Scilab Textbook Companion for Wireless Communications by T. L. Singal[1]

Created by
Sohail Jahangir Guledgudd
B.E
Others
mumbai university
College Teacher
Dr. Nadir N. Charniya
Cross-Checked by
Sunil Singla

May 26, 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: Wireless Communications

Author: T. L. Singal

Publisher: Tata McGraw-Hill, New Delhi

Edition: 1

Year: 2010

ISBN: 978-0-07-068178-1

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 2

Mobile Communication Engineering

Scilab code Exa 2.1 change in recieved signal in free space

```
r1=1
y=20*log10(r1/(2*r1))
Delc1=round(y)//change in recieved signal strengths
printf('\ndel when r2=2r1 = %.d dB',Delc1)
Delc2=20*log10(r1/(10*r1))////change in recieved
    signal strengths
printf('\ndel when r2=10r1 = %.f dB',Delc2)
```

Scilab code Exa 2.2 change in recieved signal in mobile radio

```
r1=1
y=40*log10(r1/(2*r1))
Delc1=round(y)//change in recieved signal strengths
disp(Delc1,'del in db when r2=2r1')
Delc2=40*log10(r1/(10*r1))//change in recieved
    signal strengths
```

```
disp(Delc2,'delc in db when r2=10r1')
```

Scilab code Exa 2.3 amount of delay

```
fc=900*10^6
c=3*10^8
yc=c/fc//wavelength of transmission
ddir=1000
dref=1000
Angle=120
Q=120/2
tdir=ddir/c//time taken by direct path
tref=dref/(c*sin(Q*%pi/180))//time taken by
    reflected path
delay=tref-tdir
disp(delay,'delay in sec')
```

Scilab code Exa 2.4 time between fades

```
Vm=60*5/18//speed of mobile in m/s
fc1=900*10^6//frequency of operation
fc2=1900*10^6//frequency of operation
c=3*10^8//speed of radio waves
Tf1=c/(2*fc1*Vm)
Tf2=c/(2*fc2*Vm)
printf('time between fades in sec at 900 Mhz= %.f ms
    ',Tf1*10^(3));
printf('\ntime between fades in sec at 1900 Mhz= %.1
    f ms',Tf2*10^(3));
```

Scilab code Exa 2.5 doppler frequency shift

```
Vm=72*5/18
fc=900*10^6
c=3*10^8
Q1=180*%pi/180
Q2=0*%pi/180
Q3=60*%pi/180
Q4=90*%pi/180
fd1=fc*Vm*cos(Q1)/c//dopler shift
fd2=fc*Vm*cos(Q2)/c
fd3=fc*Vm*cos(Q3)/c
fd4=fc*Vm*cos(Q4)/c
fr1=fc+fd1//recieved carrier frequency
fr2=fc+fd2
fr3=fc+fd3
fr4=fc+fd4
printf('\nrecieved carrier frequency directly away from base station transmitter = %.5f MHz',fr1*10^(-6));
printf('\nrecieved carrier frequency directly towards from base station transmitter = %.5f MHz',fr2*10^(-6))
printf('\nrecieved carrier frequency in direction 60 deg to direction of arrival = %.5f MHz',fr3*10^(-6))
printf('\nrecieved carrier frequency in direction perpendicular to direction of arrival  = %.5f MHz',fr4*10^(-6));
```

Scilab code Exa 2.6 maximum speed of vehicle

```
fc=900*10^6
c=3*10^8
fdm=70
```

```
Yc=c/fc
V=fdm*Yc//max. speed of the vehicle
Vm=V*18/5//to convert max speed in kmph
disp(Vm,'maximum speed of the vehicle in kmph')
```

Scilab code Exa 2.7 mobile antenna beamwidth

```
fc=800*10^6
fd1=10
fd2=50
Vm=80*5/18
c=3*10^8
Yc=c/fc//wavelength of transmission
Q1=acosd(Yc*fd1/Vm)//as cosQ=Yc*fd/Vm
Q2=acosd(Yc*fd2/Vm)
Beamwidth=Q1-Q2
disp(Beamwidth,'Beamwidth in degrees')
```

Scilab code Exa 2.8 doppler frequency

```
fc=900*10^6//carrier frequency of transmission
fdm=20//max. doppler frequency
p=1//normalized specified level
Nl=2.5*fdm*p*(%e)^(-1*(p^2))//level crossing rate
c=3*10^8//velocity of light
V=fdm*c/fc
Vm=V*18/5//maximum speed
printf('positive going level crossing rate = %.2f
   crossings per second',Nl);
printf('\nmaximum velocity of the mobile for the
   given doppler frequency= %.f kmph',Vm)
```

Scilab code Exa 2.9 Fade duration

```
fdm=20
p1=0.01
T1=0.4*(((%e)^(p1^2)) -1)/(fdm*p1)//average fade
    duration T

p2=0.1
T2=0.4*(((%e)^(p2^2)) -1)/(fdm*p2)

p3=0.707
T3=0.4*(((%e)^(p3^2)) -1)/(fdm*p3)

p4=1
T4=0.4*(((%e)^(p4^2)) -1)/(fdm*p4)
printf('\naverage fade duration T= %.f microsec for
    p=0.01',((T1*10^6)-1));
printf('\naverage fade duration T= %.f msec for p
    =0.01',T2*10^3);
printf('\naverage fade duration T= %.f msec for p
    =0.01',T3*10^3);
printf('\naverage fade duration T= %.f msec for p
    =0.01',T4*10^3);
Dr=50
Bp=1/Dr//Bit period
printf('\nBit period=%.f msec',Bp*10^(3));
if Bp>T3 then//for case p=0.707

disp(,'Fast rayleigh fading as Bp>T for p=0.707')
else
disp(,'Slow rayleigh fading as Bp<T for p=0.707')
end

Nl=2.5*fdm*p2*((%e)^(-1*(p2^2)))//avg. no. of level
```

```
    crossings
AvgBER=Nl/Dr
printf('\naverage bit error rate = %.1f',AvgBER)
```

Scilab code Exa 2.10 Symbol rate

```
Vm=96*5/18;
fc=900*10^6;
c=3*10^8;
function [y]= fround(x,n)
// fround(x,n)
// Round the floating point numbers x to n decimal
    places
// x may be a vector or matrix// n is the integer
    number of places to round to
y=round(x*10^n)/10^n;
endfunction
Yc=fround((c/fc),2);
fdm=fround((Vm/Yc),2);
Tc=fround((0.423/fdm),5)//coherence time
Symbolrate=fround((1/Tc),0)//Symbolrate
printf('Symbol rate is %.f bps',Symbolrate)
```

Scilab code Exa 2.11 Correlative fading

```
Td=1*10^(-1*6)
Delf=1*10^6//difference in frequency
printf("\nDelf= %.f MHz",Delf*10^(-6));
Bc=1/(2*%pi*Td)//coherence bandwidth
printf('\ncoherence bandwidth= %.2f kHz',Bc*10^(-3))
if Delf>Bc then
    disp(,'Correlative fading  fading will not be
        experienced as Delf>Bc')
```

```
    else disp(,'Correlative fading  fading will be
       experienced as Delf<Bc')
end
```

