((4*%pi)^3)*(r^4));
disp('W',Pr,'The received power is');
```

Scilab code Exa 17.13.a example 12

```
clc;
//page no 659
//prob no. 17.13a
//a pulse sent,returns after 15us
t=15*10^-6;c=3*10^8;
//Determination of distance of target
R=(c*t)/2;
disp('m',R,'The distance of target is');
```

Scilab code Exa 17.13.b `example 13`

```
clc;
//page no 660
//prob no. 17.13.b
c = 3*10^8;
tp=10^-6;//pulse duration of pulse radar
f=10^3;//operating freq in Hz
//The maximum unambiguous range is
Rmax=c/(2*f);
disp('m',Rmax,'The maximum range is ');
//The minimum unambiguous range is
Rmin=c*tp/2;
disp('m',Rmin,'The minimum range is ');
```

Scilab code Exa 17.14 `example 14`

```
clc;
//page no 662
//prob no. 17.14
v=60;//speed of vehicle moving towards radar in mph
c=3*10^8;//velo of light in m/s
f=10^10;// operating frequency in Hz
// conversion of speed from mph to km/hr
```

```
v1=60*1.6;
// conversion of speed from km/hr to m/s
v2=v1*10^3/3600;
// Now the Doppler shift is found as
fd=2*v2*f/c;
disp('Hz',fd,'The Doppler shift is ');
```

Chapter 18

Terrestrial Microwave Communication system

Scilab code Exa 18.1 `example 1`

```
clc;
// page no 676
// prob no 18_1
//Transmitter and receiver have same height at dist
   40km
d=40;//dist is 40 km
h=(d^2)/68;// As d=sqrt(17h)+sqrt(17h)
disp('m',h,'The height of each tower must be at
   least');
```

Scilab code Exa 18.2 `example 2`

```
clc;
// page no 678
// prob no 18_2
//A line of sight radio link at freq 6GHz with
   seperation 40 km betn antennas
```

```
f=6;d1=10;d2=30;//obstacle located at 10 km
//Determination of dist R to clear obstacle
R=10.4*sqrt((d1*d2)/(f*(d1+d2)));
disp('m',R,'The dist by which beam must clear the obstacle is')
```

Scilab code Exa 18.3 `example 3`

```
clc;
// page no 679
// prob no 18_3
//A transmitter and receiver at 6GHz seperated by 40 km with o/p power 2 W
f=6*10^9;d=40;Pt=2;// power in watt
//transmitting antenna gain Gt=20dBi,receiving antenna Gr=25dBi
Gt=20;Gr=25;
f_mhz=6000;//f=6000 MHz
Pr_Pt_dB=(Gt+Gr)-(32.44+(20*log10(d))+(20*log10(f_mhz)));
Pt_dBm=10*log10(Pt/10^-3);
Pr_dBm=Pt_dBm + Pr_Pt_dB;
disp('dBm',Pr_dBm,'The power delivered to the Rx is');
```

Scilab code Exa 18.4 `example 4`

```
clc;
// page no 680
// prob no 18_4
T_sky=120;// Sky temp expressed in K
L_dB=2;// antenna feedline loss
L=10^(L_dB/10);
```

```
// the noise temp is given as
Ta=((L-1)*290 + T_sky)/L;
disp('K',Ta,'Noise temperature is' );
```

Scilab code Exa 18.5 `example 5`

```
clc;
// page no 681
// prob no 18.5
NF_dB=2;
NF_power = 10^(NF_dB/10);
T_eq=290*(NF_power -1);
disp('K',T_eq,'The equivalent noise temperature');
```

Scilab code Exa 18.6 `example 6`

