Scilab Textbook Companion for Radio - Frequency And Microwave Communication Circuits by D. K. Mishra[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: Radio - Frequency And Microwave Communication Circuits

Author: D. K. Mishra

Publisher: John Wiley & Sons Inc., New Jersey

Edition: 2

Year: 2004

ISBN: 0-471-47873-3

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

communication systems

Scilab code Exa 2.1 1

```
1 // data given in question
2 // diameter of dish (m)
3 d=30;
4 //frequency of radiation (Hz)
5 f=4*10^9;
6 // speed of light(m/s)
7 c=3*10^8;
8 // efficiency of aperture
9 e=0.6;
10 //data print
11 printf("\nd=30 m\tf=4 GHz\te=0.6\n")
12 // equation and result
13 printf("\nresult:-")
14 wavelength=c/f
15 printf("\nwavelength of radiating signal=c/f= %.3f m
   ",wavelength)
16 A=%pi*d^2/4
17 printf("\narea of aperture A=pi*d^2/4=%.4f m^2",A)
18 G=4*%pi*A*e/wavelength^2
19
20 printf("\nantenna gain G=4*pi*A*e/wavelength^2 =%.3f
```

```
    ",G)
21 printf("=%.0f dB",10*log10(G))
22 BW=65*wavelength/d
23 printf("\nhalf power beam width BW=65*wavelength/d=%
    .4f degree",BW)
```

Scilab code Exa 2.2 2

```
1  //impedance of transmission line
2  Za=73
3  //impedance of antenna
4  Zo=50
5  //radiation efficiency
6  ecd=1
7  I=integrate('(sin(x))^4','x',0,%pi)*2*%pi
8  Do=4*%pi/I
9  printf("\nDo=%.4f=%.4f dB",Do,10*log10(Do))
10 //voltage reflection coefficient
11 F=(Za-Zo)/(Za+Zo)
12 printf("\nvoltage reflection coefficient\nF=(Za-Zo)
    /(Za+Zo)=%f",F)
13 //mismatch efficiency of antenna
14 er=1-F^2
15 printf("\nmismatch efficiency of antenna\ner=1-F^2=%
    .4f=%.4f dB",er,10*log10(er))
16 //overall gain
17 Go=10*log10(Do)+10*log10(er)+10*log10(ecd)
18 printf("\noverall gain\nGo=Do+er+ecd=%.4f dB",Go)
```

Scilab code Exa 2.3 3

```
1 printf("\nunit vector along the polarization of
    incident wave is ui=[1 0 0]")
```

```
2 ui=[1 0 0];
3 printf("\nunit vector along the antenna polarization
    ua=[1 1 0]*(1/sqrt(2))\n")
4 ua=[1 1 0]*(1/sqrt(2));
5 d=ui*ua'
6 printf("\npolarization loss factor |ui*ua|^2=%.2f",d
   ^2)
7 printf("=%.2f dB",10*log10(d^2))
```

Scilab code Exa 2.4 4

```
1 // data
2 // output of high power amplifier(W)
3 Pt=500;
4 //efficiency
5 e=0.8;
6 //gain of transmitting antenna(60dB=10^6)
7 G=10^6;
8 // data print
9 printf("\nPt=500 W\te=0.8\tG=60 dB\n")
10 //equations and result
11 printf("\nresult:-")
12 Pant=e*Pt
13 printf("\noutput power of antenna Pant=%.2f W",Pant)
14 L=Pt/Pant
15 printf("\ninput/output power ratio L=Pt/Pant=%.2f=%
   .4f dB",L,10*log10(L))
16 EIRP=Pt*G/L
17 printf("\nEIRP =%.4f dBw",10*log10(Pt)+10*log10(G)
   -10*log10(L))
18 printf("\nEIRP=Pt*G/L=%.2e W",EIRP)
```

Scilab code Exa 2.5 5

```
// data in question
//distance of satellite from earth surface(m)
R=35860000;
//operating frequency of satellite(Hz)
f=4*10^9;
c=3*10^8;
//data print
printf("\nR=35,860 km\tf=4 GHz\n")
//equations and result
printf("\nresult:-")
wavelength=c/f
printf("\nwavelength of signal = c/f = %.3f m",
   wavelength)
space_loss_ratio=(wavelength/(4*%pi*R))^2
printf("\nspace loss ratio=(wavelength/(4*pi*R))^2 =
    %.2e",space_loss_ratio)
printf(" = %.4f dB",10*log10(space_loss_ratio))
```

Scilab code Exa 2.6 6

```
//date in question
//transmitting antenna gain (dB)
Gt=37
// ground station antenna gain (dB)
Gr=45.8
//frequency of signal
f=20*10^3
//distance from ground station
R=36941.031
//data print
printf("\nGt=37\tGr=45.8\tf=20GHz\tR=36941.031km\n")
//equation and result
printf("\nresult:-")
Pt=10*log10(2000)
printf("\npower transmitted\n\tPt=10*log10(2000)=%.4
```

```
    f dB\n",Pt)
16 Pr=Pt+Gt+Gr-20*log10(f*R)-32.4418     //Pt,Pr in dBm
    and Gt,Gr in dB f in MHz and R in km
17 printf("\npower received at earth station\n\tPr=Pt+
    Gt+Gr-20*log10(f*R)-32.4418=%f dBm",Pr)
18 Gt=0     //Gt in dB
19 Gr=0     //Gr in dB
20 Pr=Pt+Gt+Gr-20*log10(f*R)-32.4418
21 printf("\nif two antennas are isotropic \n\tPr=%f
    dBm=%.4emW",Pr,10^(Pr/10))
```

Scilab code Exa 2.7 7

```
1  //data in question
2  // input power to the antenna(W)
3  Ps=2;
4  //reflection coefficient of transmitting antenna
5  Yt=0.1
6  //reflection coefficient of receiving antenna
7  Yr=0.2
8  //distance between two antennas
9  //consider
10 A=10^(-5)
11 R=100*(A)
12 //maximum directivity of receiving antenna(20 dB =
    10^(20/10))
13 Gr=10^(20/10)
14 //maximum directivity of transmitting antenna(16dB
    =10^(16/10))
15 Gt=10^(16/10)
16 //data print
17 printf("\nPs=2 W\tYt=0.1\tYr=0.2\tR=100   \tGr=20 dB\
    tGt=16 dB\n")
18 //equations and result
19 // power transmitted in the forward direction
```

```
20 printf("\nresult:-")
21 Pt = (1-Yt^2)*Ps
22 printf("\npower transmitted in the forward direction
   \n\tPt = (1-Yt^2)*Ps=%.2f W",Pt)
23 //Friis transmission equation
24 Pr=Pt*(A/(4*%pi*R))^2*Gr*Gt
25 printf("\nFriis equation \n\tPr=Pt*(  /(4*pi*R))^2*
   Gr*Gt=%fW",Pr)
26 printf(" =%.0f mW",Pr*1000)
27 //power delivered to receiver
28 Pd=(1-Yr^2)*Pr
29 printf("\npower delivered to receiver\n\tPd=(1-Yr^2)
   *Pr=%.1f mW",Pd*1000)
```

Scilab code Exa 2.8 8

```
1 //data in question
2 //power transmission(W)
3 Pt=25000
4 //operating frequency(Hz)
5 f=12*10^9
6 //gain of transmitter antenna(25dB)
7 Gt=10^(25/10)
8 //gain of receiver antenna(25dB)
9 Gr=10^(25/10)
10 //distance between two radars(m)
11 R=10000
12 //surface area of target radar(m^2)
13 A=8
14 c=3*10^8
15 //data print
16 printf("\nPt=25 kW\tf=12 GHz\tGt=Gr=25 dB\tR=10 km\
   tA=8 m^2\n")
17 //equation and result
18 printf("\nresult:-")
```

```
19 //wavelength L
20 L=c/f
21 printf("\nwavelength of signal L=c/f=%.3f m",L)
22 Pr=Gr*Gt*Pt*A*L^2/(4*%pi*(4*%pi*R^2)^2)
23 printf("\nreceived power \nPr=Gr*Gt*Pt*A*L^2/(4*pi
   *(4*pi*R^2)^2)= %.2eW",Pr)
24 printf(" = %.2f pW",Pr*10^12)
```

Scilab code Exa 2.9 9

```
1 //data in question
2 //noise power at Th=290 K(dBm)
3 P1=-70
4 Th=290
5 //noise power at Tc=77 K(dBm)
6 P2=-75
7 Tc=77
8 //given noise temperature(K)
9 Ts=450
10 //frequency band B
11 B=1.5*10^9-500*10^6
12 //power gain of amplifier(10dB=10)
13 G=10
14 //boltzamn constant
15 k=1.38*10^(-23)
16 //data print
17 printf("\nP1=-70 dBm at Th=290 K\tP2=-75 dBm at Tc
   =77 K \tTs=450 K G=10\n")
18 //equation and result
19 printf("\nresult:-")
20 //Y-factor(Y=P1/P2 = (P1-P2)dBm)
21 Y=10^((P1-P2)/10)
22 printf("\n Y-factor = 10^((P1-P2)/10) = %.4f",Y)
23 //equivalent noise temperature
24 Te=(Th-Y*Tc)/(Y-1)
```

```
25 printf("\nequivalent noise temperature\nTe=(Th-Y*Tc)
   /(Y-1)=%.2f K",Te)
26 //noise power output of amplifier
27 Po=G*k*Ts*B+G*k*Te*B
28 printf("\nnoise power output\nPo=G*k*Ts*B+G*k*Te*B=%
   .4e W",Po)
29 printf(" = %.4f dBm\n",10*log10(Po*1000))
```

Scilab code Exa 2.10 10

```
1 //data in question
2 //noise figure(dB)
3 NF=3.5
4 //band width(Hz)
5 B=(12-10)*10^9
6 //amplifier gain
7 G=10^(20/10)
8 To=290
9 k=1.38*10^-23
10 //data print
11 printf("\nNF=3.5 dB\tB=2 GHz  \tG=20dB\n")
12 //equations and result
13 //noise factor
14 F=10^(NF/10)
15 printf("\nnoise factor\nF=10^(NF/10)=%f",F)
16 No=F*k*To*B*G
17 printf("\noutput noise power\nNo=F*k*To*B*G=%.4e W",
   No)
18 printf(" = %.1f dBm",10*log10(No*1000))
```