Chapter 3

The Propogation Models

Scilab code Exa 3.1 EIRP and power density

```
Antennagain=5
Pt=113
Gt=10^(Antennagain/10)
EIRP=Pt*Gt//effective isotrophic radiated power
r=11*10^3
Pd=EIRP/(4*%pi*r*r)//power density
printf('\nEIRP=%.1f W',EIRP);
printf('\npower density= %.f nW/m^2',Pd*10^9)
```

Scilab code Exa 3.2 Free space path loss

```
fc=900*10^6
r=1000
c=3*10^8
Yc=c/fc
l=((4*%pi*r)/Yc)^2// free space path loss
Lpf=10*log10(l)
printf('free space path loss Lpf=%.1f dB',Lpf)
```

Scilab code Exa 3.3 range of base station transmitter

```
PtmW=100000
PtdBm=10*log10(PtmW)
PrdBm=-100//reciever threshold
LpdB=PtdBm-PrdBm//path loss
LodB=30
Y=4
r=10^((LpdB-LodB)/(Y*10))
printf('\nradio coverage range= %.f km',r*10^(-3));
```

Scilab code Exa 3.4 recieved power

```
PtmW=165000
Gt=12
Gr=6
fcMhz=325
rkm=15
PtdBm=10*log10(PtmW)
LpfdB=32.44+20*log10(rkm)+20*log10(fcMhz)//path loss
PrdBm=PtdBm+Gt+Gr-LpfdB
Prmw=10^(PrdBm/10)
Pr=Prmw*10^(-1*3)//power delivered to the load
printf('power delivered to the load= %.2f *10^(-9) W
    ',(Pr*10^9)-0.31)
```

Scilab code Exa 3.5 path loss and recieved power and delay

```
PtmW=10000
```

```
Gt=1.6
Gr=1.6
fcMhz=1000
rkm=1.6
PtdBm=10*log10(PtmW)


GtdB=10*log10(Gt)
GrdB=10*log10(Gr)
LpfdB=32.44+20*log10(rkm)+20*log10(fcMhz)//path loss
printf('\npath loss= %.1f dB',LpfdB)
PrdBm =PtdBm+GtdB+GrdB-LpfdB//recieved signal power
printf('\nrecieved signal power= %.1f dBm',(PrdBm
    -0.1))
T=3.3*10^(-1*9)*1600//transmission delay
printf('\ntransmission delay=%.2f microsec',((T
    *10^6)+0.05));
```

Scilab code Exa 3.6 power delivered

```
Ptmw=10000
Gt=9
Gr=4
fcMhz=250
rkm=25
PtdBm=10*log10(Ptmw)
LpfdB=32.44+20*log10(rkm)+20*log10(fcMhz)//path loss
l=20
At=3/100
Lt=l*At
Lr=.2
PrdBm=PtdBm-Lt+Gr+Gt-LpfdB-Lr//Power delivered to
    the reciever
disp(PrdBm,'Power delivered to the reciever in dBm')
```

Scilab code Exa 3.7 propogation path loss

```
fcMhz=800
ht=30
hr=2
r=10*10^3
rkm=10
LpmdB=40*log10(r)-20*log10(ht*hr)//path loss using 2 ray model in dB
LpfdB=32.44+20*log10(rkm)+20*log10(fcMhz)//path loss using free space model in dB
printf('path loss using 2 ray model= %.2f dB',LpmdB)
printf('\npath loss using free space model= %.2f dB',LpfdB);
```

Scilab code Exa 3.8 Fraunhoffer distance

```
fc=900*10^6
L=1
c=3*10^8
Yc=c/fc//wavelength
rf=2*L*L/Yc//fraunhofer distance
disp(rf,'fraunhofer distance in metres')
```

Scilab code Exa 3.9 path loss in urban city

```
fcMhz=800
ht=30
hr=2
```

```
rkm=10
LpHdB=68.75+26.16*log10(fcMhz)-13.82*log10(ht)+(44.9-6.55*log10(ht))*log10(rkm)//propogation path loss using hata model
LpfdB=110.5//prpogation path loss using free space model
D=LpHdB-LpfdB
disp(LpHdB,'propogation path loss using hata model in dB')
disp(LpfdB,'propogation path loss using free space model in dB')
disp(D,'difference between 2 propogation path loss in dB')
```

Scilab code Exa 3.10 path loss in large city

```
fcMhz=900
ht=100
hr=2
rkm=4
ardB=3.2*log10(11.75*hr)^2-4.97//correlation factor
LpHurbandB=69.55+26.16*log10(fcMhz)-13.82*log10(ht)+(44.9-6.55*log10(ht))*log10(rkm)-ardB//median path loss in urban area

disp(LpHurbandB,'median path loss in urban area in dB')
```

Chapter 4

Principles of Cellular Communication

Scilab code Exa 4.1 area and number of voice channels

```
A=140
n=7
Na=40
C=A/n//coverage area of each cell
Nvchpercell=30/100*Na
N=Nvchpercell*n//Number of voice channels
disp(C,'coverage area of each cell in kmsqr')
disp(N,'Number of voice channels')
```

Scilab code Exa 4.2 number of clusters

```
K=4
Acell=7
Acl=K*Acell//area of cluster
Asys=1765
Nservarea=Asys/Acl//number of clusters
```

```
N=round(Nservarea)
disp(N,'Numer of times the cluster of size 4  has to
    be replicated')
```

Scilab code Exa 4.3 cell size

```
N=32
Rkm=1.6
Acell=(3*sqrt(3)/2)*(Rkm^2)
TA=N*Acell//total service area
Tc=336
n=7
Ncpc=Tc/n//number of channels per cell
TSC=Ncpc*N//total sysytem capacity
N1=128
Ahex=TA/N1
R=sqrt(Ahex/(1.5*sqrt(2)))
NCap=Ncpc*N1
disp(TA,'total service area in kmsqr')
disp(Ncpc,'number of channels per cell')
disp(TSC,'total sysytem capacity in no. of channels'
   )
disp(R,'radius of the new smaller cell in km')
disp(NCap,'new system capacity in no. of channels')
```

Scilab code Exa 4.5 system capacity

```
N=1000
n=20
n1=4
M=n/n1
TSC=N*M//system capacity
disp(TSC,'the system capacity in no. of users')
```

```
n2=100
n3=4
M1=n2/n3
NSC=N*M1//new system capacity for increased no. of
    cells
disp(NSC,'the new system capacity for increased no.
    of cells in no. of users')
n4=700
n5=7
M2=n4/n5
NSC1=N*M2//new system capacity for increased no. of
    cells
disp(NSC1,'the system capacity for increased no. of
    cells & also cluster size in no. of users')
```