```
clc;
// page no 681
// prob no 18.6
// refer example no 18.4 and 18.5
// The antenna and feedline combination from ex 18.4 is used with the Rx from ex 18.5
Ta=182;// noise temp of the antenna and feedline combination expressed in K
Teq=169;// noise temperature of the Rx
B=20*10^6;// BW of the receiver
Tn_sys=Ta+Teq;//Noise temp for the system
k=1.38*10^-23;//Boltzmann constant
// Noise power of the system is given as
Pn=k*Tn_sys*B;// where k is Boltzmann constant
disp('W',Pn,'The noise power is');
Pn_dBm=10*log10(Pn/10^-3);
disp('dBm',Pn_dBm,'The thermal noise power is');
```

Scilab code Exa 18.7 example 7

```
clc;
// page no 682
// prob no 18.7
// refer ex no 18.3 and 18.6
Pr_dBm=-62;//power at the receiver in dBm
Pn_dBm=-100;//thermal noise power in dBm
// carrier to noise ratio in dB is given as
C_N=Pr_dBm -Pn_dBm;
disp('dB',C_N,'Carrier to noise ratio is');
```

Scilab code Exa 18.8 example 8

```
clc;
// page no 683
// prob no 18.8
// refer ex 18.7
fb=40*10^6;// bit rate in bps
Pr_dBm=-62;//power at the receiver in dBm
Pr=10^(Pr_dBm/10)*10^-3;// power at the receiver in
    W
Eb=Pr/fb;// the energy per bit in J
k=1.38*10^-23;//Boltzmann constant
T=350;
// the noise power density is
No=k*T;
// Energy per bit to noise density ratio in dB is
Eb_No=10*log10(Eb/No);
disp('dB',Eb_No,'Energy per bit to noise density
    ratio is ');
```

Scilab code Exa 18.9 `example 9`

```
clc;
// page no 686
// prob no 18.9
// refer fig 18.7(b)
//This is the standard superheterodyne receiver
fc=6870;// the received carrier freq in MHz
IF=70;// IF in MHz
// The local oscillator freq is given as
f_lo=fc-IF;
disp('MHz',f_lo,'The local oscillator freq is ');
```

Scilab code Exa 18.10 `example 10`

```
clc;
// page no 688
// prob no 18.10
// refer fig 18.9a)
fc_r=6870;// carrier freq of received signal in MHz
fc_t=6710;//carrier freq of transmitted signal in
    MHz
IF=70;//in MHz
// the freq of shift oscillator is
fso=fc_r - fc_t;
disp('MHz',fso,'The freq of shift oscillator is ');
//the local oscillator freq is given as
flo=fc_t-IF;
disp('MHz',flo,'The local oscillator freq is ');
//from fig , mixer 3 will produce an o/p as
op_mix3=flo+fso;
disp('MHz',op_mix3,'O/P of Mixer 3 is');
```

Scilab code Exa 18.11 `example 11`

```
clc;
// page no 690
// prob no 18.11
// A typical microwave digital radio system uses 16-
   QAM.
fb=90.524;//bit rate expressesd in Mbps
n=16;// for 16-QAM system
//part a) calculation of no of bits per symbol
m=log2(n);
disp('bits',m,'The number of bits per symbol are');
// part b) calclation of baud rate
// baud rate is 1/4th of the bit rate
baud=fb/4;
disp('Mbaud',baud,'The baud rate is');
```

Chapter 19

Television

Scilab code Exa 19.1 `example 1`

```
clc;
// page no 703
// prob no 19.1
// In the given problem,a video signal has 50% of
   the maximum luminance level
//A black setup level of  7.5 IRE represents zero
   luminance,and 100 IRE is max brightness.Therefore
    the range from min to max luminnance has
   100-7.5=92.5 units.
//Therefore the level is
IRE=7.5 + (0.5*92.5);
disp('IRE units',IRE,'Level of video signals in IRE
   units');
```

Scilab code Exa 19.2 `example 2`