Scilab code Exa 2.11 11

```
printf("\n\t(a) Find the noise figure of this
   cascaded system.")
printf("\n\t(b) What would be the noise figure if
   the amplifier were placed before the transmission
    line?\n")
// data in question
//ambient temperature(K)
Te=300
To=290
//noise temperature of amplifier(K)
Ta=150
k=1.38*10^-23
//band width(Hz)
B=100*10^6
//gain of amplifier
Gamp=10^(15/10)
// for transmission lines
Gline=1/10^0.2
//data print
printf("\nTe=300K\tTa=150K\tB=100MHz\tGamp=15dB\
   tattenuation=2dB\n")
//equations and result
printf("\nresult:-")
//noise factor for amplifier
Famp=1+Ta/To
printf("\nFamp=1+Ta/To")
//noise for transmission lines
Fline=1+(1/Gline-1)*Te/To
printf("\nFline=1+(1/Gline-1)*Te/To")
Fcascaded=Fline+(Famp-1)/Gline
printf("\n(a)noise figure of cascaded system\n\
   tFcascaded=Fline+(Famp-1)/Gline = %.4f",Fcascaded
   )
printf(" = %.4f dB",10*log10(Fcascaded))
Fcascaded=Famp+(Fline-1)/Gamp
printf("\n(b)if the amplifier is connected before
   the line\n\tFcascaded=Famp+(Fline-1)/Gamp = %.4f"
   ,Fcascaded)
```

```
31 printf(" = %.4f dB",10*log10(Fcascaded))
```

Scilab code Exa 2.12 12

```
1  //data in question
2  //noise factor of A1
3  F1=10^(3/10)
4  //noise factor of A2
5  F2=10^(5/10)
6  //gain of amplifier A1
7  G1=10^(20/10)
8  //gain of amplifier A2
9  G2=10^(20/10)
10 //data print
11 printf("\nF1=3dB\tF2=5dB\tG1=G2=20dB\n")
12 //equation and result
13 printf("\nresult:-")
14 //overall gain of cascaded system
15 G=G1*G2
16 printf("\noverall gain of cascaded system\nG=G1*G2=
      %.2f",G)
17 printf(" = %.0f dB",10*log10(G))
18 //overall noise figure of cascaded system
19 F=F1+(F2-1)/G1
20 printf("\noverall noise of cascaded system\nF=F1+(F2
      -1)/G1 = %.6f",F)     //some difference in result
      is due to approx in calculation
21 printf(" = %.3f dB",10*log10(F))
22 F=F2+(F1-1)/G2
23 printf("\noverall noise of cascaded system when
      order of amplifiers is changed\nF=F2+(F1-1)/G2 =
      %.6f",F)
24 printf(" = %.6f dB",10*log10(F))
```

Scilab code Exa 2.13 13

```
1 //noise factor
2 F=10^(10/10)
3 //equation and result
4 printf("\nresult:-")
5 printf("\n(a)B=1MHz")
6 B=1
7 Pimds=-111+F+10*log10(B)      //F in dB, B in MHz,
    Pidms in dBm
8 printf("\n\tPimds=-111+F+10*log10(B)\n\tPimds=%.1f
    dBm",Pimds)
9 printf(" = %.2e mW",10^(Pimds/10))
10 printf("\n(b)B=1GHz")
11 B=1000
12 Pimds=-111+F+10*log10(B)      //F in dB, B in MHz,
    Pidms in dBm
13 printf("\n\tPimds=-111+F+10*log10(B)\n\tPimds=%.1f
    dBm",Pimds)
14 printf(" = %.2e mW",10^(Pimds/10))
15
16 printf("\n(c)B=10GHz")
17 B=10000
18 Pimds=-111+F+10*log10(B)      //F in dB, B in MHz,
    Pidms in dBm
19 printf("\n\tPimds=-111+F+10*log10(B)\n\tPimds=%.1f
    dBm",Pimds)
20 printf(" = %.2e mW",10^(Pimds/10))
21 printf("\n(d)B=1kHz")
22 B=0.001
23 Pimds=-111+F+10*log10(B)      //F in dB, B in MHz,
    Pidms in dBm
24 printf("\n\tPimds=-111+F+10*log10(B)\n\tPimds=%.1f
    dBm",Pimds)
```

```
25 printf(" = %.2e mW",10^(Pimds/10))
```

Scilab code Exa 2.14 14

```
1 // data in question
2 //input signal(dBm)
3 Pin=-15
4 //intercept point of characteristic curve(dBm)
5 Pip=25
6 printf("\nPin=-15dBm\tPip=25dBm\n")
7 //equations and result
8 printf("\nresult:-")
9 Pimr=(Pin-Pip)*2      //Pimr in dB; Pin,Pip in dBm
10 printf("\nintermodulation ratio\nPimr=(Pin-Pip)*2 =%
   .1f dB",Pimr)
```

Scilab code Exa 2.15 15

```
1 //data in question
2 To=290
3 //bandwidth(Hz)
4 B=500*10^3
5 k=1.38*10^-23
6 //noise factor
7 F=10^(8/10)
8 //input power at IP
9 Pip=10
10 printf("\nB=500kHz\tF=8 dB\tPip=10 dBm")
11 //equations and result
12 Nf=k*To*B*F
13 printf("\nNf=k*To*B*F=%.4e",Nf)
14 printf(" = %.2f dBm",10*log10(Nf*1000))
15 Nf=10*log10(Nf*1000)    //Nf in dBm
```

```
16 DR=2/3*(Pip-Nf)      //DR in dB; Pip,Nf in dBm
17 printf("\ndynamic range\nDR=2/3*(Pip-Nf)=%.2f dB",DR
   )
```

Chapter 3

transmission lines

Scilab code Exa 3.1 1

```
1  //resistance of line (ohm/m)
2  R=0.015
3  //operating frequency(Hz)
4  n=1.6*10^9
5  //angular frequency
6  w=2*%pi*n
7  //inductance of line(H/m)
8  L=0.002*10^(-6)
9  //conductance of line(S/m)
10 G=0.1*10^(-3)
11 //capacitance of line(F/m)
12 C=0.012*10^(-12)
13 printf("\nR=0.015ohm/m\tn=1.6GHz\tL=0.002uH/m\tG=0.1
       mS/m\tC=0.012pF/m\n")
14 //formulas and result
15 printf("\nimpedance Z=R+iwL=")
16
17 Y=complex(G,w*C)     //admittance per unit length
18 Z=complex(R,w*L)      //impedance per unit length
19 disp(Z)
20 printf("ohm/m\nadmittance Y=G+iwC=")
```

```
21 disp(Y)
22 printf("S/m\nZo=square root(Z/Y)=")
23 disp(sqrt(Z/Y))
24 printf("ohm")
```

Scilab code Exa 3.2 2

```
1  //data
2  W=2*%pi*10^8    //rad/s
3  Vp=2.5*10^8      //m/s
4  Vin=75/(50+75)*3*complex(cos(0),sin(0))      //V
5  Iin=3/(50+75)*complex(cos(0),sin(0))          //A
6  //formula and result
7  printf("\nresult:-")
8  b=W/Vp
9  printf("\nB=%.4f rad/m",b)
10 printf("\nV=1.8*cos(2*pi*10^8*t-0.8*pi*z)\ni=0.024*
       cos(2*pi*10^8*t-0.8*pi*z)")
```

Scilab code Exa 3.3 3

```
1  //data
2  R=2              //ohm/m
3  G=0.5*10^(-3)    //S/m
4  L=8*10^-9              //H/m
5  C=0.23*10^-12            //F/m
6  W=2*%pi*10^9           //Hz
7  Y=15.29*10^-4*exp(%i*1.2377)
8  Z=50.31*exp(%i*1.531)
9  //equation and result
10 printf("\nresult:-")
11 Zo=sqrt(complex(R,W*L)/complex(G,W*C))
12 y=sqrt(Z*Y)
```

```
a=real(y)
B=imag(y)
disp(Zo,"Zo=sqrt(complex(R,W*L)/complex(G,W*C))=")

disp(y,"y=sqrt(Z*Y)=")
printf("\na=%.4fNp/m\nB=%.4frad/m",a,B)
```

Scilab code Exa 3.5 5

```
//data
lambda=1
Zin=150
ZL=300
//formula and result
Zo=sqrt(Zin*ZL)
printf("\nresult:-")
printf("\n(a)d=lambda/4=%.2f m",lambda/4)
printf("\n(b)Zo=sqrt(Zin*ZL)=%.3f ohm",sqrt(Zin*ZL))
printf("\n(c)FL=(ZL-Zo)/(ZL+Zo)=%.4f",(ZL-Zo)/(ZL+Zo))
```

Scilab code Exa 3.6 6

```
//data
Zin=45      //ohm
ZL=20       //ohm
b=0.5/2     //cm
Er=2.1
L=200*10^-9     //H
f=3*10^9        //Hz
C=55.63*Er*10^-12     //F
//formulas and result
printf("\nresult:-")
```

```
Zo=sqrt(Zin*ZL)
printf("\nZo=%.0f ohm",Zo)
k=30/sqrt(200*10^-9/(55.63*Er*10^-12))
a=b/exp(k)
printf("\na=%f cm",a)
lambda=1/(f*sqrt(L*C))
printf("\nlambda=%f m",lambda)
d=lambda/4
printf("\nd=%f m =%f cm",d,d*100)
```

Scilab code Exa 3.7 7

```
//data
Zo1=80
ZL=50
h=1.6      //mm
Er=2.3
Zo=sqrt(Zo1*ZL)
A=1.4635
B=6.1739
qo=150
// formulas and result
printf("\nresult:-")
W=h*(2/%pi*(6.1739-1-log(2*6.1739-1)+(2.3-1)/(2*2.3)
   *(log(6.1739-1)+0.39-0.61/2.3)))
printf("\nW=%.4f mm",W)
F=(1+12*h/W)^(-1/2)
printf("\nF=%.6f",F)
Ee=(2.3+1)/2+(2.3-1)/2*0.383216-(2.3-1)/4.6*0.005/
   sqrt(2.0656)
printf("\nEe=%.1f",Ee)
F=4*h*sqrt(Er-1)/qo*(0.5+(1+2*log10(1+W/h))^2)
printf("\nF=%f",F)
Ee=((sqrt(2.3)-sqrt(1.9))/(1+4*F^(-1.5))+sqrt(1.9))
   ^2
```

```
21 printf("\nEe(f)=%f",Ee)
22 q=3*10^8/(2*10^9*sqrt(1.9))
23 printf("\nq=%f m",q)
24 length_of_line=q/4
25 printf("\nlength of line=%.3f m",length_of_line)
```