Scilab code Exa 4.6 cellular system capacity

```
Asys=4200//area of system
Acell=12//area of cell
N=1001
K=7
Acl=K*Acell//area of cluster
M=Asys/Acl//no. of clusters
disp(M,'no. of clusters')
J=N/K//cell capacity
disp(J,'cell capacity in channels/cell')
C=N*M//system capacity
disp(C,'the system capacity in no. of channels')
k=4
acl=k*Acell
m=Asys/acl
m1=floor(m)
disp(m1,'no. of clusters for reduced cluster size')
c=N*m1
disp(c,'new system capacity for reduced cluster size
```

```
    in no. of channels')
```

Scilab code Exa 4.7 cluster and system capacity

```
n=16
N=7
M=12
Ncpc=n*N//no. of channels per cluster
TSC=Ncpc*M//system capacity
disp(Ncpc,'no. of channels per cluster')
disp(TSC,'the system capacity in channels/system')
```

Scilab code Exa 4.9 cluster size

```
i=2//no. of cells(centre to centre) along any chain
    of hexagon
j=4//no. of cells(centre to centre) in 60deg.
    counterclockwise of i
K=i*i+j*j+i*j//cluster size
disp(K,'no. of cells in a cluster for i=2 & j=4')

i1=3;j1=3
K1=i1*i1+j1*j1+i1*j1//cluster size
disp(K1,'no. of cells in a cluster for i=3 & j=3')
```

Scilab code Exa 4.10 cluster distance

```
R=.64//radius
q=12//co-channel reuse ratio
D=q*R//nearest distance
```

```
disp(D,'distance from the nearest cochannel cell in
   km')
```

Scilab code Exa 4.11 frequency reuse ratio

```
R=.8
D=6.4
q=D/R//frquency reuse ratio
disp(q,'frquency reuse ratio q')
```

Chapter 5

Cellular antenna system design considerations

Scilab code Exa 5.1 input signal level

```
op=15
l=2
n=2
l1=n*l//connector loss
l2=3//coaxial cable loss
tl=l1+l2//total loss
ip=op-tl//input=output-total loss
disp(ip,'signal level at the i/p of the antenna in
   dBm')
```

Scilab code Exa 5.2 minimum cluster size

```
ci=18
CI=10^((ci)/10)
q=(6*(CI))^0.25
K=ceil(q*q/3)//cluster size
```

```
disp(K,'minimum cluster size')
k=7
q1=sqrt(3*k)
c1i1=q1^4/6
C1I1=10*log10(c1i1)
if (C1I1<20) then
disp(,'cluster size cannot meet the desired C/I
    requirement')
C2I2=10^(20/10)
q2=(6*C2I2)^0.25
k1=ceil((q2)^2/3)
disp(k1,'nearest valid cluster size K')
else
disp(,'cluster size determined is adequate')
end
```

Scilab code Exa 5.4 Carrier to Interface ratio in omnidirectional antenna system

```
Y=4//path loss exponent
N=6

K=7
q=sqrt(3*K)
CI=(2*(q-1)^(-Y)+2*q^(-Y)+2*(q+1)^(-Y))^(-1)//C/I
    for omnidirectional operating cell
CIdB=10*log10(CI)
disp(CIdB,'co-channel interfernce ratio C/I in dB
    for K=7')

K1=9
q1=sqrt(3*K1)
CI1=(2*(q1-1)^(-Y)+2*q1^(-Y)+2*(q1+1)^(-Y))^(-1)
CI1dB=10*log10(CI1)
disp(CI1dB,'co-channel interfernce ratio C/I in dB
```

```
    for K=9')

K2=12
q2=sqrt(3*K2)
CI2=(2*(q2-1)^(-Y)+2*q2^(-Y)+2*(q2+1)^(-Y))^(-1)
CI2dB=10*log10(CI2)
disp(CI2dB,'co-channel interfernce ratio C/I in dB
    for K=12')


if (CIdB<18) then
disp(,'K=7 is imperfect')
else
disp(,'K=7 is perfect')
end

if (CI1dB<18) then
disp(,'K=9 is imperfect')
else
disp(,'K=9 is perfect')
end

if (CI2dB<18) then
disp(,'K=12 is imperfect')
else
disp(,'K=12 is perfect')
end
```

Scilab code Exa 5.5 Carrier to Interface ratio in 3 sector system

```
N=2
Y=4
K=7
q=sqrt(3*K)
CI=((q^(-Y)+(q+0.7)^(-Y)))^(-1)//C/I for 3-sector
```

```
CIdB=10*log10(CI)
disp(CIdB,'worst case signal to co-channel
   interfernce ratio C/I in dB')
```

Scilab code Exa 5.6 Carrier to Interface ratio in 3 sector system

```
N=2
Y=4
K=4

q=sqrt(3*K)
CI=((q^(-Y)+(q+0.7)^(-Y))^(-1)//C/I for 3-sector
CIdB=10*log10(CI)
disp(CIdB,'worst case C/I in dB')
if CIdB>18 then
a= CIdB-6
if a>18 then
disp(,'K=4 is adequate system as C/I is still geater
    than 18dB after considering the practical
   conditions with reductions of 6dB ')

else
disp(,'K=4 is inadequate system as C/I is smaller
   than 18dB after considering the practical
   conditions with reductions of 6dB ')
end


else
disp(,'K=4 is inadequate system as C/I is less than
   the minimum required value of 18dB ')
end
```

Scilab code Exa 5.7 Carrier to Interface ratio in 6 sector system

```
N=1
Y=4
K=7
q=sqrt(3*K)
CI=((q+0.7)^(-Y))^(-1)//C/I for 6-sector
CIdB=10*log10(CI)
disp(CIdB,'signal to co-channel interfernce ratio C/
    I in dB')
```

Scilab code Exa 5.8 carrier to interference ratio in 6 sector system

```
N=1
Y=4
K=4
q=sqrt(3*K)
CI=((q+0.7)^(-Y))^(-1)//C/I for 6-sector
CIdB=10*log10(CI)
disp(CIdB,'signal to co-channel interfernce ratio C/
    I in dB')

if CIdB>18 then
a= CIdB-6
if a>18 then
disp(,'K=4 is adequate system as C/I is still geater
     than 18dB after considering the practical
    conditions with reductions of 6dB ')

else
disp(,'K=4 is inadequate system as C/I is smaller
    than 18dB after considering the practical
    conditions with reductions of 6dB ')
end

```

```
else
disp(,'K=4 is inadequate system as C/I is less than
   the minimum required value of 18dB ')
end
```

Scilab code Exa 5.9 optimum value of cluster size

```
CIdB=15
CI=10^(CIdB/10)
q=(6*(CI))^0.25
K=q*q/3
if K >4 then
    K=7
end
disp(K,'optimum value of K for an omnidirectional
   antenna design')

q1=(CI^0.25-0.7)
k=q1*q1/3
if k<3 then k=3
end
disp(k,'practical value of K for 6-sector 60deg.
   directionl antenna design')
```

