Scilab Textbook Companion for Principles Of Electronic Communication Systems by L. E. Frenzel[1]

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May 23, 2016

[1]Funded by a grant from the National Mission on Education through ICT, http://spoken-tutorial.org/NMEICT-Intro. This Textbook Companion and Scilab codes written in it can be downloaded from the "Textbook Companion Project" section at the website http://scilab.in

Book Description

Title: Principles Of Electronic Communication Systems

Author: L. E. Frenzel

Publisher: Tata McGraw - Hill Education, New Delhi

Edition: 3

Year: 2008

ISBN: 0-07-066755-1

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 Electronic communication

Scilab code Exa 1.1.a Calculate the wavelength of given frequency

```
//Example 1-1 a, Page No - 14

clear
clc

c=300000000
f=150000000

wavelength = c/f

printf('Wavelength is %.3f meter',wavelength)
```

Scilab code Exa 1.1.b Calculate the Wavelength of given frequency

```
//Example 1-1 b, Page No - 14

```

```
clear
clc

c=300000000
f=430000000

wavelength = c/f

printf('Wavelength is %.3f meter',wavelength)
```

Scilab code Exa 1.1.c Calculate the Wavelength of given frequency

```
//Example 1-1 c, Page No - 14

clear
clc

c=300000000
f=8000000

wavelength = c/f

printf('Wavelength is %.3f meter',wavelength)
```

Scilab code Exa 1.1.d Calculate the wavelength of given frequency

```
//Example 1-1 d, Page No - 14

clear
clc

c=300000000
f=750000
```

```
wavelength = c/f

printf('Wavelength is %.3f meter',wavelength)
```

Scilab code Exa 1.2 Calculate the frequency of the signal with given wavelength

```
//Example 1-2, Page No - 15

clear
clc

c=300000000
wavelength=1.5

frequency=c/wavelength

printf('Signal frequncy is %.3f Megahertz',frequency
    /1000000)
```

Scilab code Exa 1.3 Calculate the frequency of the signal

```
//Example 1-3, Page No - 15

clear
clc

wavelength_feet=75
wavelength_meter= 75/3.28
c=300000000

frequency=c/wavelength_meter
```

```

printf('The signal frequncy is %.3f Megahertz',
    frequency/1000000)
```

Scilab code Exa 1.4 Calculate the frequency of the electromagnetic wave

```
//Example 1-4, Page No - 15

clear
clc

wavelength_inches=8
wavelength_meter=  8/39.37
c=300000000

frequency= c/wavelength_meter

printf('\nThe signal freuency is %.3f Megahertz',
    frequency/1000000)
printf('\nThe signnalfrequency is %.3f Gegahertz',
    frequency/1000000000)
```

Scilab code Exa 1.5 Calculate the bandwidth

```
//Example 1-5, Page No - 18

clear
clc

f1=902000000
f2=928000000

bandwidth=f2-f1
```

```
printf('Width of the band is %d Megahertz',bandwidth
    /1000000)
```

Scilab code Exa 1.6 Calculate the upper frequency limit from bandwidth

```
//Example 1-6, Page No - 19

clear
clc

bandwidth_megahertz= 6
f1_megahertz=54
f2_megahertz=f1_megahertz + bandwidth_megahertz

printf('Upper frequency limit is %.3f Megahertz',
    f2_megahertz)
```

Chapter 2

The Fundamentals of Electronics A Review

Scilab code Exa 2.1 Calculate the voltage gain of the amplifier

```
clc
clear
vout=750*10^-3
vin = 30*10^-6
gain=vout/vin
printf('The Voltage gain of the amplifier is %.1f',
   gain)
```

Scilab code Exa 2.2 Calculate the input power given to the amplifier

```
//
clear
clc

pout=6
power_gain=80
```

```

pin=pout/power_gain

printf('The input power of the sigmal is %.1f mW',
   pin*1000)
```

Scilab code Exa 2.3 Calculate the output power of the three cascaded amplifier

```
clc;
clear;
A1=5;
A2=2;
A3=17;
total_gain=A1*A2*A3;
pin= 40*10^-3;
pout=total_gain*pin;
printf('The output power is %.1f watts',pout);
```

Scilab code Exa 2.4 Calculate gain of the second stage of two cascaded amplifiers

```
clc;
clear;
pin=25*10^-6;
pout=1.5*10^-3;
A1=3;
total_gain=pout/pin;
printf('\nTotal gain is %.1f',total_gain);
A2=total_gain/A1;
printf('\nThe gain of second stage is %.1f',A2);
```

Scilab code Exa 2.5.a Calculate the attenuation

```
clc;
clear;
R1=10*10^3;
R2=470;
attenuation=R2/(R2+R1);
printf('The attenuation is %.3f',attenuation);
```

Scilab code Exa 2.5.b Calculate amplifier gain need to offset the loss for an overall gain of 1

```
clc;
clear;
A1=0.045;
AT=1;
A2=AT/A1;
printf('\nThe amplifier gain need to offset the loss
    for overall gain of 1 is %.1f',A2);
```

Scilab code Exa 2.6 Calculate the attenuation factor for the amplifier

```
clc;
clear;
Vin=20*10^-6;
Vout=100*10^-3;
A1=45000;//A1 isAmplifier gain
AT=Vout/Vin;//AT is Total gain
printf('\nTotal gain is %.3f',AT);
```

```
A2=AT/A1;//A2 is attenuation factor
printf('\nThe atenuation factor needed to to keep
   the output \nvoltage from exceeding 100 mv is %.4
   f',A2);
```

Scilab code Exa 2.7.a Calculate the gain of amplifier

```
//Example 2-7 a, Page No.36

clear
clc

Vin=3*10^-3
Vout=5

gain_dB= 20*log10 (Vout/Vin)

printf('The gain of amplifier in dB is %.1f',gain_dB
   )
```