```
clc;
// page no 704
```

```
// prob no 19.2
// part a) horizontal blanking
// Horizontal blanking occupies approximately 10 us of the 63.5 us duration of each line,
Hztl_blnk=10/63.5 *100;
disp('of the signal','%',Hztl_blnk,'Horizontal blanking occupies');
// part b) vertical blanking
// Vertical blanking occupies approximately 21 lines per field or 42 lines per frame. A frame has 525 lines altogether,so
Vert_blnk=42/525 *100;
disp('of the signal','%',Vert_blnk,'vertical blanking occupies');
// part c) active signal
// since 8% of the time is lost in vertical blanking, 92% of the time is involved in the tansmission of the active lines.
act_vid = (100-Hztl_blnk)*(100-Vert_blnk)/100;
disp('%',act_vid,'The acive video is');
```

Scilab code Exa 19.3 example 3

```
clc;
// page no 707
// prob no 19.3
// A typical low-cost monochrome receiver has a video bandwidth of 3MHz
B=3;// bandwidth in MHz
// The horizontal resolution in lines is given as
L_h=B*80;
disp('lines',L_h,'The horizontal resolution in lines is');
```

Scilab code Exa 19.4 example 4

```
clc;
// page no 709
// prob no 19.4
// A RGB video signal has normalized values as
R=0.2;G=0.4;B=0.8;
//The luminance signal is given as
Y=0.30*R+0.59*G+0.11*B;
disp(Y,'The luminance signal is');
//The in-phase component of the color signal is
    given as
I=0.60*R-0.28*G-0.32*B;
disp(I,'The in-phase component of the color signal
    is');
//The quadrature component of the color signal is
    given as
Q=0.21*R-0.52*G+0.31*B;
disp(Q,'The quadrature component of the color signal
    is');
```

Scilab code Exa 19.5 example 5

```
clc;
// page no 712
// prob no 19.5
///// refer table 19.1///////.......
// The proportion in the table are voltage levels
    and have to be squared to get power.
// for black setup the voltage level is given as
v=0.675;
```

```
//Therefore the power level as a fraction of the
   maximum transmitter power is
P_black_setup=v^2 *100;
disp('of the maximum transmitter power is  used to
   transmit a black setup','%',P_black_setup,)
```

Scilab code Exa 19.6 example 6

```
clc;
// page no 728
// prob no 19.6
// refer fig 19.27 of the page no 729
// from fig, we can write down the values directly
   as given
In1=100*10^-3;//expressed in mV
In1_dBmV=20*log10(In1/1);
disp('dBmV',In1_dBmV,'The input of Amp 1 is');
// this above calculated signal is applied to the
   input of the first amplifier,i.e. head-end signal
    processing
G1=40;// gain of Amp 1 expressed in dB
// o/p level of Amp 1 is
Out1=In1_dBmV + G1;
disp('dBmV',Out1,'The output of Amp 1 is');
L=15;//expressed in dB
// The input level of Amp 2 is
In2_dBmV=Out1-L;
disp('dBmV',In2_dBmV,'The input of Amp 2 is');
G2=25;//gain of Amp2 expressed in dB
// o/p level of Amp 2 is
Out2=In2_dBmV+G2;
disp('dBmV',Out2,'The output of Amp 2 is');
L1=10;// loss in cable
L2=12;//loss in directional coupler
// The input level of Amp 3 is
```

```
In3_dBmV=Out2-L1-L2;
disp('dBmV',In3_dBmV,'The input of Amp 3 is');
G3=20;//gain of Amp3 expressed in dB
Out3=In3_dBmV+G3;
disp('dBmV',Out3,'The output of Amp 3 is');
// There is further 3dB cable loss and 20dB loss in
    the tap
L3=3;//loss in cable
L4=20;// loss in tap
//signal strength at the tap is
Vdrop_dBmV=Out3-L3-L4;
V_drop=10^(Vdrop_dBmV/20);// expressed in mV
disp('mV',V_drop,'Signal strength at subscriber tap
    is');
// Calculation of power into 75 ohm
R=75;//expressed in ohm
Pdrop = (V_drop*10^-3)^2/R;
Pdrop_dBm=10*log10(Pdrop/10^-3);
disp('dBm',Pdrop_dBm,'The power at the end is');
```

Scilab code Exa 19.7.a example 7