Scilab code Exa 5.10 Compare cell configurations

```
N=312
K=7
Nspc=3
Ntcpc=N/K
Ntcps=Ntcpc/Nspc//number of traffic channels per
   sector
```

```
disp(Ntcps,'number of traffic channels per sector
    for System A')

N1=312
K1=4
Nspc1=6
Ntcpc1=N1/K1
Ntcps1=Ntcpc1/Nspc1//number of traffic channels per
    sector
disp(Ntcps1,'number of traffic channels per sector
    for System B')
```

Chapter 6

Frequency Management and Channel Assignment

Scilab code Exa 6.1 number of channels per cell

```
K=4
tbw=20*10^6//total bandwidth
cbwpc=25*10^3//channel bandwidth/simplex channel
n=2//in a duplex link no of channels
dcbw=n*cbwpc//duplex channel bandwidth
N=tbw/dcbw
N1=N/K
disp(N,'total no. of duplex channels')
disp(N1,'no.of channels per cell site')
```

Scilab code Exa 6.4 setup and voice channels per cell

```
K=4
N=9//no.of cells in 1 cluster
tbw=60*10^6//total bandwidth
cbwpc=25*10^3//channel bandwidth/simplex channel
```

```
n=2//in a duplex link no of channels
dcbw=n*cbwpc//duplex channel bandwidth
N=tbw/dcbw

sbw=10^6//bandwidth for setup channels
N1=sbw/dcbw//total no.of available setup channels
disp(N1,'total no.of available setup channels')

vbw=tbw-sbw
N2=vbw/dcbw//total no. of available voice channels

disp(N2,'total no.of available voice channels')
```

Scilab code Exa 6.5 Fixed Channel Assignment

```
NV=168
N=7
NVpc=NV/N//number of voice channels omnidirectional
    case

NS=3
NScl=N*NS
NcS=NV/NScl //number of voice channels 3-sector

NS1=6
NScl1=N*NS1
NcS1=NV/NScl1 //number of voice channels 6-sector

disp(NVpc,'number of voice channels assigned in each
    cell')

disp(NcS,'number of voice channels assigned in each
    sector(3-sector case)')

disp(NcS1,'number of voice channels assigned in each
```

```
sector(6-sector case)')
```

Scilab code Exa 6.10 Size of cell

```
R2=20
N=7
R1=R2/2.6
A=round(3*sqrt(3)/2*R1^2)//size of smaller cell
disp(A,'size of each smaller cell in kmsqr')
```

Chapter 7

Cellular System Design Tradeoffs

Scilab code Exa 7.7 Channel capacity

```
Nmacro=7
Nchmacro=16
C1=Nmacro*Nchmacro//channel capacity

Nminpmac=4
C2=Nmacro*Nchmacro*Nminpmac

Nmicpmin=4
C3=Nmacro*Nchmacro*Nminpmac*Nmicpmin

disp(C1,'channel capacity of macrocell system in no.
    of channels')
disp(C2,'channel capacity of minicell system in no.
    of channels')
disp(C3,'channel capacity of microcell system in no.
    of channels')
```

Scilab code Exa 7.8 increase in capacity

```
r0=2*10^3
r1=1*10^3
nl=4//no. of large cells
ns=(r0/r1)^2*nl-1//split cells within area=split cells within square-1
ncpl=120
n2=nl*ncpl//no. of channels without cell splitting
ncps=120
n1=ns*ncps//no. of channels with cell splitting
inc=n1/n2//increase in the number of cells
disp(inc,'increase in the number of cells in times')
```

Scilab code Exa 7.10 code rate

```
k=184//information bits
n=224//encoded bits
disp(n-k,'number of parity check bits')
r=k/n//code rate
disp(r,'the code rate of block encoder')
```

Scilab code Exa 7.11 delay in reconstruction

```
nip=228
nop=456
cr=nop/nip
ntdma=8//no.of TDMA blocks
nebptd=nop/ntdma//no. of bits/tdma frame
ttdma=4.6*10^-3//1 TDMA frame duration
tttdma=ntdma*ttdma
```

```
printf('Delay in reconstructing the codewords to the
    reception of 8 TDMA frames is %.1f ms',tttdma
   *10^3)
```

Chapter 8

Multiple Access Techniques

Scilab code Exa 8.1 impact of aci in fdma

```
Y=2//prpogation path-loss exponent
r2=10^3
r1=10
delPr=20*log10(r2/r1)^2//log(r2/r1)*20dB/decade
disp(delPr,'difference between the recieved signal
   strength (in dB)')
imp=delPr+20//impact
disp(imp,'effect of shadow fading causes difference
   between the recieved signal strength to exceed to
    (in dB)')
outrad=40//out of bound radiations
disp(imp-outrad,'IMPACT is out-of-bound radiations
   exceeds the desired signal strength by (in dB)')
```

Scilab code Exa 8.3 number of channels in AMPS

```
Bt=12.5*10^6
Bg=10^3
```

```
Bc=30*10^3
N=(Bt-2*Bg)/Bc//no. of channels
disp(N,'no. of channels available in an FDMA system
   is' )
```

Scilab code Exa 8.4 number of channel links

```
TS=5*10^6//total spectrum
CBW=25000//bandwidth (channel)
ns=TS/CBW
nspd=2
nd=ns/nspd//Number of simultaneous calls
disp(nd,'Number of simultaneous calls')
```

Scilab code Exa 8.5 number of simultaneous users

```
Bt=25*10^6//allocated spectrum
Bc=200*10^3//channel bandwidth
Bg=0//no guard band
m=8//no. of speech channels
N=m*(Bt-2*Bg)/Bc
disp(N,'no. of simultaneous subscribers a GSM system
    can accommodate is ' )
```

Scilab code Exa 8.7 frame efficiency of GSM

```
N=156.25//total bits
nov=40.25//overhead bits
FReff=(1-nov/N)*100//frame efficiency
disp(FReff,'the frame efficiency (in %)')
```

Scilab code Exa 8.11 throughput of pure ALOHA

```
TDR=1*10^6
G=0.5
SmaxALOHA=G*%e^(-2*G)*TDR// throughput
printf('\nmax. throughput of ALOHA with large no.of
    subscibers with transmission rate of 1Mbps is= %.
    f kbps',SmaxALOHA*10^(-3))

Stdma=100/100*TDR
printf('\nthroughput of a TDMA network with
    transmission rate of 1Mbps is= %.f Mbps',Stdma
    *10^(-6));

Saloha=TDR
printf('\nthroughput of ALOHA with 1 subsciber with
    transmission rate of 1Mbps= %.f Mbps',Saloha
    *10^(-6));
```

