Scilab Textbook Companion for Principles And Applications Of GSM by V. K. Garg And J. E. Wilkes[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 3

Access Technologies

Scilab code Exa 3.1 Spectral Efficiency

```
//Determine the spectral efficiency using the given parameters

Bw = 12.5e+3;
Cd = 200;

A = 8;
At = 4000;
N = 4;
F = 4;

C = Bw/Cd;
Tc = C*A;
Ts = 3;
Tc1 = ((Tc/F) - Ts);
N1 = At/A;
T1 = 108.4

N = (T1*N1*1e+3)/(At*Bw);

disp(C, 'No. of 200 Khz channels')
```

```
disp(Tc, 'No. of traffic channels')
disp(Ts, 'No. of signaling channels')
disp(Tc1, 'No. of traffic channels per cell')
disp(N1 , 'No. of cells')
disp(T1, 'Total traffic carried by 121 channels with 2% blocking (using Erlang B Formula)')


disp(N, 'Efficiency (in Erlangs/Mhz/km2)')
```

Scilab code Exa 3.2 Spectral Efficiency of TDMA

```
//Determine the efficiency of the TDMA system

e = 13;
d = 16.2
Tf = 40;
Mt = 6;
Bu = 30;
Nu = 395;
Bw = 12.5e+3;

t = (e/d)*(Tf/Mt);
Na = ((t*Mt)/Tf)*((Bu*Nu)/Bw)
Op = (1 - Na)*100;

disp(t, 'Time slot duration (in ms)')
disp(Op, 'Percentage Overhead portion of the frame (in %)')
```

Scilab code Exa 3.3 Frame Efficiency of TDMA

```
//Determine the capacity & spectral efficiency of a
   TDMA system

Nb = 0.9;
u = 2;
Bw = 12.5e+6;
Vf = 1;
R = 16.2e+3;
N = 19;

Nu = ( ((Nb*u)/Vf) * (Bw/(R*N)) );
N1 = ( (Nu*R) / (Bw) );

disp(Nu, 'Nu')
disp(N1, 'Spectral Efficiency (in bits/sec/Hz)')
```

Scilab code Exa 3.4 Frame Efficiency of TDMA

```
//Determine the frame efficiency & no. of channels
   per frame of GSM TDMA system

Nr = 2;
Br = 148*8;
Nt = 24;
Bp = 34*8;
Bg = 8.25;
Tf = 120e-3;
Rrf = 270.8333e+3;
R = 22.8;

B0 = ( (Nr*Br) + (Nt*Bp) + (Nt+Nr)*Bg );
Bt = Tf * Rrf;
N = (1 - (B0/Bt))*100 ;
Ncf = ( (N*Rrf)/(R*1e+5) ) ;

```

```
disp(B0, 'B0')
disp(Bt, 'Bt')
disp(N, 'Frame Efficiency of TDMA system (in %)')
disp(Ncf, 'No. of channels/frame')
```

Chapter 4

Cellular Communications Fundamentals

Scilab code Exa 4.1 GSM Parameters

```
//Determine following parameters

N = 4;
Lo = 85.26;

Cn = (Lo*3600)/120;
SI =  10*log10((3.5^4)/6);

disp(Cn, 'No. of calls per cell site per hour')
disp(2558, 'No. of calls per cell site per hour (
   apprx.)')

disp(SI, 'Mean S/I ratio for cell reuse factor 4 (in
    db)')
```

Scilab code Exa 4.2 GSM Parameters

```
//Determine following parameters

N = 4;
Lo = 107.8

Cn = (Lo*3600)/120;
SI =  10*log10((3.5^4)/6);

disp(Cn, 'No. of calls per cell site per hour')
disp(SI, 'Mean S/I ratio for cell reuse factor 4 (in db)')
```

Scilab code Exa 4.3 GSM Parameters

```
//Determine following parameters

N = 7;
A = 1200;
Ct = 395;
Ts = 9597;
Tc = 358;
Te = 287.9;
Nc = 8637;

As = Ts/Tc;
E = Te/A;
Sd = Ts/A;
Cd = Nc/A;
Ae = A/N;
Cn = Tc/Ct;


disp(As, 'Avg. No. of subscribers/channel')
disp(E, 'Erlangs/mile2 )')
disp(Sd, 'Subscriber Density (in Subscribers/mile2)'
```

```
    )
disp(Cd, 'Call Density (in calls/mile2)')
disp(Ae, 'Area of each cell (in miles2)')
disp(Cn, 'Channel Reuse factor')
```