Scilab code Exa 3.8 8

```
1 Zo=50
2 C=100*10^(-12)
3 a=1.15*10^(-3)
4 //data print
5 printf("\nZo=50 ohm C=100pF/m a=0.01 dB/m\n")
6 //formula and result
7 L=C*Zo^2
8 R=a*sqrt(L/C)
9 G=R*C/L
10 vp=1/sqrt(L*C)
11 printf("\nresult:-")
12 printf("\n(a)R=a*sqrt(L/C)=%.3f ohm/m",a*sqrt(L/C))
13 printf("\n(b)L=C*Zo^2=%.3e H/m",C*Zo^2)
14 printf("\n(c)G=R*C/L=%.3e S/m",R*C/L)
15 printf("\n(d)vp=1/sqrt(L*C)=%.1e m/s",1/sqrt(L*C))
```

Scilab code Exa 3.9 9

```
1 //data
2 Zin=complex(30,60)          //ohm
3 Zsc=%i*53.1          //ohm
4 Zoc=-48.3*%i               //ohm
5 //formula and result\
6 printf("\nresult:-")
7 Zo=sqrt(Zsc*Zoc)
```

```
8  printf("\nZo=%f ohm",Zo)
9  ZL=Zoc*(Zsc-Zin)/(Zin-Zoc)
10 disp(ZL,"ZL=")
```

Scilab code Exa 3.10 10

```
1  //data
2  Zoc=-54.6*%i            //ohm
3  Zsc=103*%i               //ohm
4  d=1.5                   //m
5  Zo=sqrt(Zoc*Zsc)
6  printf("\nZo=%.0f ohm",Zo)
7  //y=1/d*atanh(sqrt(Zsc/Zoc))
8  y=1/2/d*log(complex(1,1.8969)/complex(1,-1.8969))
9  printf("\ny=")
10 disp(y)
11 printf("1/m\nnegligible real part")
                                    //real part
   negligible
```

Scilab code Exa 3.11 11

```
1  //data
2  W=2*%pi*26*10^6       //rad/s
3  Vp=200*10^6          //m/S
4  B=W/Vp
5  Zo=50    //ohm
6  Zs=50      //ohm
7  Vs=100    //volt
8  ZL=100+%i*50     //ohm
9  l=10       //m
10 //formulas and result
11 printf("\nresult:-")
```

```
printf("\nB=%f  rad/m",B)
Zin=Zo*(ZL+%i*Zo*tan(B*l))/(Zo+%i*ZL*tan(B*l))
disp(Zin,"Zin=")
VA=Vs/(Zs+Zin)*Zin
disp(VA,"VA=")
ZTh=Zo*complex(Zs,Zo*tan(B*l))/complex(Zo,Zs*tan(B*l
   ))
disp(ZTh,"ZTh=")
Vin=50*exp(%i*(-8.168))
VTh=2*Vin
disp(VTh,"VTh=")
VL=VTh/(ZTh+ZL)*ZL
disp(VL,"VL=")
F=(complex(19.21,3.52)-50)/(complex(19.21,3.52)+50)
disp(F,"F=")
Z=10
VL=Vin*(exp(-%i*B*Z)+F*exp(%i*B*Z))
disp(VL,"VL=")
```

Scilab code Exa 3.12 12

```
//data
R=250     //ohm
V250=60*sqrt(2)/11*exp(-%i*45/180*%pi) //volt
Pd=(real(V250)^2+imag(V250)^2)/(2*R)
printf("\nV250=")
disp(V250)
printf("\nPd=%f W",Pd)
```

Scilab code Exa 3.13 13

```
//data
ZL=complex(73,-42.5)
```

```
Zo=complex(50,.01)
//formula and result
printf("\nresult:-")
F=(ZL-Zo)/(ZL+Zo)
p=sqrt(real(F)^2+imag(F)^2)
VSWR=(1+p)/(1-p)
disp(F,"F=")
printf("\nVSWR=%.4f",VSWR)
```

Scilab code Exa 3.14 14

```
//data
q=2    //m
B=%pi     //rad/m
d1=.4      //m
Z2=1
S=2.4
//formula and result
printf("\nresult:-")
Z_L=complex(1,-S*tan(B*d1))/complex(S,-tan(B*d1))
disp(Z_L,"Z_L=")
disp(Z_L*100,"ZL=")
```

Scilab code Exa 3.15 15

```
//data
ZL=50+%i*100
Zo=50
Bl=%pi/2
//formula and result
printf("\nresult:-")
Z_in=Zo*(%i*Zo)/(%i*ZL)
F=(ZL-Zo)/(ZL+Zo)
```

```
x=sqrt(real(F)^2+imag(F)^2)
printf("\nx=%f",x)
VSWR=(1+x)/(1-x)
Z_L=ZL/Zo
printf("\nZ_in=")
disp(Z_in)
printf("\nF=")
disp(F)
printf("\nVSWR=%.4f",VSWR)
printf("\nZ_L=")
disp(Z_L)
```

Chapter 4

electromagnetic fields and waves

Scilab code Exa 4.3 3

```
1 Eo=8.854*10^-12
2 uo=4*%pi*10^-7
3
4 W=2/sqrt(uo*Eo)
5 printf("\nW=%.0e rad/s",W)
```

Scilab code Exa 4.4 4

```
1 Q=[0:0.01:2*%pi]
2 q=[0:0.01:%pi]
3 k=integrate('60*%pi/sin(Q)*cos(%pi/2*cos(Q))^2','Q'
    ,0,%pi/2)
4 printf("\nk=%.2f W",4*k*%pi)
```

Scilab code Exa 4.5 5

```
B=2*%pi
C=3*10^8
lambda=2*%pi/B
f=C/lambda
W=2*%pi*f
uo=4*%pi*10^-7
k=2*%pi
n=W*uo/k
printf("\n(a)lambda=%.0f m\n(b)f=%.0e Hz\n(c)n=%.4f
    ohm",lambda,f,n)
```

Scilab code Exa 4.6 6

```
uo=1.2567*10^-6
f=10^4
W=2*%pi*f
a=4
k=sqrt(W*uo*a/2)+sqrt(W*uo*a/2)*%i
B=real(k)
a=imag(k)
lambda=2*%pi/B
Vp=W/B
delta=1/a
disp(k,"k=")
printf("\nlambda=%f m\nVp=%.4e m/s\ndelta=%.4f m",
    lambda,Vp,delta)
```

Scilab code Exa 4.7 7

```

ky=6
```

```
3  kz=8
4
5  kr=sqrt(ky^2+kz^2)
6  printf("\nkr=%.0f m^-1",kr)
7  //(a)
8  O=180/%pi*asin(ky/kr)
9  theta=(180-O)*%pi/180
10 Vr=3*10^8
11 printf("\n(a)\nO=%.2f degree",O)
12 //(b)
13 lr=2*%pi/kr
14 ly=2*%pi/ky
15 lz=2*%pi/kz
16 printf("\n(b)\nlr=%.4f m\nly=%.4f m\nlz=%.4f m",lr,
       ly,lz)
17 //(c)
18 W=Vr*kr
19 f=W/lr
20 Vpy=W/ky
21 Vpz=W/kz
22 printf("\n(c)\nW=%.0e rad/s\nf=%.2e Hz\nVpy=%.1e m/s
       \nVpz=%.2e m/s",W,f,Vpy,Vpz)
23 Ver=3*10^8
24 Vey=Ver*sin(theta)
25 Vez=Ver*cos(theta)
26 printf("\n(d)\nVey=%.1e m/s\nVez=%.1e m/s",Vey,Vez)
```

Scilab code Exa 4.10 10

```
1
2  Er=2.25
3  ur=1
4  W=10^9
5  p=0.2
6  uo=4*%pi*10^-7
```

```
7  Eo=8.854*10^-12
8  ko=W*sqrt(uo*Eo)
9  k2=W*sqrt(uo*Eo*Er)
10 n1=sqrt(uo/Eo)
11 n2=sqrt(uo/Eo/Er)
12 R=(n2-n1)/(n1+n2)
13 T=2*n2/(n1+n2)
14 VSWR=(1+p)/(1-p)
15 Pav=3.84^2/(2*n2)
16 printf("\nko=%.4f rad/m\nk2=%.4f rad/m\nn1=%.4f ohm\
   nn2=%.4f ohm\nR=%.2f\nT=%.2f \nVSWR=%.2f\nPav=%.4
   f W/m^2",ko,k2,n1,n2,R,T,VSWR,Pav)
```

Scilab code Exa 4.11 11

```
1
2  for m=1:1:3
3      qo=2.5*10^-2
4      fc=3*10^8*m/(9*10^-2)
5      qc=2*4.5*10^-2/m
6      printf("\nm=%f\nfc=%.4e Hz\nlambdaC=%.2e m",m,fc
          ,qc)
7      printf("\nTM0=%.4e Hz",fc)
8      q=qo/sqrt(1-(qo/qc)^2)
9      printf("\nlambda=%.4e m\n",q)
10 end
```

Scilab code Exa 4.12 12

```
1
2  a=0.0158
3  b=0.0079
4  f=15.8*10^9
```

```
5  //TE10
6  m=1
7  n=0
8  fc=3*10^8*sqrt((m/2/a)^2+(n/2/b)^2)
9  printf("\n(a)\nfor TE10 \n\tfc=%.4e Hz",fc)
10 Vp=3*10^8/sqrt(1-(fc/f)^2)
11 //TE20
12 m=2
13 n=0
14 fc=3*10^8*sqrt((m/2/a)^2+(n/2/b)^2)
15 printf("\nfor TE20 \n\tfc=%.4e Hz",fc)
16 //TE01
17 m=0
18 n=1
19 fc=3*10^8*sqrt((m/2/a)^2+(n/2/b)^2)
20 printf("\nfor TE01 \n\tfc=%.4e Hz",fc)
21 //TE11
22 m=1
23 n=1
24 fc=3*10^8*sqrt((m/2/a)^2+(n/2/b)^2)
25 printf("\nfor TE11 \n\tfc=%.4e Hz",fc)
26 printf("\n(c)\nVp=%4e m/s",Vp)
```