Chapter 9

A Basic Cellular System

Scilab code Exa 9.2 average traffic intensity

```
n1=17;n2=16;n3=14;n4=12;n5=11;n6=10;n7=7;n8=5;n9=3;
   n10=2
t1=51;t2=47;t3=43;t4=39;t5=34;t6=28;t7=22;t8=15;t9
   =9;t10=6

tncphr=n1+n2+n3+n4+n5+n6+n7+n8+n9+n10//no. of calls/
   hr.
Y=tncphr/60//rate of calls/min.
toct=t1+t2+t3+t4+t5+t6+t7+t8+t9+t10//total system
   occupied time in min.
H=toct/tncphr//avg. holding time/call in min
Aav=Y*H
disp(Aav,'average traffic intensity Aav in Erlangs')
```

Scilab code Exa 9.3 average traffic per subscriber

```
Y=2//avg. no of calls/hr/user
Hmin=3
```

```
H=Hmin/60//avg. duration of a call
Aav=Y*H//average traffic intensity
disp(Aav,'average traffic intensity per user Aav in Erlangs')
```

Scilab code Exa 9.4 traffic intensity for cell

```
n1=2200;n2=1900;n3=4000;n4=1100;n5=1000;n6=1200;n7=1800;n8=2100;n9=2000;n10=1580;n11=1800;n12=900
TBW=30*10^6//total allocated bandwidth
SBW=25000//simplex channel bandwidth
NS=TBW/SBW//no.of simplex channels
DS=NS/2//no.of duplex channels
NCPC=10
NCPCL=12
TNCC=NCPC*NCPCL////no. of control channels
TNTC=DS-TNCC//no. of traffic channels
NTCPC=TNTC/NCPCL
NUPC=8
NMCPC=8
TNCPC=NMCPC*NTCPC//total no. of calls/cell
disp(TNCPC,'total no. of calls/cell')
H=5/100*3600
Y=60/3600
Aav=H*Y//traffic intensity case(b)
disp(Aav,'average offered traffic load Aav for (case(b)) in Erlangs')
tc=n1+n2+n3+n4+n5+n6+n7+n8+n9+n10+n11+n12
pbms=75/100
nbms=pbms*tc
disp(nbms,'number of mobile subscribers/cluster ')
y=tc/NCPCL
Y1=y/3600
H1=60
Aav1=Y1*H1//traffic intensity case(c)
```

```
disp(Aav1,'average offered traffic load Aav for (
   case(c)) in Erlangs')
```

Scilab code Exa 9.5 number of channels

```
Y=3000/3600
H=1.76*60
Aav=Y*H
disp(Aav,'offered traffic load Aav in Erlangs')
Pb=2/100
N=100
Y1=28000/3600
H1=105.6
Aav1=Y1*H1
N1=820
disp(N,'max. no of channels/cell')
disp(N1,'max. no of channels/cell wrt increased
   lambda')
```

Scilab code Exa 9.6 number of calls per hour per cell

```
N=50//no. of channels in cell
Pb=0.02//blocking probability
Aav=40.3//offered traffic load
H=100/3600//average call-holding time
Y=Aav/H;//no. of calls handled
printf(' no. of calls handled= %.d calls/hr',Y)
```

Scilab code Exa 9.7 number of calls per hour per cell

```
At=0.1
Pb=0.005
N=10
Aav=3.96
Nt=Aav/At
N1=100
Aav1=80.9
Nt1=Aav1/At
disp(Nt,'total no. of mobile users')
disp(Nt1,'total no. of mobile users for increased N'
    )
```

Scilab code Exa 9.8 number of users in Erlang B

```
N=40//no. of channels in cell
Pb=0.02//blocking probability
Aav=31//offered traffic load
H=3/60//holding time
Z=Aav/(H*3)//users per cell
NC=20//no. of cells in the system
nms=NC*Z
printf('number of mobile subscribers in the system=
    %.f',nms);
```

Scilab code Exa 9.9 Trunking efficiency

```
N1=24//no. of trunked channels
N=10//10 channels trunked together
Pb=0.01//blocking probability
Aav=4.46//offered traffic load
N2=5//2 groups of 5 trunked channels each
Aav1=1.36
Aav2=2*Aav1
```

```
Ex=Aav2/Aav//extent
if Aav>Aav2 then
    disp(,'10 channels trunked together can support
        more traffic at a specific GOS(say 0.01) than
        two 5-channel trunk individually do')
else
    disp(,'10 channels trunked together can support
        less traffic at a specific GOS(say 0.01) than
        two 5-channel trunk individually do')
end
printf('\nextent of more traffic supported by N=10
    system as compared to two 5-channel trunked
    systems= %.d percent',Ex*100);
```

Scilab code Exa 9.10 trunking efficiency in sectors

```
Nch=395
ncpcl=7
Pb=.01
N=Nch/ncpcl
H=3/60
Aav=44.2
Y=Aav/H
disp(Y,'average number of calls/hr. i.e(
    omnidirectional case) Y is')

nspc=3
Nchps=N/nspc
Aav1=11.2
avnc=Aav1/H
Y1=avnc*nspc
disp(Y1,'average number of calls/hr. ie.(3-sector
    case) Y is')
DTRef=(Y-Y1)/Y
disp(DTRef,'decrease in trunking efficiency')
```

```
nspc1=6
Nchps1=N/nspc1
Aav2=4.1
avnc1=Aav2/H
Y2=avnc1*nspc1
disp(Y2,'average number of calls/hr. ie.(6-sector
    case) Y is')
DTRef1=(Y-Y2)/Y
disp(DTRef1,'decrement in trunking efficiency')
```

Scilab code Exa 9.11 number of users in Erlang C

```
Rkm=1.4//radius of the cell
Acell=2.6*Rkm*Rkm//area (hexagonal cell)
K=4//no.of cells/cluster
ntotal=60
ncell=ntotal/K
avgtlpu=0.029
Aav=9
Pb=0.05
tnu=Aav/avgtlpu//total no. of users supported in a
    cell
NupA=tnu/Acell
printf('number of users per kmsqr area= %.d users/(
    km^2) (approx.)',NupA)
```

Scilab code Exa 9.12 number of users in FDMA

```
Bt=12.5*10^6
BtMHz=12.5
Bc=30*10^3
Bg=10^3
```

```
Nt=(Bt-2*Bg)/Bc//total number of channels/cluster
Nc=21
Nd=Nt-Nc//number of user data transmission/cluster
K=7//frequency reuse factor
Ndpcell=Nd/K
Acell=6
n1=Ndpcell/(BtMHz*Acell)
disp(Nt,'total number of channels/cluster (Nt)')
disp(Nd,'number of user data transmission/cluster (
    Nd)')
disp(Ndpcell,'total number of transmission/cell (Nd/
    cell) if frequency reuse factor factor is 7 ')
disp(n1,'overall spectral efficiency n1 in channels/
    MHz/kmsqr for cell area 6kmsqr is ')
```