Scilab code Exa 2.7.b Calculate attenuation of the filter

```
//Example 2-7 b, Page No.36

clear
clc

pin_mW = 50
pout_mW = 2

gain_dB= 10*log10(pout_mW/pin_mW)

```

```
printf('The gain/attenuation of the amplifier is %.2
   f',gain_dB)
```

Scilab code Exa 2.8 Calculate the input power given to amplifier

```
//Example 2-8, Page No- 38

clear
clc

gain_dB = 40
pout_W= 100

pin_W = pout_W/10^4

printf('The input power is %.2f watt',pin_W);
```

Scilab code Exa 2.9 Calculate the output voltage of the amplifier

```
//Example 2-9, Page No- 38

clear
clc

gain_db = 60
vin = 50*10^-6

vout = 10^(60/20)*vin

printf('The output voltage is %.2f volt',vout);
```

Scilab code Exa 2.10 Calculate the power gain for the power amplifier

```
//Example 2-10. Page No - 39

clear
clc

vin=90*10^-3
R1= 10*10^3
vout=7.8
Rout=8

pin= vin^2/R1
pout=vout^2/Rout

Ap_db = 10*log10 (pout/pin)

printf('The power gain in decibel is %.1f dB',Ap_db)
```

Scilab code Exa 2.11 Calculate the output power of the amplifier

```
//Example 2-11, Page No - 40

clear
clc

gain_db = 28
pin = 36*10^-3

pout = 10^2.8*pin;

printf('The output power is %.2f watt',pout)
```

Scilab code Exa 2.12 Calculate the input voltage given to the circuit consisting of two amplifiers

```
//Example 2-12, Page No - 40

clear
clc

gain1 = 6.8
gain2 = 14.3
attenuation1 = -16.4
attenuation2 = -2.9
vout = 800*10^-3

At = gain1+gain2+attenuation1+attenuation2
vin = vout/10^(At/20)

printf('The input voltage is %.1f mV',vin*10^3)
```

Scilab code Exa 2.13 Calculate the power in watts

```
//Example 2-13, Page No - 40

clear
clc

pout_db =12.3

pout_mW = 0.001*10^(12.3/10)

printf('The output power is %.1f mW',pout_mW*10^3)
```

Scilab code Exa 2.14 Calculate the resonant frequency of the circuit

```
//Example 2-14, Page No - 46

clear
clc

c = 2.7*10^-12
l = 33*10^-9

fr= 1/(6.28*(l*c)^0.5)

printf('The resonat frequency is %.1f Mhz',fr/10^6)
```

Scilab code Exa 2.15 Calculate the value of inductor required for the resonance of the circuit

```
//Example 2-15, Page No - 47

clear
clc

c =12*10^-12
fr = 49*10^6

l=1/(4*3.14^2*fr^2*c)

printf('The value of inductance is %.1f nH',l*10^9)
```

Scilab code Exa 2.16 Calculate the bandwidth of the resonant circuit

```
//Example 2-16, page No-49

clear
clc
```

```
fr=28*10^6
Q=70

bandwidth = fr/Q

printf('The bandwidth is %.3f Khz',bandwidth/10^3)
```

Scilab code Exa 2.17 Calculate the bandwidth resonant frequency and quality factor of the resonant circuit

```
//Example 2-17, Page No - 50

clear
clc

f1= 7.93*10^6
f2= 8.07*10^6

bw= f2-f1
fr=(f1*f2)^0.5
Q= fr/bw

printf('\n The bandwidth is %.1f Khz',bw/10^3)
printf('\n The resonant frequency is %.1f Mhz',fr
   /10^6)
printf('\n The Q of resonant circuit is %.2f',Q)
```

Scilab code Exa 2.18 Calculate the 3dB down frequencies for the resonant circuit

```
//Example 2-18, Page No - 50

```

```
clear
clc

Q=200
fr=16*10^6

bw=fr/Q
f1= fr-(bw/2)
f2=fr+(bw/2)

printf('The 3 db down frequencies of the resonant
    circuit are \nf1=%.2f Mhz\t f2=%.2f Mhz',f1/10^6,
    f2/10^6)
```

Scilab code Exa 2.19 Calculate the voltage across the capacitor of the resonant circuit

```
//Example 2-19, Page No - 52

clear
clc

Q= 150
Vs=3*10^-6

Vc= Q*Vs

printf('The voltage across capacitor is %.1f
    microvolt',Vc*10^6)
```

Scilab code Exa 2.20 Calculate the impedance of the parallel LC circuit

```
//Example 2-20, Page No - 54
```

```

clear
clc

fr= 52*10^6
Q=12
L=0.15*10^-6

Rw=(6.28*fr*L)/Q
Req= Rw*(Q^2+1)

printf('Impedance of the parellel LC circuit is %.1f
    ohm',Req)
```

Scilab code Exa 2.21 Calculate the impedance of the circuit

```
//Example 2-21, Page no - 54
clear
clc

fr= 52*10^6
Rw= 4.1
L =0.15*10^-6

Z = L/((1/(4*3.14^2*fr^2*L))*Rw)

printf('the impedance of the circuit is %.1f ohm',Z)
```

Scilab code Exa 2.22 Calculate the value of resistor required to set the bandwidth of a parallel tuned circuit to 1 Mhz

```
//Example 2-22, page no - 55

```

```
clear
clc

bw = 1*10^6
XL = 300
Rw = 10
fr =10*10^6

Q1 = XL/Rw
Rp = Rw*(Q1^2+1)

Q2 = fr/bw
Rpnew = Q2*XL

Rext = (Rpnew*Rp)/(Rp-Rpnew)

printf('The value of resistor needed to set the
    bandwidth of \nthe parellel tuned circuit to 1
    Mhz is %.1f ohm',Rext)
```