Chapter 5

resonant circuits

Scilab code Exa 5.1 1

```
1
2 //data
3 f2=9        //MHz
4 f1=11          //MHz
5 R=50            //ohm
6 W1=2*%pi*11*10^6        //rad/s
7 W2=2*%pi*9*10^6           //rad/s
8 //formula and result
9 printf("\nresult:-")
10 Wo=sqrt(W1*W2)
11 fo=sqrt(f1*f2)
12 printf("\nWo=sqrt(W1*W2)\nfo=sqrt(f1*f2)=%.6f MHz",
   fo)
13 L=R/(W1-W2)
14 printf("\nQ=Wo*L/R=Wo/(W1-W2)\nL=R/(W1-W2)=%.6e H",L
   )
15 C=1/(L*Wo^2)
16 printf("\nWo=1/sqrt(L*C)\nC=1/(L*Wo^2)=%.6e F",C)
```

Scilab code Exa 5.2 2

```
1
2 //data
3 Lp=10^(-5)      //H
4 Cp=10^(-11)      //F
5 Rp=10^5              //ohm
6 RL=10^5                //ohm
7 //formula and result
8 printf("\nresult:-")
9 Wo=1/sqrt(Lp*Cp)
10 printf("\nWo=1/sqrt(Lp*Cp)=%.0e rad/s",Wo)
11 Q=Rp/(Wo*Lp)
12 printf("\nQ=Rp/(Wo*Lp)=%.0f",Q)
13 Qe=RL/(Wo*Lp)
14 printf("\nQe=RL/(Wo*Lp)=%.0f",Qe)
15 QL=Q*Qe/(Q+Qe)
16 printf("\nQL=Q*Qe/(Q+Qe)=%.0f",QL)
```

Scilab code Exa 5.3 3

```
1
2 //data
3 R2=62.5*10^3      //ohm
4 E=1
5 L1=320*10^(-9)      //H
6 L2=20*10^(-9)          //H
7 //formula and result
8 printf("\nresult:-")
9 n=sqrt(E*L1/L2)
10 printf("\nn=sqrt(E*L1/L2)=%.0f",n)
11 R1=n^(2)*R2
12 printf("\nZ1=n^2*Z2\nY1=Y2/n^2=1/n^2*complex(1/R2,W*
    C2)\n\nR1=n^2*R2=%.0e ohm\n",R1)
13 C1=(6+1/4^2*30.7)*10^-12
```

```
14 printf("\nC1=%.2e F\n",C1)
15 Wo=1/sqrt(L1*C1)
16 printf("\nWo=1/sqrt(L1*C1)=%.4e rad/s\n",Wo)
17 fo=Wo/(2*%pi)
18 printf("\nfo=Wo/(2*pi)=%.2e Hz\n",fo)
19 Q=R1/(Wo*L1)
20 printf("\nQ=R1/(Wo*L1)=%.4f",Q)
```

Scilab code Exa 5.5 5

```
1
2 //data
3 a=0.455*10^-3      //m
4 b=1.499*10^-3      //m
5 W=2*%pi*5*10^9      //rad/s
6 uo=4*%pi*10^-7
7 q=5.813*10^7
8 Eo=8.854*10^-12
9 Er=2.08
10 d=0.0004
11 //formula and result
12 printf("\nresult:-")
13 Rs=sqrt(W*uo/2/q)
14 printf("\nRs=%f ohm",Rs)
15 ac=Rs*(1/a+1/b)/(2*log(b/a)*sqrt(uo/Eo))
16 printf("\nac=%f Np/m",ac)
17 ac=ac*sqrt(Er)
18 ad=W/2*sqrt(uo*Eo*Er)*(d)
19 Bo=2*%pi*5*10^9/(3*10^8)
20 Bd=2*%pi*5*10^9*sqrt(2.08)/(3*10^8)
21 a=0.058768
22 Qair=Bo/(2*a)
23 a=0.114963
24 Qteflon=Bd/(2*a)
25 printf("\n\twith teflon\n ac=%f Np/m\nad=%f Np/m\nBo
```

```
=%f rad/m\nBd=%f rad/m,\nQair=%f,\nQteflon=%f",ac
,ad,Bo,Bd,Qair,Qteflon)
```

Scilab code Exa 5.6 6

```
1
2  Zo=50
3  Er=2.08
4  B=60*%pi^2/Zo/sqrt(Er)
5  c=3*10^8
6  f=2*10^9
7  Ee=1.7875
8  t=0.159*10^-6
9  a=5.813*10^7
10 fGHz=2
11 A=Zo/60*((Er+1)/2)^(1/2)+(Er-1)/(Er+1)*(0.23+0.11/Er
   )
12 printf("\nA=%.4f\nB=%.4f",A,B)
13 h=1.59*10^-3
14 if A>1.52 then
15     W=h*(8*exp(A)/(exp(2*A)-2))
16 else
17     W=h*(2/%pi*(B-1-log(2*B-1)+(Er-1)/2/Er*(log(B-1)
       +0.39-0.61/Er)))
18 end
19 printf("\nW=%.6f cm",W)
20
21 Ere=0.5*(2.08+1+(2.08-1)/sqrt(1+12/3.192094))
   -(2.08-1)*0.0001/4.6/sqrt(3.1921)
22 printf("\nEre=%.4f",Ere)
23 l=c/(2*f*sqrt(Ee))
24 printf("\nl=%.6f m",l)
25 We=W/h+0.3979*t/h*(1+log(2*h/t))
26 printf("\nWe/h=%.4f",We)
27 F=1+1/We*(1-1.25*t/(%pi*h)+1.25/%pi*log(2*h/t))
```

```
ac=44.1255*10^-5*F*Zo*Ere/h*sqrt(fGHz/a)*(We+0.667*
   We/(We+1.444))
printf("\nac=%.4f Np/m",ac)
del=0.00040
ad=10.4766*Er/(Er-1)*(Ere-1)/sqrt(Ere)*fGHz*tan(del)
printf("\nad=%.4f Np/m",ad)
B=2*%pi/(2*l)
printf("\nB=%.4f rad/m",B)
Q=B/(2*(ac+ad))
printf("\nQ=%.1f",Q)
```

Scilab code Exa 5.7 7

```

a=2.286*10^-2
b=1.016*10^-2
f=9.379*10^9
c=1/2/sqrt((9379/300)^2-(1/2/a)^2)
printf("\nc=%.5f m = %.4f cm",c,c*100)
```

Scilab code Exa 5.8 8

```

//data
Er=2.05
ur=1
a=.016 //m
b=.0071    //m
c=.0156    //m
m=1
p=1
printf("\nresult:-")
fr=(300/sqrt(ur*Er))*sqrt((m/(2*a))^2+(p/(2*c))^2)
```

```
12 printf("\nfr=(300/sqrt(ur*Er))*sqrt((m/(2*a))^2+(p
    /(2*C))^2)\n =%.3e MHz",fr)
```

Scilab code Exa 5.9 9

```
1
2 w=2*%pi*5*10^9
3 u=4*%pi*10^-7
4 a=5.8*10^7
5 r=sqrt((3.832^2+(%pi/2)^2)/(5000*2*%pi/300)^2)
6 h=2*r
7 del=sqrt(2/(w*u*a))
8 printf("\ndel=%.4e m",del)
9 Qc=47.7465*10^6/(9.3459*10^-7*5*10^9)*(3.832^2+(%pi
    /2)^2)^1.5/((3.832^2+(%pi/2)^2)+1)
10 printf("\nQc=%.2f",Qc)
```

Scilab code Exa 5.10 10

```
1
2 fr=35*10^9
3 w=2*%pi*fr
4 Es=9.9
5 Er=36
6 uo=4*%pi*10^-7
7 Eo=8.8154*10^-12
8 z1=1.2892*10^8/(fr*sqrt(Es))
9 z2=1.2892*10^8/(fr*sqrt(Er))
10 r=0.835*10^-3
11 printf("\n1.2892*10^8/(fr*sqrt(Es))=%.3e m",z1)
12 printf("\n1.2892*10^8/(fr*sqrt(Er))=%.3e m",z2)
13 ko=w*sqrt(uo*Eo)
14 y=sqrt((ko*r)^2*(Er-1)-5.784)
```

```
15 printf("\ny=%.3f",y)
16 k_=2.405/r+y/(2.405*r*(1+2.43/y+0.291*y))
17 printf("\nk_=%.3e",k_)
18 a1=sqrt(k_^2-ko^2*Es)
19 a2=sqrt(k_^2-ko^2)
20 B=sqrt(ko^2*Er-k_^2)
21 printf("\na1=%.3e\na2=%.3e\nB=%.3e",a1,a2,B)
22 d=10^-3
23 t=.25*10^-3
24 h=1/B*(atan(a1/(B*tanh(a1*t)))+atan(a2/(B*tanh(a2*d)
   )))
25 printf("\nh=%.3e m",h)
```

Chapter 6

impedance matching networks

Scilab code Exa 6.1 1

```
1
2 //data
3 Zo=100
4 ZL=complex(50,-75)
5 B=2*%pi
6 XL=-0.75
7 RL=0.5
8 Y_L=Zo/ZL
9 //formulas and result
10 printf("\nresult:-")
11 G_L=real(Y_L)
12 B_L=imag(Y_L)
13 disp(Y_L,"Y_L=")
14 A=G_L*(G_L-1)+B_L^2
15 printf("\nA=%.4f",A)
16 ds=1/B*atan((XL+sqrt(XL^2-A*(1-RL)))/A)
17 printf("\nds=%f*lambda",ds)                    //
     calculation mistake in book
18 ds=1/B*atan((XL-sqrt(XL^2-A*(1-RL)))/A)
19 printf("\nds=%f*lambda",ds)
20 X_s=-1.2748
```

```
21 Ls=1/B*acot(X_s)
22 printf("\nLs=%f*lambda",Ls)
23 X_s=1.2748
24 Ls=1/B*acot(X_s)
25 printf("\nLs=%f*lambda",Ls)
```

Scilab code Exa 6.3 3

```
1
2 FL=0.4*exp(-%i*30*%pi/180)
3 Fin=0.2*exp(%i*45*%pi/180)
4 Z_L=(1+FL)/(1-FL)
5 Z_in=(1+Fin)/(1-Fin)
6 Y_in=(1-Fin)/(1+Fin)
7 disp(Z_L,"Z_L=")
8 disp(Z_in,"Z_in=")
9 disp(Y_in,"Y_in=")
10 //Y_in=(1+%i*Z_L*tan(Bl))/(Z_L+%i*tan(Bl))
11 Y_in=1/Z_in
12 disp(Y_in,"Y_in=")
```