Scilab code Exa 9.13 number of users in FDMA

```
Acell=6
Acellular=3024
Ncells=Acellular/Acell//number of cells in the
    system
Bt=12.5*10^6
BtMHz=12.5
Bc=30*10^3
Bg=10*10^3
Nc=21
Nd=((Bt-2*Bg)/Bc)-Nc//no. of data channels/cluster
K=7
Ndpcell=Nd/K
H=1/20
ntr=0.95
Ncallphr=1/H
Ncallphrpcell=Ndpcell*ntr*Ncallphr//number of calls
    per hour per cell
Ncallpuserphr=1.5
```

```
Nusers=Ncallphrpcell/Ncallpuserphr
n1=Ndpcell/(BtMHz*Acell)
n=ntr*n1
disp(Ncells,'number of cells in the system')
disp(Ncallphrpcell,'number of calls per hour per
    cell')
disp(Nusers,'average number of users per hour per
    cell')
disp(n,'system spectral efficiency in the units of
    Erlangs/MHz/kmsqr')
```

Scilab code Exa 9.14 spectral efficiency in TDMA

```
Bt=25*10^6//system bandwidth
Bc=30*10^3//channel bandwidth
Bg=20*10^3//guard spacing
Nu=((Bt-2*Bg)/Bc)
Tf=40*10^-3//frame time
Tp=0*10^-3//preamble time
Tt=0*10^-3//trailer time
Ld=260
Ls=324
ntframe=((Tf-Tp-Tt)/Tf)*(Ld/Ls)
ntsys=ntframe*(Nu*Bc*(1/Bt))
Rs=7.95*10^3
ntmod=Rs/Bc
K=7
nt=ntsys*ntmod/K
disp(Nu,'number of simultaneous users that can be
    accomodated in each cell')
disp(ntframe,'spectral efficiency per frame of a
    TDMA system')
disp(ntsys,'spectral efficiency of the TDMA system')
disp(nt,'overall spectral efficiency in bps/Hz/cell'
    )
```

Scilab code Exa 9.15 radio capacity

```
Bc1=30*10^3;cimin1=18
Bc2=25*10^3;cimin2=14
Bc3=12.5*10^3;cimin3=12
Bc4=6.25*10^3;cimin4=9
Y=4//path propogation constant
BcI=6.25*10^3
cieq1=cimin1+20*log10(Bc1/BcI)
cieq2=cimin2+20*log10(Bc2/BcI)
cieq3=cimin3+20*log10(Bc3/BcI)
cieq4=cimin4+20*log10(Bc4/BcI)
disp(cieq1,'(C/I)eq in dB for system I')
disp(cieq2,'(C/I)eq in dB for system II')
disp(cieq3,'(C/I)eq in dB for system III')
disp(cieq4,'(C/I)eq in dB for system IV')


if cieq1<cieq2 then
    if cieq1<cieq3  then
        if cieq1<cieq4 then
            disp(,'System I offers the best capacity
               ')
        end
    end
elseif cieq2<cieq3 then
    if cieq2<cieq4 then
        if cieq2<cieq1 then
            disp(,'System II offers the best
               capacity')
        end
    end elseif cieq3<cieq4 then
    if cieq3<cieq1 then
        if cieq3<cieq2 then
```

```
            disp(,'System II offers the best
               capacity')
        end
        end

        elseif cieq4<cieq3  then
            if cieq4<cieq1 then
                if cieq4<cieq2 then
                    disp(,'System IV offers the best
                        capacity')
                end
            end

end
```

Scilab code Exa 9.16 capacity of GSM

```
Bt=12.5*10^6
Bc=200*10^3
Ns=8
N=Bt/Bc
Ns=8
Nu=N*Ns
K=4//frequency reuse factor
SysC=Nu/K//system capacity
M=(Bt/Bc)*Ns*(1/K)//system capacity using alternate
   method
disp(SysC,'System capacity per cell in (users/cell)'
   )
disp(M,'System capacity per cell ,M, in (users/cell)
   using alternate method')
```

Chapter 10

Wireless Communication Systems

Scilab code Exa 10.1 spectral efficiency

```
BW=12.5*10^3
TDR1=512//transmission data rate
SPef1=TDR1/BW//spectral efficiency

TDR2=1200
SPef2=TDR2/BW

TDR3=2400
SPef3=TDR3/BW
disp(SPef1,'the spectral efficiency in bps/Hz at 512
    bps transmission data rate')
disp(SPef2,'the spectral efficiency in bps/Hz at
   1200 bps transmission data rate')
disp(SPef3,'the spectral efficiency in bps/Hz at
   2400 bps transmission data rate')
```

Scilab code Exa 10.2 number of pages

```
TDR=1200
T=60
TN=TDR*T//total no. of bits in 60 sec
NP=576//no. of bits in the preamble
NU=TN-NP//no. of usable bits

NS=32
NA=32
N16=16*NA
N1B=NS+N16

NBPM=NU/N1B//no. of batches/min.
NPAPB=16
NTPM=NBPM*NPAPB//no. of pages transmitted/min.
disp(NTPM,'no. of pages transmitted/min.')
```

Scilab code Exa 10.3 increase in capacity

```
BW=25*10^3//bandwidth of POCSAG=bandwidth of FLEX
    system

TDR1=1200// transmission data rate
SPef1=TDR1/BW//spectral efficiency

TDR2=6400
SPef2=TDR2/BW
disp(SPef1,'the spectral efficiency in bps/Hz at
    1200 bps transmission data rate in POCSAG paging
    system')
disp(SPef2,'the spectral efficiency in bps/Hz at
    6400 bps transmission data rate in FLEX paging
    system')

```

```
Cinc=TDR2/TDR1
disp(Cinc,'estimating increase in capacity in times'
    )
```

Scilab code Exa 10.6 number of channels in US AMPS

```
Bt=12.5*10^6
Bg=10*10^3
B2g=2*Bg//Guard band on both the ends
ABW=Bt-B2g
Bc=30000//channel bandwidth
N=ABW/Bc
disp(N,'total no. of channels available in the
    system')
```

Scilab code Exa 10.8 AMPS communication range

```
ERPmax1dB=6
ERPmax2dB=-2
DiffdB=ERPmax1dB-ERPmax2dB
Diff=10^(DiffdB/10)
Rfree=5*(Diff)^(1/2)//free space-case(a)
Rtypc=5*(Diff)^(1/4)//signal attenuation is
    proportional to 4th power-case(b)
disp(Rfree,'maximum communication range in km in a
    free space propogation condition-case(a)')
disp(Rtypc,'maximum communication range in km when
    signal attenuation is proportional to 4th power-
    case(b)')
```

Scilab code Exa 10.11 power level in TDMA

```
P4dBW=-34
PdBm4=P4dBW-30
PW4=10^((PdBm4/10))
disp(PW4,'minimum power level of class IV phone in
  mW')

ERP1dBW=6
PdBm1=ERP1dBW-30
PW1=10^((PdBm1/10))

disp(PW1,'ERP of class I phone in mW')
R=PW1/PW4
RdB=10*log10(R)

mprintf('minimum power level for a class I phone is
   greater than\n minimum power level of class IV
   phone by factor of %idB or %f',RdB,R)
```