Scilab code Exa 2.23 Calculate the cutoff frequency of the single section RC low pass filter

```
//Example 2-23, Page No - 55

clear
clc

R = 8.2*10^3
C =0.0033*10^-6

fco = 1/(6.28* R*C)

printf('The cut off frequency is %.2f Khz',fco/10^3)
```

Scilab code Exa 2.24 Calculate the closest resistor value for the cutoff frequency

```
//Example 2-24, Page No - 57

clear
clc

fco =3.4*10^3
C = 0.047*10^-6
R = 1/(6.28* fco* C)

printf('The value of the resistor is %.1f ohm', R)
printf('\nThe closest standard value is 1000 ohm ')
```

Scilab code Exa 2.25 Calculate the value of the capacitor required in RC twin T notch filter

```
//Example 2-25, page no - 61

clear
clc

fnotch = 120
R = 220*10^3

C = 1/(6.28*R*fnotch)

printf('The value of capacitance required is %.3f
   microfarad',2*C*10^6)
```

Scilab code Exa 2.26 Calculate the frequency and rms value of the fifth harmonic of the square wave

```
//Example 2-26,Page No - 82

clear
clc

Vpeak =3
f=48*10^3

fifth_harmonic = 5*f
Vrms=(4/3.14)*(3/5)*0.707

printf('The frequency of the fifth harmonic is %.1f
    Khz',fifth_harmonic/10^3)
printf('\n The RMS voltage of the fifth harmonic is
    %.2f',Vrms)
```

Scilab code Exa 2.27 Calculate the average dc value signal and the minimum bandwidth necessary to pass signal without excessive distortion

```
//Example 2-27, page No - 87

clear
clc

Vpeak = 5
f = 4*10^6
duty_cycle=0.3

T = 1/f
```

```
t0 = duty_cycle*T
Vavg = Vpeak*duty_cycle
min_bw =1/t0

printf('The average DC value is %.1f volt',Vavg)
printf('\n The minimum bandwidth required is %.3f
    Mhz',min_bw/10^6)
```

Scilab code Exa 2.28 Calculate the bandwidth required to pass the pulse train

```
//Example 2-28, Page No - 88

clear
clc

tr =6*10^-9

min_bw=(35/0.006)

printf('The minimum bandwidth is %.1f Mhz',min_bw
    /10^2)
```

Scilab code Exa 2.29 Calculate the fastest rise time that can passed by the circuit

```
//Example 2-29, Page No - 89

clear
clc

bw= 200*10^3

```

```
tr= 0.35/(bw*10^-3)

printf('The fastest rise time of the circuit is %.2f
    microseconds',tr*10^3)
```

Scilab code Exa 2.30 Calculate the rise time of the displayed square wave

```
//Example 2-30, Page no - 90

clear
clc

bw_mhz = 60
tri_ns= 15

tra_osci = 0.35/(bw_mhz)
tra_comp = 1.1*(tri_ns^2 + (tra_osci*10^3)^2)^0.5

printf('The rise time of the displayed square wave
   is %.1f ns',tra_comp)
```

Chapter 3

Amplitude Modulation Fundamentals

Scilab code Exa 3.1 Calculate modulation index Vc and Vm for the AM signal

```
//Example 3-1, Page No - 99

clear
clc

Vmax = 5.9
Vmin = 1.2

m = (Vmax-Vmin)/(Vmax+Vmin)
Vc = (Vmax+Vmin)/2
Vm = (Vmax-Vmin)/2

m = Vm/Vc
printf('The modulation index is %.3f',m)
printf('\n Vc=%.1f\tVm=%.1f (for 2 volt/div on
    verticle scale) ',Vc,Vm)
```

Scilab code Exa 3.2 Calculate the frequencies of the lower and upper sideband of the standard AM broadcast station and also calculate bandwidth

```
//Example 3-2 ,Page No - 102

clear
clc

frq =980*10^3
frq_range = 5*10^3

fusb = frq+frq_range
flsb = frq-frq_range
bw=fusb-flsb

printf('The upper sideband is at %.1f Khz\n Lower
   sideband is at %.1f Khz\n and the babdwidth is %
   .1f Khz',fusb/10^3,flsb/10^3,bw/10^3)
```

Scilab code Exa 3.3 Calculate the total power and power in one sideband

```
//Example 3-3, Page No - 106

clear
clc

Pc = 30
m=0.85

Pt = Pc*(1+ (m^2/2))

Psb_both =Pt-Pc
```

```
Psb_one = Psb_both/2

printf('The total power is %.1f watt \n The power in
    one sideband is %.1f watt',Pt,Psb_one)
```

Scilab code Exa 3.4 Calculate the carrier power total powerand sideband power

```
//Example 3-4, Page No - 108

clear
clc

R = 40
I = 4.8
m=0.9

Pc = I^2*R
Pt = (I*(1+(m^2/2))^0.5)^2*R
Psb = Pt-Pc

printf('The carrier power is %.1f watt\n Total power
    = %.1f watt\n Sideband Power =%.1f watt',Pc,Pt,
   Psb)
```

Scilab code Exa 3.5 Calculate the percentage of modulation

```
//Example 3-5, Page No - 108

clear
clc

It = 5.1
```

```
Ic =4.8

m=(2*((It/Ic)^2-1))^0.5

printf('The percentage of modulation is %.1f',m*100)
```

Scilab code Exa 3.6 Calculate the power in one sideband of the transmitter

```
// Example 3-6, Page No - 109

clear
clc

m = 0.9
Pc = 921.6

Psb = (m^2*Pc)/4

printf('The power in one sideband %.1f watt ',Psb)
```

Scilab code Exa 3.7 Calculate the Peak Envelop Power for the SSB transmitter

```
//Example 3-7,Page No- 113

clear
clc

Vpp = 178
R = 75

Vp =Vpp/2
```

```
Vrms = 0.707*Vp
PEP =(Vrms^2/R)

printf('The peak envelop power is %0.1f watt', PEP)
```