Scilab code Exa 6.5 5

```
1
2 RL=50
3 Rs=75
4
5 R1=sqrt(Rs*(Rs-RL))
6 R2=sqrt(RL^2*Rs/(Rs-RL))
7 attenuation=20*log10(R2*RL/(R1*(R2+RL)+R2*RL))
8 printf("\nR1=%.1f ohm\nR2=%.1f ohm\nattenuation(dB)=
    %.2f dB",R1,R2,attenuation)
```

Scilab code Exa 6.6 6

```
1
2 Rp=600
3 Rs=50
4 W=2*%pi*400*10^6
5 Q=sqrt(Rp/Rs-1)
6 Xs=Q*Rs
7 Xp=Rp/Q
8 Cs=1/W/Xs
9 Lp=Xp/W
10 Ls=Xs/W
11 Cp=1/W/Xp
12 printf("\nQ=%.4f\nXs=%.4f ohm\nXp=%.4f ohm\nCs=%.2e
    F\nLp=%.3e H\nLs=%.3e H\nCp=%.2e F",Q,Xs,Xp,Cs,Lp
    ,Ls,Cp)
```

Scilab code Exa 6.7 7

```
1
2 Rp=600    //ohm
3 Rs=173.2      //ohm
4 Q=sqrt(Rp/Rs-1)
5 Xs=Q*Rs
6 Xp=Rp/Q
7 printf("\nQ=%.4f\nXs=%.4f ohm\nXp=%.4f ohm\n",Q,Xs,
    Xp)
8 Rp=173.2      //ohm
9 Rs=50           //ohm
10 Q=sqrt(Rp/Rs-1)
11 Xs=Q*Rs
12 Xp=Rp/Q
```

```
13 printf("\nQ=%.4f\nXs=%.4f ohm\nXp=%.4f ohm\n",Q,Xs,
   Xp)
```

Scilab code Exa 6.8 8

```
1
2 f=500*10^6
3 W=2*%pi*f
4 Rp=50
5 Rs=10
6 Q=sqrt(Rp/Rs-1)
7 Xs=Q*Rs
8 Xp=Rp/Q
9 Ls=(Xs-10)/W
10 Cp=1/W/Xp
11 Cs=1/W/(Xs+10)
12 Lp=Xp/W
13 printf("\nQ=%.0f\nXs=%.0f ohm\nXp=%.0f ohm\nLs=%.4e
   H\nCp=%e F\nCs=%e F\nLp=%e H",Q,Xs,Xp,Ls,Cp,Cs,Lp
   )
```

Scilab code Exa 6.9 9

```
1
2 ZL=10^3/(8-%i*12)
3 Rp=50
4 W=2*%pi*10^9
5 Rs=real(ZL)
6 Q=sqrt(Rp/Rs-1)
7 Xs=Q*Rs
8 Xc=Xs+imag(ZL)
9 Xp=Rp/Q
10 C=1/W/Xc
```

```
11 L=Xp/W
12 disp(ZL,"ZL=")
13 printf("\nQ=%.4f\nXs=%.4f ohm\nXp=%.4f ohm\nC=%.4e F
       \nL=%.4e H\n",Q,Xs,Xp,C,L)
14 printf("\nXs=57.6923-21.0654 ohm\nXp=91.2909 ohm\nCp
       =1.7434 F")
```

Scilab code Exa 6.10 10

```
1
2 W=2*%pi*10^9
3 Gs=0.02
4 Gp=0.008
5 Q=sqrt(Gs/Gp-1)
6 Bs=Gs/Q
7 Bp=Q*Gp
8 printf("\nQ=%.4f\nBs=%.4f S\nBp=%.2f S\n",Q,Bs,Bp)
```

Chapter 7

impedance transformers

Scilab code Exa 7.1 1

```
1
2 RL=100
3 Zo=50
4 PM=0.05
5 c=3*10^8
6 f=900*10^6
7 lambda=c/f
8 Z1=sqrt(RL*Zo)
9 l=lambda/4
10 fractional_bandwidth=2-4/%pi*acos(abs(2*PM*sqrt(Zo*
    RL)/(RL-Zo)/sqrt(1-PM^2)))
11 printf("\nZ1=%f ohm\nl=%.4f m\nfractional bandwidth=
    %.7f",Z1,l,fractional_bandwidth)
```

Scilab code Exa 7.5 5

```
1
2 delf=0.6
```

```
3  fo=1
4  Zo=100
5  Qz=acos(1/sqrt(2)*cos((2-delf/fo)/4*%pi))
6  Qm=acos(sqrt(2)*cos(Qz))
7  Z_L=5
8  k=sqrt((Z_L-1)^2/4/Z_L*cotg(Qz)^4)
9  Pm=sqrt(k^2/(1+k^2))
10 Z1=sqrt(((Z_L-1)^2/4/tan(Qz)^4+Z_L)^(1/2)+(Z_L-1)/2/
     tan(Qz)^2)
11 Z2=Z_L/Z1*Zo
12 Z_in=Z1^2/Z2^2*Z_L*10^4
13 F=(Z_in-1)/(Z_in+1)
14 printf("\nQz=%.4f rad\nQm=%.1f\nk=%.4f\nPm=%.4f\nZ_1
     =%.2f ohm\nZ2=%.2f ohm\nZ-in=%.4f\nF=%.4f",Qz,Qm,
     k,Pm,Z1,Z2,Z_in,F)
```

Chapter 8

two port networks

Scilab code Exa 8.1 1

```
1
2  I1=1
3  V1=6*I1
4  Z11=V1/I1
5  V2=6*I1
6  Z21=V2/I1
7  I2=1
8  V1=6*I2
9  Z12=V1/I2
10 V2=6*I2
11 Z22=V2/I2
12 A=[Z11,Z12;Z21,Z22]
13 printf("\nA=")
14 disp(A)
```

Scilab code Exa 8.2 2

```
1
```

```
2  I1=1
3  V1=12*I1
4  V2=0
5  Z21=V2/I1
6  Z11=V1/I1
7  I2=1
8  V2=3*I2
9  V1=0
10 Z12=V1/I2
11 V2=3*I2
12 Z22=V2/I2
13 A=[Z11,Z12;Z21,Z22]
14 printf("\nA=")
15 disp(A)
```

Scilab code Exa 8.3 3

```
1
2  I1=1
3  V1=18*I1
4  V2=6*I1
5  Z11=V1/I1
6  Z21=V2/I1
7  I2=1
8  V2=9*I2
9  V1=6*I2
10 Z12=V1/I2
11 Z22=V2/I2
12 A=[Z11,Z12;Z21,Z22]
13 printf("\nA=")
14 disp(A)
```

Scilab code Exa 8.5 5

```
1
2 V2=1
3 V1=1
4 V2=0
5 I1=0.05*V1
6 I2=-0.05*V1
7 Y11=I1/V1
8 Y21=I2/V1
9 I2=0.05*V2
10 I1=-0.05*V2
11 Y12=-0.05
12 Y22=0.05
13 A=[Y11,Y12;Y21,Y22]
14 printf("\nA=")
15 disp(A)
```

Scilab code Exa 8.6 6

```
1
2 V1=1
3 V2=1
4 I1=0.0225/0.325*V1
5 VN=I1/(0.2+0.025)
6 I2=-0.2*VN
7 Y11=I1/V1
8 Y21=I2/V1
9 I2=0.025/0.325*V2
10 VM=I2/(0.1+0.025)
11 I1=-0.1*VM
12 Y12=I1/V2
13 Y22=I2/V2
14 A=[Y11,Y12;Y21,Y22]
15 printf("\nA=")
16 disp(A)
```

Scilab code Exa 8.7 7

```
1
2 V1=1
3 V2=1
4 I1=0.1192*V1
5 IN=0.05*I1/(0.05+(0.1*(0.2+0.025)/(0.1+0.2+0.025)))
6 IM=0.2*0.0692*V1/(0.2+0.025)
7 I2=-(IN+IM)
8 Y11=I1/V1
9 Y21=I2/V1
10 I2=(0.05+0.2*(0.1+0.025)/(0.2+0.1+0.025))*V2
11 IN=0.05*I2/(0.05+(0.2*(0.1+0.025)/(0.2+.1+0.025)))
12 IM=0.1*0.0769*V2/(0.1+0.025)
13 I1=-(IN+IM)
14 Y12=I1/V2
15 Y22=I2/V2
16 A=[Y11,Y12;Y21,Y22]
17 printf("\nA=")
18 disp(A)
```

Scilab code Exa 8.9 9

```
1
2 I1=1
3 V1=14*I1
4 I2=-2/3*I1
5 h11=V1/I1
6 h21=I2/I1
7 V2=9*I2
8 V1=6*I2
9 h12=V1/V2
```

```
10 h22=I2/V2
11 A=[h11,h12;h21,h22]
12 printf("\nA=")
13 disp(A)
```

Scilab code Exa 8.10 10

```
1
2 I1=1
3 I2=-I1
4 V1=I1
5 B=-V1/I2
6 D=-I1/I2
7 V2=V1
8 I1=0
9 A=V1/V2
10 C=I1/V2
11 M=[A,B;C,D]
12 printf("\nA=")
13 disp(M)
```

Scilab code Exa 8.14 14

```
1
2 V1in=.5*(10*exp(%i*%pi/180*0)+50*.1*exp(%i*%pi
    /180*40))
3 disp(V1in)
4 V1ref=0.5*(10*exp(%i*%pi/180*0)-50*.1*exp(%i*%pi
    /180*40))
5 disp(V1ref)
6 V2in=0.5*(12*exp(%i*%pi/180*30)+50*.15*exp(%i*%pi
    /180*100))
7 disp(V2in)
```

```
8 V2ref=0.5*(12*exp(%i*%pi/180*30)-50*.15*exp(%i*%pi
    /180*100))
9 disp(V2ref)
```

Scilab code Exa 8.17 17

```
1
2 n=10
3 S11=(n^2-1)/(n^2+1)
4 S21=2*n/(n^2+1)
5 S22=(1-n^2)/(1+n^2)
6 S12=2*n/(n^2+1)
7 A=[S11,S12;S21,S22]
8 disp(A)
```

Scilab code Exa 8.19 19

```
1
2 Zo1=50
3 Zo2=50
4 Vs1=1
5 Vs2=1
6 Z1=%i*50+50*(-%i*25)/(50-%i*25)
7 S11=(Z1-Zo1)/(Z1+Zo1)
8 Z2=(50+%i*50)*(-%i*25)/(50+%i*50-25*%i)
9 S22=(Z2-Zo2)/(Z2+Zo2)
10 V2=(10-%i*20)/(50+%i*50+10-%i*20)*Vs1
11 S21=2*V2/Vs1
12 V2=(10-%i*30)/(50+10-%i*30)*Vs2
13 V1=50/(50+%i*50)*V2
14 S12=2*V1/Vs2
15 A=[S11,S12;S21,S22]
16 disp(A,"A=")
```