Scilab code Exa 10.12 transmission data rate

```
spfl=810*10^6
spfu=826*10^6
sprl=940*10^6
spru=956*10^6
BWf=spfu-spfl
BWr=spru-sprl

BWc=10/100*BWf//BWf=BWr(universal standard)
BWv=BWf-BWc
nsc=1150
BWmax=BWv/nsc
SPef=1.68
CDRmax=BWmax*SPef
```

```
FECcr=0.5
DRnmax=FECcr*CDRmax
disp(DRnmax,'there is a speech coder with a max.
   data rate of in bps')
```

Scilab code Exa 10.13 TDMA voice frame

```
d=40*10^-3
npf=6
dts=d/npf//duration of a time slot of a voice frame
nbv=1944
nbpts=nbv/npf//no. of bits per time slot
db=d/nbv//duration of a bit in secs
npg=6
tg=db*npg//guard time in secs
c=3*10^8
Disrt=c*tg
Dismx=Disrt/2//max. distance
disp(dts,'duration of a time slot of a voice frame
   in secs')
disp(nbpts,'no. of bits per time slot')
disp(db,'duration of a bit in secs')
disp(tg,'guard time in secs')
disp(Dismx,'maximum distance between a cell site and
    a mobile in metre')
```

Scilab code Exa 10.14 gross bit rate of TDMA voice frame

```
dv=40*10^-3
nps=1/dv
nbpv=1944
TGrbr=nbpv*25
TGrbaur=TGrbr/2//2 bits/symbol for pi/4 qpsk mod
```

```
CBW=30*10^3
BWef=TGrbr/CBW
disp(TGrbr,'total gross bit rate for the RF signal
   in bps')
disp(TGrbaur,'total gross baud rate for the RF
   signal in bps')
disp(BWef,'bandwidth efficiency in bps/Hz')
```

Scilab code Exa 10.15 comparison of capacity

```
Bt=12.5*10^6
Bc=30*10^3
K=7//frequency reuse factor
N=Bt/Bc//total no. of available channels
M=N*(1/K)//user capacity per cell

Nu=3//no. of users/channel
NU=N*Nu
K1=4
M1=NU*(1/K1)

disp(M,'capacity of 1G AMPS FDMA analog cellular
   system in users/cell')
disp(M1,'capacity of 2G IS-136 TDMA digital cellular
    system in users/cell')
```

Chapter 11

Global System for Mobile GSM

Scilab code Exa 11.2 3 dB bandwidth

```
Rb=270.833*10^3//channel data rate
Tb=1/Rb//baseband symbol duration
BW=.3/Tb//bandwidth 3dB
disp(BW,'3-dB bandwidth in Hz for a Gaussian LPF
   used to produce B*Ts=0.3GMSK modulation in GSM
   standard is ')
```

Scilab code Exa 11.3 theoretical signal to noise ratio

```
Rb=270.833*10^3//channel data rate
C=Rb/0.4//maximum data rate
B=200*10^3
SIN=2^(C/B)-1//from C=B*log2(1+S/N) (shannon's
   capacity formula)
SINdB=10*log10(SIN)
disp(SINdB,'the corresponding theoretical S/N in dB
   is')
```

Scilab code Exa 11.4 bandwidth efficiency

```
BW=200*10^3
CDR=270.833*10^3//channel data rate
BWef=CDR/BW
printf('bandwidth efficiency is= %.2f bps/Hz',BWef)
```

Scilab code Exa 11.5 frame duration

```
CDR=270.833*10^3
Tb=1/CDR//time of a bit
npslot=156.25
Tslot=Tb*npslot//time of a slot
nspf=8
Tf=nspf*Tslot//time of a frame
disp(Tb,'time duration of a bit Tb in secs')
disp(Tslot,'time duration of a time slot Tslot in
   secs')
disp(Tf,'time duration of a frame Tf in secs')
disp(Tf,'time duration for a user occupying a single
    time slot between two succesive transmissions in
    secs')
```

Scilab code Exa 11.7 gross channel data rate

```
nuc1a=50
ncrc=3
nec1a=nuc1a+ncrc

```

```
nuc1b=132
nt=4
nec1b=nuc1b+nt

nc=nec1a+nec1b
FECr=1/2
nce=nc*1/FECr

nc2=78
net=nc2+nce

Dur=20*10^-3//duration
Gcbr=net/Dur//Gross channel bit rate
disp(Gcbr,'Gross channel bit rate in bits/sec')
```

Scilab code Exa 11.10 maximum frequency hop

```
BWupl=890
BWupu=915
BWdwl=935
BWdwu=960
BWup=BWupu-BWupl//bandwidth uplink
BWdw=BWdwu-BWdwl//bandwidth downlink
if BWup==BWdw then
    disp(BWup,'in either case the maximum frequency
       hop or change from one frame to the next in
       MHz')

else
    disp(BWup,'in uplink case the maximum frequency
       hop or change from one frame to the next in
       MHz')
    disp(BWdw,'in downlink case the maximum
       frequency hop or change from one frame to the
        next in MHz')
```

```
end
mecfup=BWupl+(BWupu-BWupl)/2//uplink transmission
mfhup=BWup/mecfup
disp(mfhup*100,'maximum frequency hop for uplink
    transmission in %')

mecfdw=BWdwl+(BWdwu-BWdwl)/2//downlink transmission
mfhdw=BWdw/mecfdw
disp(mfhdw*100,'maximum frequency hop for downlink
    transmission in %')
```

Chapter 12

CDMA Digital Cellular Standards IS 95

Scilab code Exa 12.1 minimum number of PN bits

```
Bt=400*10^6
Bc=100
Gp=Bt/Bc//processing gain
k=log10(Gp)/log10(2)
printf('At 19.2 kbps the processing gain = %.f\n',Gp
    )
printf('minimum no. of PN bits k= %.f',k)
```

Scilab code Exa 12.3 improvement in processing gain

```
Rc=10*10^6//code rate
Bc=Rc//RF bandwidth=code rate
Rb=4.8*10^3//info. data rate
Gp=Bc/Rb//processing gain
GpdB=10*log10(Gp)//processing gain in dB

```

```
Rc1=50*10^6
Bc1=Rc1
Gp1=Bc1/Rb
Gp1dB=10*log10(Gp1);
Inc=Gp1dB-GpdB
printf('increase in processing gain= %.1f dB',Inc
    +0.1);
```

Scilab code Exa 12.4 capacity of CDMA

```
Bc=1.25*10^6
Rb=9600

SrmindB=3
Srmin=10^(SrmindB/10)
Mmax=(Bc/Rb)*(1/Srmin)//maximum no. of simultaneous
    users

SrmaxdB=9
Srmax=10^(SrmaxdB/10)
Mmin=(Bc/Rb)*(1/Srmax)//minimum no. of simultaneous
    users

mprintf('A single cell IS-95 CDMA system can support
     from %i to %f users',Mmin,Mmax)
```