Scilab code Exa 3.8 Calculate the Peak Envelope Power and average power of the transmitter

```
//Example 3-8,Page No - 113

clear
clc

Vs =24
Im =9.3

PEP = Vs*Im
Pavg1 = PEP/3
Pavg2 = PEP/4

printf('The peak envelope power is %.1f watt\n
    Average power of transmitter is %.1f watt to %.1f
     watt',PEP,Pavg2,Pavg1)
```

Chapter 4

Amplitude Modulator and Demodulator circuits

Scilab code Exa 4.1 Calculate the RF input power AF powe carrier output power Power in one sideband maximum and minimum dc supply voltage swing

```
//Example 4-1, Page No - 129

clear
clc

Vcc =48
I = 3.5
effi_percent=70
modulation_percent= 67
m = modulation_percent/100

Pi = Vcc*I
Pc=Pi
Pm = Pi/2
Pout = (effi_percent*Pi)/100
Ps = Pc*((m^2)/4)
max_swing = 2*Vcc
```

```

printf('The input power is %.1f watt \n AF power required for the 100 percent modulation is %.1f watt \n The carrier output power is %.1f watt\n', Pi,Pm,Pout)
printf('The power in one sideband %.2f watt \n Maximum swing = %.1f volt\n Minimum swing =0.0 volt',Ps,max_swing)
```

Scilab code Exa 4.2 Calculate the upper and lower sideband ranges of the SSB transmitter and center frequency of a bandpass filter

```
//Example 4-2,Page NO - 145

clear
clc

fc =4.2*10^6
voice_f_l = 300
voice_f_u = 3400

fll_usb = fc + voice_f_l
ful_usb = fc + voice_f_u

fll_lsb = fc - voice_f_l
ful_lsb = fc - voice_f_u

flsb = (fll_lsb + ful_lsb)/2

printf('The range for USB is %.1f Hz to %.1f Hz', fll_usb,ful_usb)
printf('\n The range for LSB is %.1f Hz to %.1f Hz', fll_lsb,ful_lsb)
printf('\n The approximate center frequency of the filter \n to select the lower sideband is %.1f Hz
```

```
',flsb)
```

Chapter 5

Fundamentals of Frequency Modulation

Scilab code Exa 5.1 Calculate the maximum and minimum frequencies that occur during modulation

```
//Example 5-1   Page No - 153

clear
clc

f = 915*10^6
fm_deviation =12.5*10^3

max_deviation = f + fm_deviation
min_deviation = f - fm_deviation

printf('Maximum frequency occur during modulation is
    %.1f Khz',max_deviation/1000)
printf('\n Minimum frequency occur during modulation
    is %.1f Khz',min_deviation/1000)
```

Scilab code Exa 5.2 Calculate the deviation of TV sound

```
//Example 5-2, Page No - 160

clear
clc

max_deviation = 25*10^3
fm =15*10^3

mf =max_deviation/fm

printf('The deviation ratio of the TV sound is %.3f'
    ,mf)
```

Scilab code Exa 5.3 Calculate the maximum modulating frequency

```
//Example 5-3, Page No - 162

clear
clc

mf = 2.2
fd = 7.48*10^3

fm = fd/mf

printf('The maximum modulating frequency is %.1f Khz
    ',fm/1000)
```

Scilab code Exa 5.4 Sate the amplitudes of the carrier and four sidebands of FM signal

```
//Example 5-4, Page No - 164

clear
clc

J0 = -0.4
J1 = -0.07
J2 = 0.36
J3 = 0.43
J4 = 0.28

printf('The amplitude of the carrier is %.1f',J0)
printf('\n Amplitudes of the first four sidebands
    are \n%.2f\t %.2f\t %.2f\t %.2f',J1,J2,J3,J4)
```

Scilab code Exa 5.5 Calculate the bandwidth of the FM signal

```
//Example 5-5, page No - 165

clear
clc

fd = 30*10^3
fm = 5*10^3
N=9


bw1 = 2*fm*N
bw2 = 2*[fd+fm]

printf('The maximum bandwidth of the fm signal
    calculated from fig 5.8 is %.1f Khz',bw1/10^3)
printf('\n The maximum bandwidth using carlos rule
    is %.1f khz',bw2/10^3)
```

Scilab code Exa 5.6 Calculate the frequency deviation caused by the noise and improved output signal to noise ratio

```
//Example 5-6, Page No - 167

clear
clc

S_N = 2.8
fm = 1.5*10^3
fd =4*10^3

fi= asin(1/S_N)
delta = fi*fm
SN =fd/delta

printf('The frequency deviation caused by the noise
   %.3f Hz',delta)
printf('\n The improved output signal to noise ratio
     is %.1f ',SN)
```

Chapter 6

FM circuits

Scilab code Exa 6.1 Calculate the value of the inductor required to resonate the circuit

```
//Example 6-1, Page No - 178

clear
clc

Vc =40*10^-12
c = 20*10^-12
f0 = 5.5*10^6
Ct = Vc+c

L = 1/((6.28*f0)^2*Ct)

printf('The value of the inductance is %.2f
   microhenry',L*10^6)
```

Scilab code Exa 6.2 Calculate the frequency of the carrier crystal oscillator and the phase shift require to produce the necessary deviation

```
//Example 6-2, Page No - 186

clear
clc

f=168.96*10^6
multiplier=24
deviation = 5*10^3
fm = 2.8*10^3
f0 =f/multiplier
fd= deviation/multiplier

phaseshift = fd/fm
phaseshift_degrees = phaseshift*57.3
total_phaseshift =2*phaseshift_degrees

printf('The crystal oscillator frequency is %.2f Mhz
   ',f0/10^6)
printf('\n The total phase shift is %.3f degrees',
   total_phaseshift)
```