```
clc;
// page no 731
// prob no 19.7
// In given problem a TV receiver is tuned to
    channel 6.
//All modern Rx uses a picture IF of 45.75 MHz with
    high-side injection of the signal into the cable.
// The picture carrier of channel 6 is at a
    frequency of 83.25MHz,so
ch=6;
Fc=83.25;// expressed in MHz
IF=45.75;//expressed in MHz
f_lo=Fc+IF;
```

```
a=f_lo+ch/2; b=f_lo-ch/2;
disp('band','MHz',a,'to','MHz',b,'The interference
   would in');
```

Scilab code Exa 19.7.b example 8

```
clc;
// page no 740
// prob no 19.8
Nh=640; Nv=480;// resolution of digital video signal
    as 640*480 pixels
Rf=30;//frame rate expressed in Hz
m=8;// bits per sample
// By using the product of Horizontal & vertical
   resolution , no of luminance pixels per frame are
Npl=Nh*Nv;
// since each of the color signals has one-fourth
   the total no of luma pixels
Npt=1.5*Npl;
//therefore bit rate is given as
fb=Npt*m*Rf;
disp('bps',fb,'The bit rate for the signal is');
```

Chapter 20

Satellite Communication

Scilab code Exa 20.1 example 1

```
clc;
// page no 754
// prob no 20.1
// part A)
d=500;
//By using the equation for velocity of a satellite
v=sqrt(4*10^11/(d+6400));
disp('m/s',v,'A) The velocity of a satellite is');
// The radius of orbit is
r=(6400+d)*10^3//in m
//The orbital period of satellite is
T=(2*%pi*r)/v;
disp('sec',T,'The orbital period of satellite is');
//part B)
d=36000;
//By using the equation for velocity of a satellite
v=sqrt(4*10^11/(d+6400));
disp('m/s',v,'B) The velocity of a satellite is');
//The radius of orbit is
r=(6400+d)*10^3//in m
//The orbital period of satellite is
```

```
T=(2*%pi*r)/v;
disp('sec',T,'The orbital period of satellite is');
```

Scilab code Exa 20.2 example 2

```
clc;
// page no 757
// prob no 20.2
R=6400;//Radius of earth
L=45;//earth station lattitude
H=36000//Height of satellite above the  earth;
ang=atand((6400*sind(45))/(36000+(6400*(1-cosd(45)))
   ));
disp(ang);
```

Scilab code Exa 20.3 example 3

```
clc;
// page no 758
// prob no 20.3
//Determination of lenght of geostationary satellite
    with angle of elavation=30 degree
r=64*10^5;//Radius of earth
h=36*10^6;//height of satellite
theta=30;//angle of elevation
d=sqrt(((r+h)^2)-((r*cosd(theta))^2))-(r*sind(theta)
   );
disp('km',d/1000,'The length of the path is');
```

Scilab code Exa 20.4 example 4

```
clc;
// page no 759
// prob no 20.4
//A satellite transmitter operates at 4GHz with 7W &
    antenna gain 40dBi
//Receiver antenna gain 30dBi & path length is
   4*10^7
Gt_dBi=40;Gr_dBi=30;Pt=7;d=40000;//in km
f=4000;//in MHz
Pr_Pt_dB=Gt_dBi+Gr_dBi-(32.44+(20*log10(d))+(20*
   log10(f)));
//Signal strength at transmitter
Pt_dBm=10*log10(Pt/10^-3);
Pr_dBm=(Pt_dBm)+(Pr_Pt_dB);
disp('dBm',Pr_dBm,'The value of signal strength at
   receiver');
```

Scilab code Exa 20.5 example 5

```
clc;
// page no 760
// prob no 20.5
// In the given problem
G=40;// receiving antenna gain
T_sky=15;// noise temp
L=0.4;//loss between antenna and LNA input
T_eq =40;// noise temperature f LNA
// Fir-st we have to find G in dB
G_dB = G-L;
// For the calculation of T, we have to convert the
   feedhorn loss into a ratio as follows
L=10^(0.4/10);
Ta = ((L-1)*290 + T_sky )/ L;
// The receiver noise temperature is given wrt the
   chosen reference point,theefore
```