Scilab code Exa 4.4 GSM Parameters

```
//Determine following parameters

N = 7;
C = 395;

Nc = C/N;
Se1 = 39.8/63.1;
Se2 = 5.8648/1.384;

disp(Nc, 'No. of voice channels/cell site')
disp(Se1, 'Spectral Efficiency in analog system')

disp(Se2, 'Spectral Efficiency in digital system')
```

Chapter 6

Radio Link Features in GSM Systems

Scilab code Exa 6.1 Adaptive Array Elements

```
//Consider GSM system with following data and show the advantage of adaptive array antennas

kT = -174;
Bw = 200e+3;
F = 7;
SI = 12;

W = 29;
Lc = 2;
fm = 10;
Gbs = 20;
Gm = 0;

Gamma = 4;
PLmax = 139;
I0 = 80;

Acover = 6e+4;
```

```
PRmin = kT + (10*log10(Bw)) + F + SI ;
PLmax = W - PRmin - Lc - fm + Gbs + Gm ;
R = (PLmax - I0)^(1/4);
N = Acover/(2.6*R^2);

disp(PRmin, 'Required minimum received power is (in dBm)')
disp(PLmax, 'Max. allowable path loss is (in dB)')
disp(R, 'Cell Radius (in miles)')
disp(N, 'No. of cells required')
```

Chapter 13

Propagation Path Loss and Propagation Models

Scilab code Exa 13.1 Level Crossing Rate

```
//Determine level-crossing rate, avg. duration of
   fade for a cellular system and a vehicle speed.

f = 900e+6;
c = 3e+8;
v = 6.67;
rho = 0.3162;

lambda = c/f;
fm = v/lambda;

n0 = sqrt(2*%pi)*fm;
Tr = (1.105-1)/(n0*rho);
Tr1 = (1/(3*v)) * (rho/sqrt(2*%pi));

disp(n0, 'Level-crossing rate')
disp(Tr, 'Avg. duration of fade (in s)')
disp(Tr1, 'Avg. duration of fade, using appx. exp. (
   in s)')
```

Scilab code Exa 13.2 Received Power

```
//Determine received signal power at MS receiver and
    SNR of received signal

lamda = 0.2;
d = 8000;
Gt = 8;
L0 = 8;
T0 = 1.38e-23;
Bw = 0.2e+6;
T = 1160+290;


Lp = -20*log10(lamda/(4*%pi*d));
Pr = Lp + Gt - L0;
Pn1 = T0*T*Bw;
Pn = 10*log10(Pn1);

SNR = -Pr-Pn;

disp(-Pr, 'Recieved Signal power (in dBW)')
disp(SNR, 'SNR of received signal (in dB)')
```

Scilab code Exa 13.3 SNR

```
//Determine received signal power at MS receiver and
    SNR of received signal

lamda = 30*3;
d = 8000;
```

```
Gt = 8;
L0 = 8;
T0 = 1.38e-23;
Bw = 0.2e+6;
T = 1160+290;


Lp = -20*log10(lamda/(d^2));
Pr = Lp + Gt - L0;
Pn1 = T0*T*Bw;
Pn = 10*log10(Pn1);

SNR = -Pr-Pn;

disp(-Pr, 'Recieved Signal power (in dBW)')
disp(SNR, 'SNR of received signal (in dB)')
```

Scilab code Exa 13.4 Signal Sensitivity

```
//Determine the probability that the signal exceeds
   the receiver senstivity

Smin = 100;
Pr = -110;

Ps =  0.5 - 0.5*((Pr + Smin)/(10*1.414));

disp(Ps, 'Probability that the signal exceeds the
   receiver senstivity is')
```

Scilab code Exa 13.5 Mean Path Loss

```
//Determine mean path loss by two models
```

```

Lr = 31.7;
gamma1 = 5.22;
gamma2 = 3.27;
R = 30;
R0 = 1;
FAF = 24.4;


Ls1 = Lr + 10*gamma1*log10(R/R0) ;
Ls2 = Lr + 10*gamma1*log10(R/R0) + FAF ;

disp(Ls1, 'Mean path loss by 1st model (in dB)')
disp(Ls2, 'Mean path loss by 2nd model (in dB)')
```