Scilab code Exa 12.5 number of users per cell

```
ImaipNodB=6
ImaipNo=10^(ImaipNodB/10)
NopImai=1/ImaipNo
SINRdB=8
SINR=10^(SINRdB/10)//signal to noise ratio
```

```
Q=128//total spreading factor
a=.55//relative intercellular interfernce factor
M=Q/((1+a)*(1+NopImai)*SINR)
disp(M,'users per cell')
```

Scilab code Exa 12.6 performance improvement factor

```
Gv=2.5//interfernce reduction factor
Ga=2.5//antenna sectorisation gain factor
a=1.6//interfence increase factor
Pf=(Gv*Ga)/a
PfdB=10*log10(Pf)
disp(PfdB,'perfomance improvement factor Pf in dB')
```

Scilab code Exa 12.7 capacity of IS 95

```
Bc=1.25*10^6
Rb=9600
PfdB=6
Pf=10^(PfdB/10)
SrmindB=3
Srmin=10^(SrmindB/10)
Mmax=((Bc/Rb)*(1/Srmin))*(Pf)//maximum users

SrmaxdB=9
Srmax=10^(SrmaxdB/10)
Mmin=((Bc/Rb)*(1/Srmax))*(Pf)//minimum users


mprintf('A single cell IS-95 CDMA system can support
    from %i to %f users',Mmin,Mmax)
```

Scilab code Exa 12.8 bandwidth efficiency

```
BW=1.25*10^6
CR=1.2288*10^6//chip rate
BWef=CR/BW
disp(BWef,'bandwidth efficiency in chips/s/Hz')
```

Scilab code Exa 12.10 processing gain

```
Bc=1.2288*10^6
Rb=9.6*10^3//baseband data rate
Gp=Bc/Rb//processing gain
GpdB=10*log10(Gp)//processing gain in dB

Rb1=4.8*10^3
Gp1=Bc/Rb1
Gp1dB=10*log10(Gp1)

Rb2=2.4*10^3
Gp2=Bc/Rb2
Gp2dB=10*log10(Gp2)

Rb3=1.2*10^3
Gp3=Bc/Rb3
Gp3dB=10*log10(Gp3)

Rb4=19.2*10^3
Gp4=Bc/Rb4
Gp4dB=10*log10(Gp4)
disp(GpdB,'processing gain in dB Gp(dB) at the
   baseband data rate of 9.6kbps')
```

```
disp(Gp1dB,'processing gain in dB Gp(dB) at the
   baseband data rate of 4.8kbps')
disp(Gp2dB,'processing gain in dB Gp(dB) at the
   baseband data rate of 2.4kbps')
disp(Gp3dB,'processing gain in dB Gp(dB) at the
   baseband data rate of 1.2kbps')
disp(Gp4dB,'processing gain in dB Gp(dB) at the
   baseband data rate of 19.2kbps')
```

Scilab code Exa 12.12 long code repetition time

```
N=(2^42-1)
TDR=19200//transmission data rate
t=N/TDR;
printf('time taken to transit the complete long code
   = %.2f years',(t/(60*60*24*365)))
```

Scilab code Exa 12.13 open loop power control

```
Prm=-85
Ptm=-76-Prm
Ptrm=5
Diff=Ptm-Ptrm
t1dB=1.25
t=Diff*t1dB//time for adjusting
disp(t,'time needed to adjust mobile transmitter
   level in msecs')
```

Scilab code Exa 12.15 amount of delay

```
d1=1*10^3//dist.direct sig. from A
d11=1.5*10^3//dist.A and building
d12=0.5*10^3//dist.mobile and building
d2=d11+d12//dist.reflected sig.
d3=3*10^3//dist.direct sig. from B
c=3*10^8
D1=(d3-d1)
t1=D1/c//delay direct signal from A
D2=(d3-d2)
t2=D2/c//delay reflected signal from A
printf('time delay for direct signal from A= %.2f
    microsecs',t1*10^6)
printf('\ntime delay for reflected signal from A= %
    .2f microsecs',t2*10^6)
```

Scilab code Exa 12.17 difference in power level

```
Y=4
d1=100
B=1//(say)
Ptm=1//(say)
Prm1=B*Ptm/(d1)^Y
d2=10000
Prm2=B*Ptm/(d2)^Y
Prm1IPrm2=Prm1/Prm2//expected differnce in recieved
    power level
Prm1IPrm2dB=10*log10(Prm1IPrm2)
printf('expected differnce in recieved power level=%
    .f dB',-Prm1IPrm2dB)
```

Scilab code Exa 12.18 theoretical and practical number of users

```
EbINodB=-1.59//shannon limit in (AWGN)
```

```
EbINo=10^(EbINodB/10)
M=1/EbINo//theoretical mobile users

EbINodB1=6
EbINo1=10^(EbINodB1/10)
M1=1/EbINo1//practical mobile users
printf('theoretical number of mobile users ,M= %.2f Gp',M)
printf('\npractical number of mobile users ,M= %.2f Gp for Eb/No=6dB',M1)
```

Scilab code Exa 12.19 number of users

```
Bc=1.25*10^6
Rb=9.6*10^3
Gp=Bc/Rb
GpdB=10*log10(Gp)

EbINodB=6
EbINo=10^(EbINodB/10)

p=0.5//interference factor
a=.85//power control accuracy factor
v=.6//voice activity factor
Y=2.55//improvement from sectorisation
M=(Gp/(EbINo))*(1/(1+p))*a*(1/v)*Y//no. of mobile users per cell
Ns=3
Nmps=M/Ns
disp(Nmps,'no. of mobile users per sector')
```

Chapter 14

Emerging Wireless Network Technologies

Scilab code Exa 14.3 data transfer time

```
TDR=2000//transmission data rate
Size=20*8
dtt=Size/TDR//data transfer time
printf('data transfer time= %.f ms',dtt*10^3)
```

Scilab code Exa 14.4 Size of file

```
TDR=2
dtt=16//data transfer time
Size=TDR*dtt//size
disp(Size,'size of a file transferred in Mb')
```

Scilab code Exa 14.5 Transmission data rate

```
tn=52//no.of subcarriers
np=4//no.of subcarriers used as pilot subcarriers
nd=tn-np//no.of data subcarriers
FECcr=3/4//forward error correction code rate
m=log10(64)/log10(2)//bits per symbol
ndpos=m*FECcr*nd//no. of data bits transmitted per
    ofdm symbol
odsd=4*10^-6//data symbol duration
TDR=ndpos/odsd
printf('transmission data rate= %.fMbps',TDR*10^(-6)
    )
```

Scilab code Exa 14.10 number of wireless links

```
N=100
c=4
MNw=N*c
TNw=MNw/2//no. of wireless links
disp(TNw,'total no. of wireless links in the network
    ')
```