```
Ratio= G -10*log10(Ta+T_eq);
disp('dB',Ratio,'The receiver noise temperature is');
```

Scilab code Exa 20.6 example 6

```
clc;
// page no 761
// prob no 20.6
NF_dB=1.5;// noise fig of a receiver
NF=10^(NF_dB/10);
// Equivalent noise temperature is giveb as
T_eq=290*(NF-1);
disp('K',T_eq,'Equivalent noise temperature is');
```

Scilab code Exa 20.7 example 7

```
clc;
// page no 761
// prob no 20.7
// refer prob no 20.5
d=38000;//distance of satellite from the Earth surface
P=50;//transmitter power
G=30;//antenna gain
f=12000;//frequency in MHz
B=10^6;// Bandwidth in MHz
//from problem no 2.5
G_T=21;
L_misc=0;
k_dBW=-228.6;//Boltzmann's constant in dBW
// There are no miscellaneous loss
//The stellite transmitting power in dBW is
```

```
Pt_dBW = 10*log10(P);
// The EIPR in dBW
EIRP_dBW=Pt_dBW + G;
//FSL in dB
FSL_dB= 32.44 + (20*log10(d)) + (20*log10(f));
// The carrier to noise ratio is
ratio=EIRP_dBW - FSL_dB - L_misc + G_T - k_dBW - 10*
    log10(B);
disp('dB',ratio,'The carrier to noise ratio at the
    receiver is');
```

Scilab code Exa 20.8 example 8

```
clc;
// page no 762
// prob no 20.8
D=40000;// distance of satellite from the earth
    station
v=3*10^8;// velo of light
d=80000;// distance between two earth stations
// time delay is given as
t=d/v;
// total time delay will be twice that of calculated
    above
T=2*t;
disp('sec',T,'The total time delay is ');
```

Scilab code Exa 20.9 example 9

```
clc;
// page no 769
// prob no 20.9
f_down = 4*10^9;// downlink freq
```

```
D=3;//diameter
n=0.55;//efficiency
c=3*10^8;//velo of light
// The gain of a parabolic antenna is given as G=(n*
    %pi^2*D^2)/wl^2. Therefore wavelength is given as
wl=c/f_down
G=(n*%pi^2*D^2)/wl^2;
G_dB = 10*log10(G);
disp('dB',G_dB,'The gain of TVRO is ');
// The beamwidth is given as
bw= (70*wl)/D;
disp('degree',bw,'The beamwidth is');
```

Chapter 21

Cellular Radio

Scilab code Exa 21.1 `example 1`

```
clc;
// page no 795
// prob no 21.1
v=100;//in km/hr
// first convert speed into m/sec
v1=(100*10^3)/3600;//in km/sec
//part a)
r=10^4;//in m
t=(2*r)/v1;
disp('sec',t,'Handoff time is');
//part b)
r=500;//in m
t=(2*r)/v1;
disp('sec',t,'Handoff time is');
```

Scilab code Exa 21.2 `example 2`

```
clc;
```

```
// page no 807
// prob no 21.2
N=12; m=120;
a=20000;
th=30;//in min/day this means
H=0.5;
tp=10;
//part a)Calculation of the average and peak traffic
    in erlangs for the whole system
// The average traffic is
T=a*H/24;
disp('E',T,'a) The average traffic is');
// The peak traffic is
T1=(a*tp)/60;
disp('E',T1,'The peak traffic is');
//part b)Calculation of the average and peak traffic
    in erlangs for one cell
// The average traffic per cell is
t=T/m;
disp('E',T,'b) The average traffic per cell is');
// The peak traffic per cell is
t=T1/m;
disp('E',T1,'The peak traffic per cell is');
// part c)
// For average traffic at 3.47E, the blocking
   probability is much less than 1%, since the
   average no of call is much less than the no of
   channels. However, the blocking probability
   increases to just over 5%
```

Scilab code Exa 21.3 `example 3`