Chapter 14

Planning and Design of a GSM Wireless Network

Scilab code Exa 14.2 Planning of Wireless Network

```
//Determine the following parameters.

t = 120;
d = 24;
BH = 5;
BW = 5000;
RFw = 200;
S = 60000;
A = 500;

E = t/(d*BH*60);
Nrf = BW/RFw;
Srf = Nrf/(4*3);
TCH = Srf*8;
Tbts = 9.82*3;  //Using Erlang B table
Sbts = (Tbts*1000)/TCH;
BTSn = S/Sbts;
R = sqrt(A/(BTSn*Srf));

```

```
disp(E, 'Erlangs per subscriber')
disp(TCH, 'Traffic Channels per sector')
disp(BTSn, 'No. of BTS in a zone')
disp(R, 'Avg. Hexagonal cell radius (in Km)')
```

Scilab code Exa 14.3 Determine Signal power

```
//Determine the minimum signal power required

K = 1.38e-20;
T = 290;
Nf = 5;
EbNt = 13.5;
Rb = 271;
Bc = 200;
Tg = 0;
Rg = 12;
Rl = 2.5;
Fm = 10;

Nt = 10*log10(K*T) + Nf;
SNr = EbNt + 10*log10(Rb/Bc);
Smin = EbNt + 10*log10(Rb*1000) + Nt;
Lpmax = 30 - Smin + (Tg+Rg) - (Rl+Fm );

disp(Smin, 'Min. Signal Power Required (in dBm)')
disp(Lpmax, 'Max. allowable path loss (in dB)')
```

Scilab code Exa 14.4 Cellular System

```
//Design a cellular system using GMSK modulation

Smin = -102;
```

```
fc = 900;
ht = 160;
ahr = 2.69;
d = 10;
Gt = 16;
Gr = 1;
Lft = 1;
Lfr = 1;
fm = 10.5;

Lp = 69.55 + 26.16*log10(fc) - 13.83*log10(ht) - ahr
    + (44.9 - 6.55*log10(ht))*log10(d) ;
Pt = Smin - (Gt+Gr) + (Lft + Lfr + fm) + Lp;

disp(Lp, 'Path Loss (in dB)')
disp(Pt, 'Required transmitted power for a GMSK MS (
   in dBm)')
```

Scilab code Exa 14.5 PCS System

```
//Design a cellular system for PCS system using QPSK
    modulation

Smin = -91.4;
fc = 1800;
ht = 50;
ahr = -4.53;
d = 1;
Gt = 12;
Gr = 0;
Lft = 1;
Lfr = 1;
fm = 10.5;

Lp = 69.55 + 26.16*log10(fc) - 13.83*log10(ht) - ahr
```

```
    + (44.9 - 6.55*log10(ht))*log10(d) ;
Pt = Smin - (Gt+Gr) + (Lft + Lfr + fm) + Lp;

disp(Lp, 'Path Loss (in dB)')
disp(Pt, 'Required transmitted power for a GMSK MS (
    in dBm)')
```

Scilab code Exa 14.6 TDMA frame for Cellular System

```
//Design a TDMA frame for a cellular system

Nca1 = 1'
Nca2 = 2;
Rbmin = 8;
a1 = 0.1;
nf = 0.75;
Rc = 0.5;

Nslot1 = 16/Nca1;
Nslot2 = 16/Nca2;
Rs1 = (Rbmin*(1+a1)*Nslot1)/(nf*Rc);
Rs2 = (Rbmin*(1+a1)*Nslot2)/(nf*Rc);

disp(Nslot1, 'Nslot for Nca=1')
disp(Nslot2, 'Nslot for Nca=2')
disp(Rs1, 'Rs for Nca=1 (in ksymbols/s)')
disp(Rs2, 'Rs for Nca=2 (in ksymbols/s)')
```

Chapter 17

An Overview of Signaling System 7

Scilab code Exa 17.1 Mean STP message transfer time

```
//Determine the mean STP message transfer time using
    ITU-T recommendations

Tph = 22;
Tod = 8.2;

t = Tph + Tod ;

disp(t, 'STP Message Transfer Time (in ms)')
```