Chapter 9

filter design

Scilab code Exa 9.2 2

```
1
2 foo=2.05*10^6
3 fc=2*10^6
4 Zo=75
5 Wc=2*%pi*2*10^6
6 L=Zo/Wc*2
7 C=2/(Zo*Wc)
8 m=sqrt(1-(fc/foo)^2)
9 printf("\nm=%.4f",m)
10 printf("\nm*L/2=%.2e H",m*L/2)
11 printf("\nm*C=%.3e F",m*C)
12 printf("\n(1-m^2)*L/4/m=%.2e",(1-m^2)*L/4/m)
```

Scilab code Exa 9.3 3

```
1
2 Zo=75
3 Wc=2*%pi*2*10^6
```

```
4  foo=2.05*10^6
5  L=Zo/Wc*2
6  m=0.6
7  C=2/(Zo*Wc)
8  printf("\nm*L/2=%.2e H",m*L/2)
9  printf("\nm*C=%.3e F",m*C/2)
10 printf("\n(1-m^2)*L/4/m=%.2e",(1-m^2)*L/2/m)
```

Scilab code Exa 9.4 4

```
1
2  Zo=75
3  Wc=2*%pi*2*10^6
4  foo=1.95*10^6
5  fc=2*10^6
6  L=Zo/Wc/2
7  C=1/2/(Zo*Wc)
8  m=sqrt(1-(foo/fc)^2)
9  printf("\nL=%.3e H",L)
10 printf("\nC=%.3e F",C)
11 printf("\nm=%.4f",m)
12 printf("\n2*C/m=%.4e F",2*C/m)
13 printf("\nL/m=%.4e H",L/m)
14 printf("\n4*m*C/(1-m^2)=%.4e F",4*m*C/(1-m^2))
```

Scilab code Exa 9.5 5

```
1
2  Le=3
3  E=10^(Le/10)-1
4  L=15
5  Wc=1
6  W=1.3*Wc
```

```
7  n=1/2*(log10(10^(L/10)-1)-log10(E))/log10(W/Wc)
8  m=acosh(sqrt(10^(0.1*L)-1))/acosh(W/Wc)
9  printf("\nn=%.2f",n)
10 printf("\nm=%.3f",m)
```

Scilab code Exa 9.6 6

```
1
2  L=30
3  W=40*10^6
4  Wc=10*10^6
5  Le=3
6  E=10^(Le/10)
7  Zo=50
8  Wc=2*%pi*10^6*10
9  L=Zo/Wc
10 C=2/(Zo*Wc)
11 n=1/2*(log10(10^(L/10)-1)-log10(E))/log10(W/Wc)
12 printf("\nn=%.2f",n)
13 printf("\ng1=%.0f\ng2=%.0f\ng3=%.0f",2*sin(%pi/6),2*
       sin(%pi/2),2*sin(%pi*5/6))
14 printf("\n")
15 printf("\nL1=L3=%.4e H",L)
16 printf("\nC2=%.3e F",C)
17 Zo=50
18 Wc=2*%pi*10^6*10
19 L=Zo*2/Wc
20 C=1/(Zo*Wc)
21 printf("\nL2=%.4e H",L)
22 printf("\nC1=C3=%.4e F",C)
```

Scilab code Exa 9.7 7

```
1
2 Gr=0.01
3 m=acosh(sqrt(10^(0.1*L)-1)/sqrt(10^(0.1*Gr-1)))/
     acosh(W/Wc)
4 printf("\nm=%.0f\n",m)
5 m=3
6 E=log(coth(Gr/17.37))
7 X=sinh(E/2/m)
8 n=3
9 gp=1
10
11 for p=1:1:n
12     ap=sin((2*p-1)*%pi/2/m)
13     bp=X^2+sin(p*%pi/m)^2
14     printf("\nap=%.4f\nbp=%.4f\n",ap,bp)
15 end
16 gp=0.62425
17 printf("\ng0=g4=1")
18 printf("\np=1\tgp=0.62425")
19 for p=2:1:n
20     gp=4*sin((2*(p-1)-1)*%pi/2/m)*sin((2*p-1)*%pi/2/
         m)/(X^2+sin((p-1)*%pi/m)^2)/gp
21      printf("\np=%.0f\tgp=%.5f",p,gp)
22 end
23
24 printf("\nL1=L3=%.4e H\nC1=%.4e F",75*0.62425/(2*%pi
     *10^8),0.9662/(75*2*%pi*10^8))
```

Scilab code Exa 9.8 8

```
1
2 m=3
3 for p=1:1:3
4     ap=sin((2*p-1)*%pi/2/m)
5     printf("\np=%.0f\tap=%.3f",p,ap)
```

```
6  end
7  Gr=3
8
9  E=log(coth(Gr/17.37))
10 X=sinh(E/2/m)
11 printf("\nE=%.4f\nX=%.4f",E,X)
12 for p=1:1:3
13     bp=X^2+sin(p*%pi/m)^2
14     printf("\np=%.0f\tbp=%.4f",p,bp)
15 end
16 gp=3.349
17 printf("\ng0=g4=1\ng1=3.349")
18 for p=2:1:3
19     gp=4*sin((2*(p-1)-1)*%pi/2/m)*sin((2*p-1)*%pi/2/
       m)/(X^2+sin((p-1)*%pi/m)^2)/gp
20     printf("\ngp=%.4f",gp)
21 end
22 printf("\nL1=L3=%.1e H\nC2=%.4e F",75*3.349/(2*%pi
   *10^8),0.7116/(75*2*%pi*10^8))
```

Scilab code Exa 9.9 9

```
1
2  gL=0.62425
3  gc=0.9662
4  m=3
5  Wc=2*%pi*100*10^6
6  CHP=1/(Wc*gL)
7  LHP=1/(Wc*gc)
8  printf("\nCHP=%.3e F\nLHP=%.3e H",CHP,LHP)
9  C1=2.5495/75*10^3
10 L2=75*1.6472
11 printf("\nC1=C3=%.0f pF\nL2=%.1f nH",C1,L2)
```

Scilab code Exa 9.10 10

```
1
2 fl=10*10^6
3 fu=40*10^6
4 Wu=2*%pi*40*10^6
5 Wl=2*%pi*10*10^6
6 gc=0.9662
7 gL=0.62425
8 Wo=2*%pi*20*10^6
9 fo=sqrt(fl*fu)
10 printf("\nfo=%.2e Hz",fo)
11
12 CBP1=(Wu-Wl)/(Wo^2*gL)
13 LBP1=gL/(Wu-Wl)
14 printf("\nCBP1=%.3e F\nLBP1=%.4e H",CBP1,LBP1)
15
16 CBP2=(Wu-Wl)/(Wo^2*gc)
17 LBP2=gc/(Wu-Wl)
18 printf("\nCBP2=%.3e F\nLBP2=%.4e H",CBP2,LBP2)
19
20
21 printf("\nC1=C3=%.2f pF",19.122*1000/75)
22
23 printf("\nL1=L3=%.4f nH",75*3.3116)
24
25 printf("\nL2=%.4f uH",75*12.354/1000)
26
27 printf("\nC2=%.3f pF",5.1258/75*1000)
```

Scilab code Exa 9.11 11

```
1
2 fl=10*10^6
3 fu=40*10^6
4 Wu=2*%pi*40*10^6
5 Wl=2*%pi*10*10^6
6 gc=2
7 gL=1
8 Wo=2*%pi*20*10^6
9 fo=sqrt(fl*fu)
10 printf("\nfo=%.2e Hz",fo)
11
12 CBP1=(Wu-Wl)/(Wo^2*gL)
13 LBP1=gL/(Wu-Wl)
14 printf("\nCBS1=%.3e F\nLBS1=%.4e H",CBP1,LBP1)
15 LBP2=1/gc/(Wu-Wl)
16 CBP2=(Wu-Wl)*gc/(Wo^2)
17
18 printf("\nCBP2=%.3e F\nLBP2=%.4e H",LBP2,CBP2)
19
20
21 printf("\nC1=C3=%.2f pF",5.305/75*1000)
22
23 printf("\nL1=L3=%.4f nH",75*11.94)
24
25 printf("\nL2=%.4f uH",75*2.653/1000)
26
27 printf("\nC2=%.3f pF",23.87/75*1000)
```

Scilab code Exa 9.12 12

```
1
2
3 printf("\ngo=g4=1")
4 n=3
5 for p=1:1:3
```

```
6       gp=2*sin((2*p-1)*%pi/2/n)
7           printf("\ngp=%.2f",gp)
8   end
9
10  printf("\nQ1=Q3=%.4f rad=%.1f degree"
        ,50/150,50/150*180/%pi)
11  printf("\nQ2=%.2f rad=%.2f degree"
        ,30*2/50,30*2/50*180/%pi)
```

Scilab code Exa 9.13 13

```
1
2   n=3
3   printf("\ngo=g4=1")
4   for p=1:1:3
5       gp=2*sin((2*p-1)*%pi/2/n)
6           printf("\ngp=%.2f",gp)
7   end
```

Chapter 10

signal flow graphs and their applications

Scilab code Exa 10.10 10

```
1
2 Zs=20
3 Zo=50
4 ZL=30
5 S11=0.45*exp(%i*150*%pi/180)
6 S21=0.01*exp(-10*%pi/180*%i)
7 S12=2.05*exp(10*%pi/180*%i)
8 S22=0.4*exp(-150*%pi/180*%i)
9 function x=mod(n)
10     r=real(n)
11     i=imag(n)
12     x=sqrt(r^2+i^2)
13 endfunction
14 Fs=(Zs-Zo)/(Zs+Zo)
15 printf("\nFs=(Zs-Zo)/(Zs+Zo)=%.3f",Fs)
16 FL=(ZL-Zo)/(ZL+Zo)
17 printf("\nFL=(ZL-Zo)/(ZL-Zo)=%.3f",FL)
18 Fin=S11+(S21*S12*FL)/(1-S22*FL)
19 disp(Fin,"Fin=")
```

```
20 Fout=S22+(S21*S12*Fs)/(1-S11*Fs)
21 disp(Fout,"Fout=")
22 GT=(1-mod(Fs)^2)*mod(S12)^2/mod(1-S11*Fs)^2*(1-mod(
      FL)^2)/mod(1-Fout*FL)^2
23 printf("\nGT=%.4f",GT)
24 GP=mod(S12)^2*(1-mod(FL)^2)/mod(1-S22*FL)^2/(1-mod(
      Fin)^2)
25 printf("\nGP=%.4f",GP)
26 GA=(1-mod(Fs)^2)/mod((1-S11*Fs))^2*mod(S12)^2/(1-mod
      (Fout)^2)
27 printf("\nGA=%.4f",GA)
28
29 printf("\nGT(dB)=%.1f dB\nGP(dB)=%.2f dB\nGA(dB)=%.2
      f dB",10*log10(GT),10*log10(GP),10*log10(GA))
```