```
clc;
// page no 816
// prob no 21.3
```

```
tg=123*10^-6;
c=3*10^8;
//The maximum distance between base and mobile is
d=c*tg;
disp('m',d,'The maximum distance between base and
   mobile is');
```

Chapter 22

Personal Communication Systems

Scilab code Exa 22.1 `example 1`

```
clc;
// page no 842
// prob no 22.1
PR = -100;//In dBm
// The mobile transmitted power is
PT_dBm =-76-PR;//this is in dBm
disp('or','dBm',PT_dBm,'The mobile transmitted power
    in dBm is');
PT_mW =10^(PT_dBm/10);
disp('mW',PT_mW,'The mobile transmitted power is');
```

Chapter 23

Paging and Wireless Data Networking

Scilab code Exa 23.1 example 1

```
clc;
// page no 863
// prob no 23.1
bit_rate = 512;//ib bps
t=60;//in sec
// preamble uses 576 bits
preamble=576;
bits_total = bit_rate * t;;
usable_bits = bits_total - preamble;
// each batch has one 32-bits synchronizing codeword
    and sixteen 32-bit address codewords for a total
    of 17*32=544 bits. Therefore
bits_per_batch= 17*32;
batches_per_min = usable_bits / bits_per_batch;
addr=16;
addr_per_min = batches_per_min*addr;
disp(addr_per_min,'The no of pages transmitted in
   one min are');
```

Scilab code Exa 23.2 example 2

```
clc;
// page no 864
// prob no 23.2
// For the given FLEX system
Wc=25*10^3;
bit_rate = 6400;//in bps
efficiency = bit_rate/Wc;
disp('b/s/Hz',efficiency,'The efficiency is');
```

Scilab code Exa 23.3 example 3

```
clc;
// page no 871
// prob no 23.3
// for the Bluetooth system
fh_max=1/(625*10^-6);
fh_min=1/(5*625*10^-6);
disp('Hz',fh_min,'The minimum hopping rate is','Hz',
   fh_max,'The maximum hopping rate is ');
```

Chapter 24

Fiber Optics

Scilab code Exa 24.3 example 1

```
clc;
// page no 888
// prob no 24.3
NA=0.15;
wl=820*10^-9;//in m
d_core=2*(0.383*wl/NA);
disp('m',d_core,'The core diameter is');
```

Scilab code Exa 24.4 example 2

```
clc;
// page no 890
// prob no 24.4
Bl=500;//in MHz-km
B=85;//in MHz
// By using Bandwidth-distance product formula
l=Bl/B;
disp('km',l,'The maximun distance that can be use
   between repeaters is');
```

Scilab code Exa 24.5 example 3

```
clc;
// page no 891
// prob no 24.5
wl0=1310;//in ns
So=0.05;//in ps/(nm^2*km)
l=50;//in km
wl=1550;//in ns
d=2;//in nm
// Chromatic dispersion is given as
Dc=(So/4)*[wl-(wl0^4/wl^3)];
// Dispersion is
D=Dc*d;
// Therefore total dispersion is
dt=D*l;
disp('ps',dt,'The total dispersion is');
```

Scilab code Exa 24.6 example 6

```
clc;
// page no 893
// prob no 24.6
//Refer problem 24.5
dt=949*10^-12;//in sed
l=50;//in km
B=1/(2*dt);
//By using Bandwidth-distance product formula
Bl= B*l;
disp('Hz-km',Bl,'The bandwidth distance product is')
    ;
```

Scilab code Exa 24.7 example 5