Scilab code Exa 6.3 Calculate two capacitance values require to achieve the total deviation for the FM transmitter

```
//Example 6-3, Page No - 187

clear
clc

R =1*10^3
phaseshift =4.263
phaseshift_center= 45
f =7.04*10^6

phase_l = phaseshift_center - phaseshift
```

```
phase_u = phaseshift_center + phaseshift
phaserange_total = phase_u - phase_l

Xc1 = 1161
C1 = 1/(6.28*f*Xc1)
Xc2 = 861
C2 = 1/(6.28*f*Xc2)

printf('The two values of the capacitance to achieve
    total \ndeviation are %.2f to %.2f picofarad',C1
    *10^12,C2*10^12)
```

Chapter 7

Digital Communication Techniques

Scilab code Exa 7.1 Calculate the signal frequency fourth harmonic and minimum sampling frequency

```
//Example 7-1, Page No - 210

clear
clc

t = 71.4*10^-6

f = 1/t
fourth_harmonic = f*4
min_sampling = 2*fourth_harmonic

printf('The frequency of the signal is %.1f Khz',f
   /10^3)
printf('\n The fourth harmonic is %.1f Khz ',
   fourth_harmonic/10^3)
printf('\n Minimum sampling rate is %.1f khz',
   min_sampling/10^3)
```

Scilab code Exa 7.2 Calculate the number of discrete levels represented by the ADC Number of voltage increments used to divide the voltage range and the resolution of the digitization

```
//Example 7-2, Page no - 222

clear
clc

N = 14
discrete_levels = 2^N
num_vltg_inc =2^N-1
resolution = 12/discrete_levels

printf('The numbedr of discrete levels that are
   represented \n using N number of bits are %d',
   discrete_levels)
printf('\n the number odf voltage increments
   required to divide \n the voltage range are %d',
   num_vltg_inc)
printf('\n Resolution of the digitization %.1f
   microvolt',resolution*10^6)
```

Scilab code Exa 7.3 Calculate the SINAD and ENOB

```
//Example 7-3, Page No - 225

clear
clc

N =12
SINAD1=78
```

```
SINAD2 = 6.02*N + 1.76
ENOB =(SINAD1 -1.76)/6.02

printf('The SINAD for 12 bit convertre is %d dB',SINAD2)
printf('\n The ENOB for the converter with SINAD of 78 dB is %.2f bits',ENOB)
```

Scilab code Exa 7.4 Calculate the output voltage and gain of the compander

```
//Example 7-4,Page No - 233

clear
clc

Vm = 1
Vin = 0.25
mu =255

Vout = (Vm*log(1+mu*(Vin/Vm)))/log(1+mu)
gain =Vout/Vin

printf('The output voltage of the compander %.2f volt',Vout)
printf('\n Gain of the compander is %d',gain)
```

Scilab code Exa 7.5 Calculate the output voltage and gain of the compander

```
//Example 7-5, Page No - 234

clear
```

```
clc

Vin = 0.8
Vm =1
mu =255

Vout = (Vm*log(1+mu*(Vin/Vm)))/log(1+mu)
gain =Vout/Vin

printf('The output voltage of the compander %.2f
   volt',Vout)
printf('\n Gain of the compander is %.1f',gain)
```

Chapter 8

Radio Transmitters

Scilab code Exa 8.1 Calculate the maximum and the minimum frequencies of the crystal given the stability of the crystal

```
//Example 8-1, Page No - 249

clear
clc

f = 16*10^6
ppm = 200

frequency_variation = 200 *16

min_f = f - frequency_variation
max_f = f + frequency_variation

printf('The minimum and maximum frequencies for the
    crystal of \n 16 Mhz with stability of 200 are %d
     Hz and %d Hz respectively',min_f,max_f)
```

Scilab code Exa 8.2 Calculate output frequency of the transmitter and maximum and minimum frequencies that can be achieved by the transmitter

```
//Example 8-2, Page No - 250

clear
clc

f =14.9*10^6
mul_factor = 2*3*3
stability_ppm =300
variation = 0.0003
total_variation = variation* mul_factor

fout = f * mul_factor
frequency_variation = fout*total_variation

f_lower = fout - frequency_variation
f_upper = fout + frequency_variation

printf('The output frequency of the transmitter is %
    .1f Mhz',fout/10^6)
printf('\n The maximum and minimum frequencies of
    the transmitter are \n %.2f Mhz and %.2f Mhz ',
    f_lower/10^6,f_upper/10^6)
```

Scilab code Exa 8.3 Calculate the output frequency of the synthesizer

```
//Example 8-3, Page No - 259

clear
clc

f = 10*10^6
div_factor = 100
```

```
A =63
N = 285
M=32

ref = f/div_factor
R =M*N+A
fout= R*ref

printf('The output frequency of the synthesizer is %
    .1 f Mhz',fout/10^6)
```

Scilab code Exa 8.4 Find that step change in theoutput frequency of the synthesizer is equal to the phase detector reference range

```
//Example 8-4, Page No - 259

clear
clc

f = 10*10^6
div_factor = 100
A =64
N = 285
M=32

ref = f/div_factor
R =M*N+A
fout= R*ref

printf('The output frequency of the synthesizer is %
    .1 f Mhz',fout/10^6)
printf('\n The step change is %.1 f Mhz ',fout
    /10^6-918.3)
```

Chapter 9

Communication Receivers

Scilab code Exa 9.1 Calculate the local oscillator tuning range the frequency of the second local oscillator and first IF image frequency range of the Superheterodyne receiver

```
//Example 9-1,Page No - 318

clear
clc

fl =220*10^6
fm =224*10^6
IF1 = 10.7*10^6
IF = 1.5*10^6

IF2 =IF1+IF
tune_l =fl+IF1
tune_m = fm+IF1

IF1_imgl = tune_l+IF1
IF2_imgm = tune_m+IF1

printf('The local oscillatior tuning range is %.1f
   to %.1f Mhz',tune_l/10^6,tune_m/10^6)
```

```
printf('\n Frequency of the second local oscillator
    is %.1f Mhz',IF2/10^6)
printf('\n First IF image range is %.1fto %.1f Mhz',
    IF1_imgl/10^6,IF2_imgm/10^6)
```