Scilab code Exa 17.2 EN Bloc and Overlap Signalling

```
//Determine the no. of circuits for en bloc
    signaling and overlap signaling

S = 0.7;
```

```
Hs = 150;
U = 1-S;
Hu = 20;

SC = 0.8;

Ns = 11;
Nu = 4;

D = S*Hs + U*Hu ;
BHCA = (3600*SC)/D; //Using value from table - 3600
N = Ns*S + Nu*U ;
M1 = ( (95/2)*S + (63/2)*U );     //From Table given
M2 = ( (114/2)*S + (63/2)*U );
N1 = (8000*3600*0.2)/(M1*BHCA);
N2 = (8000*3600*0.2)/(M2*BHCA);

disp(D, 'Mean duration of a call (in s)')
disp(BHCA, 'No. of Busy Hour Call Attempts (BHCA) per circuit')
disp(N+0.1, 'Mean no. of digits dialed per call (apprx.)')
disp(N1, 'No. of circuits serviced by En Bloc Signalling');
disp(N2, 'No. of circuits serviced by Overlap Signalling');
```

Chapter 18

Telecommunication Traffic Engineering

Scilab code Exa 18.1 Traffic Measurement Units

```
//Determine the usage in seconds ,CCS and Erlangs
   which has accumulated on the piece of the
   equipment

U = (450-0)*(5/3600)

disp(U, 'Usage in Erlangs')
disp(U*36, 'Usage in CCS')
disp(U*36*100, 'Usage in seconds')
```

Scilab code Exa 18.2 Offered Load

```
//Determine the offered load

CCS = 2900;
p = 0.05;
```

```

U = CCS/(1-p);

disp(U, 'Offered Load (in CCS)');
```

Scilab code Exa 18.3 Traffic Intensity

```
//Determine the traffic intensity

t = 120;

I = (2*t)/3600;

disp(I*36, 'Traiffic Intensity (in CCS)');
```

Scilab code Exa 18.4 Traffic Intensity

```
////Determine the traffic intensity in Erlangs and
    CCS

n = 10;
t = 1.5;
Cd = 60+74+80+90+92+70+96+48+64+126;

CAR = n/t;
Hbar = Cd/10;

I = (CAR*Hbar)/3600;

disp(I, 'Traiffic Intensity (in Erlangs)');
disp(I*36, 'Traiffic Intensity (in CCS)');
```

Scilab code Exa 18.5 Traffic Intensity

```
////Determine the traffic intensity during the eight
    -hour period and the busy hour

n = 11;
t = 8;
Cd1 = 3+10+7+10+5+5+1+5+15+34+5;
Cd2 = 34+5;
CAR2 = 2;

CAR1 = n/t;
Hbar1 = Cd1/(n*60);
Hbar2 = Cd2/(CAR2*60);

I1 = CAR1 * Hbar1 ;
I2 = CAR2 * Hbar2 ;

disp(I1*36, 'Traiffic Intensity (in CCS)')
disp(I2*36, 'Traiffic Intensity during busy hour (in
    CCS)')
```

Scilab code Exa 18.6 Data Collection Categories

```
//Determine ABS/BH switch calling rate and CCS for a
    switch

RL = 12000;
n = 80000;
BL = 64000;
HL = 4000;
CRr = 2;
```

```
CRb = 3;
CRh = 10;
HTr = 140;
HTb = 160;
HTh = 200;

RLp = RL/n;
BLp = BL/n;
HLp = HL/n;
CCSrl = CRr * (HTr/100);
CCSbl = CRb * (HTb/100);
CCShl = CRh * (HTh/100);
SCR = (CRr*RLp) + (CRb*BLp) + (CRh*HLp) ;
Sccs = (CCSrl*RLp) + (CCSbl*BLp) + (CCShl*HLp) ;

Aht = (Sccs/SCR)*100;
ABSc = SCR*n;
ABSu = (Sccs*n)/36;

Dcc = 1.5*ABSc;
De = 1.5*ABSu;

disp(Dcc, 'Design call capacity based on HD')
disp(De, 'Design erlangs based on HD')
```

Scilab code Exa 18.7 Offered Load

```
//Determine the offered load and channels required

CPH = 4000;
ACH = 150

A = (CPH*ACH)/3600;

disp(A, 'Offered Load');
```

```
disp(182, 'Channels REquired (using Erlang B table)'
   )
```

Scilab code Exa 18.8 GSM Users

```
//Determine the no. of users supported

BHA = 1.2;
ACH = 120;

C = 40.26;    //from Erlang B table

At = (BHA*ACH)/3600;
N = C/At;

disp(N, 'No. of users supported');
```