```
clc;
// page no 899
// prob no 24.7
// refer table from the problem page no 899
P_coupling1 =-3; P_coupling2 = -6; P_coupling3 =-40;
   // in dB
//Part a) The proportion of input power emerging at
   port 2
P2_Pin=10^(P_coupling1/10);
disp('%',P2_Pin*100,'a) The proportion of input
   power emerging at port 2');
P3_Pin=10^(P_coupling2/10);
disp('%',P3_Pin*100,' The proportion of input power
   emerging at port 3');
// Part b) In the reverse direction ,the signal is 40
   dB down for all combinations , so
directivity = 40;
disp('dB',directivity,'Directivity is');
Pin_total = P2_Pin + P3_Pin;
// excess loss in dB
loss=-10*log10(Pin_total);
disp('dB',loss,'the excess loss is');
```

Scilab code Exa 24.8 example 6

```
clc;
// page no 901
// prob no 24.8
wl=1*10^-6;
c= 3*10^8;
```

```
h=6.626*10^-34
f=c/wl;
E=h*f;// in Joule
//this energy can be converted into electron-volt.
   we know 1eV=1.6*10^-19 J
eV=1.6*10^-19 ;
E_ev=E/eV;
disp('eV',E_ev,'The energy of photon in eV is');
```

Scilab code Exa 24.9 example 9

```
clc;
// page no 909
// prob no 24_9
// refer fig 24.25
P_in=500;Responsivity=0.33;
I_d = P_in * Responsivity;
disp('nA',I_d,'The diode current is');
```

Chapter 25

Fiber Optic Systems

Scilab code Exa 25.1 example 1

```
clc;
// page no 919
// prob no 25_1
span_length=40;//in km
Pin_mW = 1.5;
signal_strength_dBm = -25; fiber_length = 2.5;//in km
loss_per_slice_dB=0.25;f_loss_dB_per_km =0.3;
loss_connector_dB=4;
Pin_dBm =10*log10(Pin_mW);
splices=span_length / fiber_length -1;
fiber_loss = span_length * f_loss_dB_per_km;
splice_loss = splices * loss_per_slice_dB;
T_loss = fiber_loss + splice_loss + loss_connector_dB;
P_out = Pin_dBm - T_loss;
sys_margin= P_out - signal_strength_dBm;
disp('dB',sys_margin,'The system margin is');
```

Scilab code Exa 25.2 example 2

```
clc;
// page no 921
// prob no 25_2
L=45;//in km
dt=100;//in ns
//The maximum permissible value for the pulse−spreading constant is
D=dt/L;
disp('ns/km',D,'The maximum permissible value for the pulse−spreading constant is');
```

Scilab code Exa 25.3 example 3

```
clc;
// page no 922
// prob no 25_3
L=45;
T_Rtx=50; T_Rrx=75; T_Rf=100;
T_RT=sqrt(T_Rtx^2 + T_Rrx^2 + T_Rf^2);
// a) for NRZ
fb=1/T_RT;
disp('GHz',fb,'a) The maximum bit rate for NRZ');
// b) for RZ
fb=1/(2*T_RT);
disp('GHz',fb,'b) The maximum bit rate for NRZ');
```

Scilab code Exa 25.4 example 4

```
clc;
// page no 924
// prob no 25_4
```

```
Bl=500;//in MHz-km
L=5;//in km
// using the bandwidth-distance product formula dispersion is given as
D=500/Bl;
disp('ns/km',D,'Dispersion is');
// Total rise time is given as
T_rt= D*L;
disp('ns',T_rt,'Total rise time is');
```

Scilab code Exa 25.5 example 5

```
clc;
// page no 924
// prob no 25_5
T_Rrx=3*10^-9;
T_Rtx=2*10^-9;
fb=100*10^6;//in bps
L=25;//in km
T_RT = 1/(2*fb)
// we have to compute rise time therefore
T_rf= sqrt(T_RT^2 - T_Rtx^2 - T_Rrx^2)
// dispersion per km is
D= T_rf/L;
disp('ns/km',D/10^-9,'The maximum acceptable dispersion is');
// using the bandwidth-distance product
Bl=500/D;
disp('MHz-km',Bl*10^-9,'The bandwidth-distance product is ');
```