Scilab code Exa 9.2 Calculate the open circuit noise voltage

```
//Example 9-2,Page No - 324

clear
clc

R = 100*10^3
T = 273+25
B = 20*10^3
k = 1.38*10^-23

Vn=(4*k*T*B*R)^0.5

printf('The noise voltage across 100k resistor is %
    .2f microvolt',Vn*10^6)
```

Scilab code Exa 9.3 What is the input thermal noise voltage of a receiver

```
// Example 9-3, Page No - 324

clear
clc

R=75
B=6*10^6
T = 29+273
k =1.38*10^-23
```

```
Vn = (4*k*T*B*R)^0.5

printf('The input themal noise is %.2f microvolt',Vn
    *10^6)
```

Scilab code Exa 9.4 Calculate the average noise power of a device

```
//Example 9-4, Page No - 326

clear
clc

Tc=32.2
Tk=273+Tc
B =30*10^3
k =1.38*10^-23

Pn=k*Tk*B

printf('The average noise power is %.2f*10^-16 W',Pn
    *10^16)
```

Scilab code Exa 9.5 Calculate the noise factor and noise figure of the RF amplifier

```
//Example 9-5, page No- 329

clear
clc

SN_ip = 8
SN_op = 6

```

```
NR = SN_ip/SN_op
NF = 10*log10(NR)

printf('The noise factor is %.3f',NR)
printf('\n The noise figure is %.2f dB',NF)
```

Scilab code Exa 9.6 Calculate the input noise power the input signal power signal to noise ratio in decibels for receiver and noise factor signal to noise ratio and noise temperature for the amplifier

```
//Example 9-6,Page No- 330

clear
clc

R= 75
T=31+273
k=1.38*106-23
B=6*10^6
Vs = 8.3*10^-6
NF=2.8

Vn = (4*k*T*B*R)^0.5
Pn = Vn^2/R
Ps = Vs^2/R
SN = (Ps*10^12)/(Pn/10^12)

SN_dB =10*log10(SN)
NR = 10^0.28
SN_op = SN/NR

Tn = 290*(NR-1)

printf('The input noise power is %.1f pW',Pn/10^12)
printf('\n The input signal power is %.3f pW',Ps
```

```
*10^12)
printf('\n Signal to noise ratio in decibels %f',SN)
printf('\n The noise factor is %.1f',NR)
printf('\n Signal to noise ratio of the amplifier is %f',SN_op)
printf('\n The noise temperature of the amplifier %.1f K',Tn)
```

Chapter 10

Multiplexing and Demultiplexing

Scilab code Exa 10.1 Calculate the number of cahnnels carried by the cable TV service

```
//Example 10-1,Page No - 368

clear
clc

BW_service = 860*10^6
BW_ch = 6*10^6

total_ch = BW_service/BW_ch

printf('Total number of channels are %d',total_ch)
```

Scilab code Exa 10.2 Calculate the number of available data channels number of bits per frame serial data rate for the PCM system

```
//Example 10-2, Page No -380

clear
clc

channels =16
sampling_rate= 3.5*10^3
w_len=6

available_ch =channels-1
bpf =channels*w_len
data_rate = sampling_rate * bpf

printf('Available channels are %d',available_ch)
printf('\n Bits Per Frame =%d',bpf)
printf('\n The serial data rate %.1f Khz',data_rate
    /10^3)
```

Chapter 11

The Transmission of Binary data in Communication Systems

Scilab code Exa 11.1 Calculate the time required to transmit single word single bit and speed of transmission for the serially transmitted data

```
//Example 11-1,Page No-392

clear
clc

t=0.0016
No_words=256
bits_word = 12

tword= t/No_words
tbit = tword/bits_word
bps =1/tbit

printf('The time duration of the word %.1f
    microsecond',tword*10^8)
printf('\n The time duration of the one bit is %.4f
```

```
    microseconds',tbit*10^8)
printf('\n The speed of transmission is %.1f kbps',
    bps/10^5)
```

Scilab code Exa 11.2 Calculate the maximum theoretical data rate the maximum theoretical channel capacity and the number coding levels required to achieve the maximum speed

```
//Example 11-2, Page no - 400

clear
clc

B=12.5*10^3
SN_dB= 25

C_th = 2*B
SN=316.2
C =B*3.32*log10(SN+1)
N= 2^(C/(2*B))

printf('The maximum theorotical data rate is %.1f
    kbps',C_th/10^3)
printf('\n  The maximum theorotical capacity of
    channel is %.1f Kbps',C/10^3)
printf('\n The number of levels needed to acheive
    maximum speed are %d',N)
```

Scilab code Exa 11.3 Calculate the average number of errors that can be expected in the transmission

```
//Example 11-3,Page no - 430

```

```
clear
clc

block =512
packets =8
BER = 2*10^-4

avg_errors = block*packets*8*BER

printf('Average number of errors are %.4f',
   avg_errors)
```

Chapter 12

Introduction to Networking and Local Area Network

Scilab code Exa 12.1 Calculate the number of interconnecting wires required to communicate with each PC in the office

```
//Example 12-1, page No - 448

clear
clc

N = 20

L = (N*(N-1))/2

printf('The number of interconnecting wires required
    are %d',L)
```