Scilab code Exa 10.11 11

```
1
2 Zo=50
3 S11=0.97*exp(-43*%i*%pi/180)
4 S12=0.0
5 S21=3.39*exp(%i*140*%pi/180)
6 S22=0.63*exp(-%i*32*%pi/180)
7 FL=0.63*exp(%i*32*%pi/180)
8 Fs=0.97*exp(%i*43*%pi/180)
9 function x=mod(n)
10     r=real(n)
11     i=imag(n)
12     x=sqrt(r^2+i^2)
13 endfunction
14 Fin=S11+S12*S21*FL/(1-S22*FL)
15 Fout=S22+S21*S12*Fs/(1-S11*Fs)
16 GTU=(1-mod(Fs)^2)/mod(1-mod(S11)*mod(Fs))^2*mod(S21)
      ^2*(1-mod(FL)^2)/mod(1-mod(S22)*mod(FL))^2
17 printf("\nGTU=%.4f",GTU)
```

```
18 GP=1/(1-mod(Fin)^2)*mod(S21)^2*(1-mod(FL)^2)/(1-mod(
      S22)*mod(FL))^2
19 printf("\nGP=%.4f",GP)
20 GA=(1-mod(Fs)^2)*mod(S21)^2/(1-mod(S11)*mod(Fs))
      ^2/(1-mod(Fout)^2)
21 printf("\nGA=%.4f",GA)
```

Chapter 11

transistor amplifier design

Scilab code Exa 11.1 1

```
1
2 function x=mod(n)
3     r=real(n)
4     i=imag(n)
5     x=sqrt(r^2+i^2)
6 endfunction
7 S11=0.894*exp(-%i*60.6*%pi/180)
8 S12=0.02*exp(%i*62.4*%pi/180)
9 S21=3.122*exp(%i*123.6*%pi/180)
10 S22=0.781*exp(-%i*27.6*%pi/180)
11 del=mod(S11*S22-S12*S21)
12 k=(1+mod(del)^2-mod(S11)^2-mod(S22)^2)/2/mod(S12*S21
   )
13 disp(del,"|del|=mod(S11*S22-S12*S21)=")
14 disp(k,"k=(1+mod(del)^2-mod(S11)^2-mod(S22)^2)/2*mod
   (S12*S21)=")
```

Scilab code Exa 11.2 2

```
1
2 Zo=50
3 S11=0.6*exp(-%i*155*%pi/180)
4 S22=0.48*exp(-%i*20*%pi/180)
5 S12=0
6 S21=6*exp(%i*180*%pi/180)
7 Ss11=0.606*exp(%i*155*%pi/180)
8 Ss22=0.48*exp(%i*20*%pi/180)
9 function x=mod(n)
10     r=real(n)
11     i=imag(n)
12     x=sqrt(r^2+i^2)
13 endfunction
14 //k=(1-mod(S11)^2-mod(S22)^2+mod(del)^2)/(2*mod(S12*
     S21))
15 del=mod(S11*S22-S12*S21)
16 disp(mod(del),"mod(del)=")
17 GTUmax=(1-mod(Ss11)^2)*mod(S21)^2/mod((1-mod(S11)^2)
     )^2*(1-mod(Ss22)^2)/mod((1-mod(S22)^2))^2
18 disp(GTUmax,"GTUmax=")
19 disp(10*log10(GTUmax),"GTUmax in dB=")
```

Scilab code Exa 11.3 3

```
1
2 S11=0.614*exp(-%i*167.4*%pi/180)
3 S21=2.187*exp(%i*32.4*%pi/180)
4 S12=0.046*exp(%i*65*%pi/180)
5 S22=0.716*exp(-%i*83*%pi/180)
6 del=(S11*S22-S12*S21)
7 B1=1+mod(S11)^2-mod(S22)^2-mod(del)^2
8 B2=1+mod(S22)^2-mod(S11)^2-mod(del)^2
9 C1=S11-Ss22*del
10 C2=S22-Ss11*del
11 function x=mod(n)
```

```
12      r=real(n)
13      i=imag(n)
14      x=sqrt(r^2+i^2)
15  endfunction
16
17  disp(mod(del),"del=")
18  k=(1-mod(S11)^2-mod(S22)^2+mod(del)^2)/(2*mod(S12*
       S21))
19  disp(k,"k=")
20  FMS=(B1-sqrt(B1^2-4*mod(C1)^2))/(2*C1)
21  disp(FMS,"FMS=")
22  FML= (B2-sqrt(B2^2-4*mod(C2)^2))/(2*C2)
23  disp(FML,"FML=")
24  GTmax=mod(S21)/mod(S12)*(k-sqrt(k^2-1))
25  printf("\nGTmax=%.3f",GTmax)
26  printf("\nGTmax in dB=%.2f dB",10*log10(GTmax))
```

Scilab code Exa 11.4 4

```
1
2  //for transistor A
3  function x=mod(n)
4      r=real(n)
5      i=imag(n)
6      x=sqrt(r^2+i^2)
7  endfunction
8
9  S11=0.45*exp(%i*%pi/180*150)
10 S12=0.01*exp(-%i*%pi/180*10)
11 S21=2.05*exp(%i*%pi/180*10)
12 S22=0.4*exp(-%i*%pi/180*150)
13 UA=(mod(S12)*mod(S21)*mod(S11)*mod(S22))/(1-mod(S11)
       ^2)/(1-mod(S22)^2)
14 disp(UA,"UA=")
15 //for transistor B
```

```
16 S11=0.641*exp(-%i*%pi/180*171.3)
17 S12=0.057*exp(%i*%pi/180*16.3)
18 S21=2.058*exp(%i*%pi/180*28.5)
19 S22=0.572*exp(-%i*%pi/180*95.7)
20 UB=(mod(S12)*mod(S21)*mod(S11)*mod(S22))/(1-mod(S11)
      ^2)/(1-mod(S22)^2)
21 disp(UB,"UB=")
```

Scilab code Exa 11.5 5

```
1
2 S11=0.75*exp(-%i*120*%pi/180)
3 S22=0.6*exp(-%i*70*%pi/180)
4 S21=2.5*exp(%i*80*%pi/180)
5 function x=mod(n)
6     r=real(n)
7     i=imag(n)
8     x=sqrt(r^2+i^2)
9 endfunction
10 GSmax=1/(1-mod(S11)^2)
11 GLmax=1/(1-mod(S22)^2)
12 Go=mod(S21)^2
13 disp(GSmax,"GSmax=")
14 disp(10*log10(GSmax),"GSmax in dB=")
15 disp(GLmax,"GLmax=")
16 disp(10*log10(GLmax),"GLmax in dB=")
17 disp(Go,"Go=")
18 disp(10*log10(Go),"Go in dB=")
19 GTUmax=10*log10(GSmax*GLmax*Go)
20 disp(GTUmax,"GTUmax=")
```

Scilab code Exa 11.6 6

```
1
2  Gs=10^0.5
3  S11=2.27*exp(-%i*%pi/180*120)
4  S21=4*exp(%i*%pi/180*50)
5  S12=0
6  S22=0.6*exp(-%i*%pi/180*80)
7  Ss11=2.27*exp(%i*%pi/180*120)
8  function x=mod(n)
9      r=real(n)
10     i=imag(n)
11     x=sqrt(r^2+i^2)
12 endfunction
13 //(b)
14 gs=Gs*(1-mod(S11)^2)
15 Rs=(1-mod(S11)^2)*sqrt(1-gs)/(1-(1-gs)*mod(S11)^2)
16 ds=gs*(Ss11)/(1-(1-gs)*mod(S11)^2)
17 printf("\nGs=%.4f\ngs=%.4f\nRs=%.4f",Gs,gs,Rs)
18 disp(ds,"ds=")
19 Gs=10^.3
20 gs=Gs*(1-mod(S11)^2)
21 Rs=(1-mod(S11)^2)*sqrt(1-gs)/(1-(1-gs)*mod(S11)^2)
22 ds=gs*(Ss11)/(1-(1-gs)*mod(S11)^2)
23 printf("\nGs=%.4f\ngs=%.4f\nRs=%.4f",Gs,gs,Rs)
24 disp(ds,"ds=")
25 GLmax=1/(1-mod(S22)^2)
26 disp(GLmax,"GLmax=")
27 Go=mod(S21)^2
28 disp(Go,"Go=")
29 GTU=3+10*log10(GLmax*Go)
30 printf("\nGTU=%.4f  dB",GTU)
```

Chapter 12

oscillator design

Scilab code Exa 12.1 1

```
1
2 R1=10000
3 R2=1
4 C=.002*10^-6
5 L=10^-6
6 //B=complex(0,W*L)/complex(R1-W^2*R2*C*L,W*(L+R1*R2*
    C))
7 W=sqrt(R1/(R2*L*C))
8 printf("\nW=sqrt(R1/(R2*L*C))=%.2e rad/s",W)
9 f=W/(2*%pi)
10 printf("\nf=W/(2*pi)=%.3eHz",f)
11 A=1+R1*R2*C/L
12 printf("\nA=1+R1*R2*C/L=%.3f",A)
```

Scilab code Exa 12.2 2

```
1
2 //unit in SI
```

```
3  L1=10^-9
4  L2=10^-9
5  Go=4.5*10^-3
6  RL=50
7  W=2*%pi*150*10^6
8  n=sqrt(1/(Go*RL))
9  disp(n,"n=")
10 L3=L2/n^2
11 printf("\nconsidering L1=L2=1nH")
12 printf("\nL3=L2/n^2=%.4e H",L3)
13 C=1/((L1+L2)*W^2)
14 printf("\nC=1/((L1+L2)*W^2)=%.5e F",C)
```