Scilab code Exa 12.2 Calculate the time required for the transmission of data on Ethernet packet and Token ring packet

```
//Example 12-2, Page No - 474

clear
clc

block = 1500
ethernet = 10*10^6
token_ring = 16*10^6

t1_bit = 1/ethernet
t1_byte = 8*t1_bit
t1_1526 = 1526 *t1_byte
t2_bit = 1/token_ring
t2_byte = 8 * t2_bit
t2_1521 =1521*t2_byte

printf('Time required for the ethernet with the
    speed of 10Mbps is %.3f ns',t1_1526*10^6)
printf('\n Time required for the token ring format
    with the speed of 16 Mbps is %.3f ns',t2_1521
    *10^6)
```

Chapter 13

Transmission Lines

Scilab code Exa 13.1 1 Calculate the length of the cable considered to be a transmission line

```
//Example 13-1, Page No- 483

clear
clc

f= 450*10^6
lamda = 984/f
len =0.1*lamda

printf('%.3f feet long conductors would be
    considered as the transmission line ',len*10^6)
```

Scilab code Exa 13.2 Calculate the physical length of the transmission line

```
//Example 13-2, Page No- 484

```

```
clear
clc

lamda = 2.19
len = (3/8)*lamda

printf('The pyhsical length of the transmission line
    %.2f feet',len)
```

Scilab code Exa 13.3 Calculate the total attenuation and output power of the antenna

```
//Example 13-3, Page No - 492

clear
clc

len = 165
attn_100ft = 5.3
pin = 100
attn_ft = 5.3/100

total_attn = attn_ft * len
pout = pin *0.1335

printf('The total attenuation of the cable is %.3f
  dB',total_attn)
printf('\n Output power is %.2f W',pout)
```

Scilab code Exa 13.4 Calculate the load impedance equivalent inductance time delay phase shift and total attenuation of the cable

```
//Example 13-4, Page No- 494
```

```

clear
clc

len =150
C =13.5
Z0 =93
f =2.5*10^6
attn_100ft =2.8

L =C*Z0^2
td =(L*C)^0.5
theta = ((360)*188.3)/(1/f)
attn_ft = attn_100ft/100
total_attn = attn_ft*150

printf('The load impedance required to terminate the the line\n to avoid the reflections is %d ohm',Z0)
printf('\n The equivalent inductance per feet is %.2f nH',L/10^3)
printf('\n The time delay introduced by the cable per feet is %.3f ns',td/10^3)
printf('\n The phase shift occurs in degrees for the 2.5 Mhz sine wave is %.2f',theta/10^9)
printf('\n The total attenuation is %.1f dB',total_attn)
```

Scilab code Exa 13.5 Calculate the SWR reflection coefficient and value of resistive load

```
//Example 13-5,Page No - 501

clear
clc
```

```
vmax= 52
vmin= 17
Z0 = 75

SWR = vmax/vmin
ref_coeff = (vmax-vmin)/(vmax+vmin)
Zl1 = Z0*SWR
Zl2 = Z0/SWR

printf('The standing wave ratio is %.2f',SWR)
printf('\n Reflection coefficient is %.2f',ref_coeff
    )
printf('\n The value of resistive load is %.2f or %
    .2f ohm',Zl1,Zl2)
```

Scilab code Exa 13.6 Calculate the output power of the cable

```
//Example 13-6,Page No- 503

clear
clc

SWR =3.05
ref_pwr =0.2562
pin =30

pout = pin -(pin*((SWR-1)/(SWR+1))^2)

printf('The output power of the cable is %.3f W',
    pout)
```

Scilab code Exa 13.7 Calculate the characteristics impedance of the microstrip transmission line and the reactance of the capacitor

```
//Example 13-7,Page no - 508

clear
clc

C =4*10^-12
f =800*10^6
diele = 3.5
h = 0.0625
w = 0.13
t = 0.002

Z0 = 38.8*log(0.374/0.106)
Xc = 1/(6.28*f*C)

printf('The charecteristics impedance of the
   transmission line is %.1f ohm',Z0)
printf('\n The reactance of the capacitor is %.2f
   ohm',Xc)
```

Scilab code Exa 13.8 Calculate the length of the transmission line

```
//Example 13-8, Page No - 508

clear
clc

lamda = (984/800)
lamda_8 =lamda/8

len = lamda_8*12*(1/3.6^0.5)

```

```
printf('The length of the transmission line is %.4f'
    ,len)
```

Chapter 14

Antennas and Wave Propagation

Scilab code Exa 14.1 Calculate the length and radiation resistance for different antennas

```
//Example 14-1, page No - 544

clear
clc

f=310*10^6

len1 =(492*0.97)/f
len2 =(492/f)*0.8
len3 =(984/f)*0.73
z1 =120*log(35/2)
len4 =234/f
z2  = 73/2

printf('The length and radiation resistance of the
    dipole \n are %.2f feet and 73 ohm respectively',
    len1*10^6)
printf('\n\nThe length of the folded dipole are %.2f
```

```
    feet ',len2*10^6)
printf('\n\nThe length and radiation resistance of
   the bow tie antenna \n are %.1f feet and %.1f ohm
    respectively',len3*10^6,z1)
printf('\n\nThe length and radiation resistance of
   the groun plane antenna \n are %.3f feet and %.1f
    ohmrespectively',len4*10^6,z2)
```

Scilab code Exa 14.2 Calculate the transmission line loss and effective radiated power

```
//Example 14-2,page No - 553

clear
clc

gain=14
len=250
attn_100=3.6
f =220*10
pin =50
p =0.126

pout =pin*p
line_loss =pin-pout
pwr_ratio = 25.1
ERP = pwr_ratio*pout
printf('The transmission line loss is %.2f',
   line_loss)
printf('\n\nEffective raduated power is %.1f W',ERP)
```

Scilab code Exa 14.3 Calculate the length of the impedance matching section

```
//Example 14-3, Page No - 556

clear
clc

Z0 =50
Zl =172
f =460*10^6
VF =0.86

len =(246/f)*VF
printf('The length of the impedance matching section
    \n needed for the Q section is %.2f feet',len
   *10^6)
```