Scilab code Exa 12.4 4

```
1
2  Cvar=3.5*10^-12
3  C1=150*10^-12
4  C2=72*10^-12
5  L=32*10^-9
6  C=Cvar+C1*C2/(C1+C2)
7  f=1/(2*%pi*sqrt(L*C))
8  printf("\nC=%.3e F\nf=%.3e Hz\n",C,f)
9  Cvar=32*10^-12
10 C=Cvar+C1*C2/(C1+C2)
11 f=1/(2*%pi*sqrt(L*C))
12 printf("\nC=%.3e F\nf=%.3e Hz\n",C,f)
13 Cvar=3.5*10^-12
14 C=Cvar+C1*C2/(C1+C2)
15 f=1/(2*%pi*sqrt(L*C))
16 printf("\nC=%.3e F\nf=%.3e Hz",C,f)
```

Scilab code Exa 12.5 5

```
1
2 Ve=2
3 Be=%pi/2
4 Kd=Ve/sin(Be)
5 printf("\nKd=%.0f",Kd)
6 //Ko=dW/Vd
7 Ko=2*%pi*100*1000
8 dWH=Kd*Ko
9 printf("\ndWH=Kd*Ko=%.4e rad/s",dWH)
10 dfH=dWH/(2*%pi)
11 printf("\ndfH=dWH/(2*pi)=%.4e Hz",dfH)
```

Scilab code Exa 12.6 6

```
1
2 Ve=2
3 Bemax=%pi/2
4 Kd=Ve/Bemax
5 printf("\nKd=%.4f",Kd)
6 Ko=2*%pi*10^5
7 dWH=Kd*Ko*Bemax
8 printf("\ndWH=Kd*Ko*Bemax=%.4e rad/s",dWH)
9 printf("\ndfH=dWH/(2*pi)=%.2e Hz",dWH/(2*%pi))
```

Scilab code Exa 12.7 7

```
1
2 Vin=2  //Volt
3 Vosc=2    //Volt
4 VPD=2  //volt
5 Ein=0.75
6 Eosc=0.75
7 Vd=1
```

```
dW=2*%pi*10^7
Km=VPD/(Vin*Vosc)
printf("\nKm=%.1f V^-1",Km)
Kd=0.5*Km*Ein*Eosc
Ko=dW/Vd
//(a)
qd=2*%pi*(11-10)*10^6/(Ko*Kd)
printf("\n(a)qd=%.4f rad = %.4f degree\n",qd,qd*180/
   %pi)
//(b)
qd=2*%pi*(9-10)*10^6/(Ko*Kd)
printf("\n(b)qd=%.4f rad = %.4f degree",qd,qd*180/
   %pi)
```

Scilab code Exa 12.8 8

```

Wo=2*%pi*2*10^6
Wf=2*%pi*2.5*10^6
Ko=10^7
Ka=10
Kd=0.5
N=20
E=0.8
Wn=10^4
C2=0.5*10^-6
Vd=(Wo-Wf)/Ko
Ve=Vd/Ka
Qe=Ve/Kd
K=Kd*Ka*Ko/N
dW=sqrt(2*(2*E*Wn*K-Wn^2))
df=dW/(2*%pi)
T1=K/Wn^2
T2=2*E/Wn-1/K
R2=T2/C2
```

```
20 R1=T1/C2-R2
21 printf("\nVd=%.4f V\nVe=%.4f V\nQe=%.4f rad\nK=%.2e\
   ndW=%.4e rad/s\ndf=%.4e Hz\nT1=%.4f s\nT2=%.4e s\
   nR2=%.2f ohm\nR1=%.3f ohm",Vd,Ve,Qe,K,dW,df,T1,T2
   ,R2,R1)
```

Scilab code Exa 12.11 11

```
1
2 FG=1.25*exp(%i*40*%pi/180)
3 Z_G=(1+FG)/(1-FG)
4 disp(Z_G)
```

Scilab code Exa 12.12 12

```
1
2 Z=50
3 S11=2.18*exp(%i*%pi/180*(-35))
4 S21=2.75*exp(%i*%pi/180*(96))
5 S12=1.26*exp(%i*%pi/180*(18))
6 S22=0.52*exp(%i*%pi/180*(155))
7 FL=0.59*exp(%i*%pi/180*(-104))
8 function [x]=mod(n)
9     r=real(n)
10    i=imag(n)
11    x=sqrt(r^2+i^2)
12 endfunction
13 del=S11*S22-S12*S21
14 k=(1-mod(S11)^2-mod(S22)^2+mod(del)^2)/(2*mod(S12*
   S21))
15 disp(del,"del=")
16 printf("\nk=%.2f",k)
17 Cs=conj(S11-del*conj(S22))/(mod(S11)^2-mod(del)^2)
```

```
18 disp(Cs,"Cs")
19 rs=mod((S12*S21)/(mod(S11)^2-mod(del)^2))
20 printf("\nrs=%.3f",rs)
21 CL=conj(S22-del*conj(S11))/(mod(S22)^2-mod(del)^2)
22 disp(CL,"CL=")
23 rL=mod(S12*S21/(mod(S22)^2-mod(del)^2))
24 printf("\nrL=%.2f",rL)
25 Fin=S11+(S12*S21*FL)/(1-S22*FL)
26 disp(Fin,"Fin=")
27 Zin=50*(1+Fin)/(1-Fin)
28 disp(Zin,"Zin=")
29 ZG=27.9+%i*1.91
30 disp(ZG,"ZG=")
31 FG=(ZG-50)/(ZG+1)
32 disp(FG,"FG=")          //calculation mistake in
      calculating FG in book
33 VSWR=(1+mod(FG))/(1-mod(FG))
34 printf("\nVSWR=%.3f",VSWR)
```

Scilab code Exa 12.13 13

```
1
2 S11=0.9*exp(%i*%pi/180*150)
3 S21=1.7*exp(-%i*%pi/180*80)
4 S12=0.07*exp(%i*%pi/180*120)
5 S22=1.08*exp(-%i*%pi/180*56)
6 function x=mod(n)
7     r=real(n)
8     i=imag(n)
9     x=sqrt(r^2+i^2)
10 endfunction
11 del1=(1-S11)*(1-S22)-S12*S21
12 disp(del1,"del1=")
13 Z_11=((1+S11)*(1-S22)+S21*S12)/del1
14 disp(Z_11,"Z_11=")
```

```
15 Z_12=2*S12/del1
16 disp(Z_12,"Z_12=")
17 Z_21=2*S21/del1
18 disp(Z_21,"Z_21=")
19 Z_22=((1-S11)*(1+S22)+S21*S12)/del1
20 disp(Z_22,"Z_22=")
21 Zinductor=%i*2*%pi*2.75*10^9*1.45*10^-9
22
23 Z_inductor=Zinductor/50
24
25 disp([Z_inductor],"[Z_inductor]")
26
27 A=[Z_11,Z_12;Z_21,Z_22]+[Z_inductor,Z_inductor;
      Z_inductor,Z_inductor]
28 disp(A,"[Z_s11,Z_s12;Z_s21,Z_s22]=")
29
30
31 del=(Z_11+1)*(Z_22+1)-A(1,2)*A(2,1)
32       disp(del,"del=")
33
34  Ss12=2*A(1,2)/del
35       disp(Ss12,"Ss12=")
36 Ss21=2*A(2,1)/del
37       disp(Ss21,"Ss21=")
38 Ss11=((A(1,1)-1)*(A(2,2)+1)-A(1,2)*A(2,1))/del
39        disp(Ss11,"Ss11=")
40 Ss22=((A(1,1)+1)*(A(2,2)-1)-A(1,2)*A(2,1))/del
41         disp(Ss22,"Ss22=")
42 del=S11*S22-S21*S12
43         disp(mod(del),"del=")
44
45
46 k=(1-mod(S11)^2-mod(S22)^2+mod(del)^2)/(2*mod(S12*
      S21))
47 disp(k,"k=")
48 Cs=conj(S11-del*conj(S22))/(mod(S11)^2-mod(del)^2)
49 disp(Cs,"Cs=")
50 rs=mod((S12*S21)/(mod(S11)^2-mod(del)^2))
```

```
51 disp(rs,"rs=")
52 CL=conj(S22-del*conj(S11))/(mod(S22)^2-mod(del)^2)
                    // I THINK
53 disp(CL,"CL=")
                                                          //
     THERE IS A
54 rL=mod(S12*S21/(mod(S22)^2-mod(del)^2))
                              // PROBLEM IN BOOK
55 disp(rL,"rL=")
                                                          //IF
      THERE IS ERROR
56 FL=0.5689*exp(%i*%pi/180*167.8)
                                      //IN CODE LET ME KNOW
57 disp(FL,"FL=")
58 Fin=S11+S12*S21*FL/(1-S22*FL)
59 disp(Fin,"Fin=")
60 Zin=50*(1+Fin)/(1-Fin)
61 disp(Zin,"Zin=")
62 ZG=-real(Zin)/3-%i*imag(Zin)
63 disp(ZG,"ZG=")
```

Chapter 13

detectors and mixers

Scilab code Exa 13.1 1

```
1
2 P=10000
3 V=1000
4 W1=4*%pi*10^6
5 Wc=2*%pi*10^8
6 a=P/V^2
7 printf("\na=%.2f",a)
8 //(b)=
9 A=1000+2*225+2*150+2*75
10 peak_power=a*A^2
11 printf("\nA=%.0f V\npeak_power=%.0f W",A,peak_power)
```

Scilab code Exa 13.2 2

```
1
2 n=1
3 q=1.602*10^-19
4 k=1.38*10^-23
```

```
T=290
Is=10^-8
a=q/(n*k*T)
Ib=0
Rj=1/(a*(Ib+Is))
printf("\n(a)Rj=%.2e  ohm",Rj)
Ib=100*10^-6
Rj=1/(a*(Ib+Is))
printf("\n(b)Rj=%.1f  ohm",Rj)
```

Scilab code Exa 13.3 3

```

//(c)
a=1
delf=10*1000
fm=1000
B=a*delf/fm
disp(B,"B=")
//(d)
a=2
delf=10*1000
fm=500
B=a*delf/fm
disp(B,"B=")
```

Scilab code Exa 13.5 5

```

IDss=50*10^-3
gm=200*10^-3
VL=.25
RL=50
```

```
6  Vp=2*VL
7  //gm=-2*IDss/Vp
8  Vp=2*IDss/gm
9  printf("\nVp=2*IDss/gm=%.2f  V",Vp)
10 gc=IDss/(2*Vp)
11 printf("\ngc=IDss/(2*Vp)=%.2e  S",gc)
12 Av=gc*RL
13 printf("\nAv=gc*RL=%.2f",Av)
```