Scilab code Exa 14.4 Calculate the length of the impedance matching section

```
//Example 14-4,Page No - 557

clear
clc

f = 460*10^6
VF = 0.66
len = (246/f)*VF

printf('The length of impedance matching section is
   %.3f feet',len*10^6)
```

Scilab code Exa 14.5 Calculate the maximum transmitting distance and received power at that distance

```
//Example 14-5,Page No - 567

clear
clc

ht =275
hr =60
f=224*10^6
pt=100
Gt = 26
Gr = 3.27

D =((2*ht)^0.5+(2*hr)^0.5)*1.61
lamda = 300/f
Pr = (pt*Gt*Gr*lamda^2)/(16*3.14^2*D^2)
printf('The maximmum transmitting distance is %.1f
    kilometer',D)
printf('\n\n The received power is %.1f nW',Pr
    *10^15)
```

Chapter 16

Microwave Communication

Scilab code Exa 16.1 Calculate the required impedance of the microstrip and its length

```
//Example 16-1, Page No - 616

clear
clc

Zsrc =50
Zld  =136
f =5800*10^6
Er =2.4
Zq =(Zsrc * Zld)^0.5
Vp =1/(Er)^0.5
lamda = 300/f
len = (lamda/4)*38.37*Vp

printf('The required impedance is %.2f ohm',Zq)
printf('\n\n The length of the microstrip %.2f inches',len*10^6)
```

Scilab code Exa 16.2 Calculate the cutoff frequency and operating frequency of the rectangular waveguide

```
//Example 16-2,Page No-623

clear
clc

w=0.65
h=0.38

fco = 300/(2*((0.65*2.54)/100))
f =1.42*fco

printf('The cutoff frequency of the %.3f Ghz',fco
    /10^3)
printf('\n\n Operating frequency of the wavwguide is
     %.2f Ghz',f/10^3)
```

Scilab code Exa 16.3 Criterion for the operation of rectangular waveguide in the C band

```
//Example 16-3,Page No- 623

clear
clc

printf('The c band is approximately 4 to 6 Ghz since
     a waveguide \n acts as a high pass filter with
    cut off frequency of \n 9.08 Ghz it will not pass
     c band signal')
```

Scilab code Exa 16.4 Calculate the lowest possible operating frequency gain and beam width for the parabolic reflector

```
//Example 16-4, page No - 648

clear
clc

lamda1 =5
f2 = 15*10^9
D=1.524

f1=984/lamda1
lamda2 =300/f2
G = (6*(D/lamda2)^2)
B = 70/(D/lamda2)

printf('The lowest possible oprerating frequency is
    %.1f Mhz ',f1)
printf('\n\n The gain at 15 Ghz is %.1f ',G/10^12)
printf('\n\n The beam width at 15Ghz is %.2f degree'
    ,B*10^6)
```

Scilab code Exa 16.5 Calculate line of sight distance to aircraft and the altitude of the aircraft

```
//Example 16-5,Page No - 661

clear
clc

T = 9.2
theta = 20
sin20 = 0.342

```

```
D_nautical = T/12.36
D_statute =D_nautical*0.87
A = D_statute*0.342


printf('\nThe line of distance to the aircraft in \
   nthe statute miles %.3f ',D_statute)
printf('\n\nThe altitude of the aircraft is %.2f mi
   and in feet it is 1161.6',A)
```

Chapter 17

Satellite Communication

Scilab code Exa 17.1 Calculate the approximate azimuth and elevation setting of the antenna

```
//Example 17-1,Page no - 678

clear
clc

stn_long = 95
stn_lat = 30
sat_long =121
rad_pos = 137
printf('The elevation setting for the antenna is 45
   degre')
azimuth = 360-rad_pos
printf('\nThe azimuth setting for the antenna is %d
   degree',azimuth)
```

Scilab code Exa 17.2 Calculate the uplink frequency and the maximum theoretical data rate of satellite transponder

```
//Example 17-2,Page No -681

clear
clc

flo = 2*10^9
fd =3840*10^6
B =36*10^6

fu =fd+flo
C =2*B

printf('The uplink frequency is %.2f Ghz',fu/10^9)
printf('\n\nThe data rate is %d Mbps', C/10^6)
```

Scilab code Exa 17.3 Calculate local oscillator frequency to achieve the desired IF

```
//Example 17-3,Page No - 691

clear
clc

fs = 4.08*10^9
fIF1 = 770*10^6
fIF2 = 140*10^6

flo1 = fs - fIF1
flo2 = fIF1 - fIF2

printf('The local oscillator frequency for first IF
    is %.1f Mhz',flo1/10^6)
printf('\n\n The local oscillator frequency for the
    second IF is %.1f Mhz',flo2/10^6)
```

Chapter 19

Optical Communication

Scilab code Exa 19.1 Calculate the critical angle of the fiber optic cable

```
//Example 19-1,page No - 760

clear
clc

NA = 0.29
critical_angle = sin (0.29)

printf('The critical angle is %.2f degree',
   critical_angle*(180/3.14))
```

Scilab code Exa 19.2 Calculate the bandwidth of the cable

```
//Example 19-2,Page No - 767

clear
clc

```

```
B_rating_Mhzkm =600*10^6
len_ft=500

bandwidth = B_rating_Mhzkm/(len_ft/3274)

printf('The bandwidth of the 500 feetr segment of
    the ccable is %.1f Mhz',bandwidth/10^6)
```

Scilab code Exa 19.3 Calculate the dispersion factor of the fiber optic cable

```
//Example 19-3,Page No - 780

clear
clc

R=43*10^6
D=1200/3274

d=1/(5*R*D)

printf('The dispersion factor is %.1f ns/km',d*10^9)
```