Scilab Textbook Companion for Linear Integrated Circuits by T. R. Ganesh Babu and B. Suseela[1]

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July 22, 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: Linear Integrated Circuits

Author: T. R. Ganesh Babu and B. Suseela

Publisher: Scitech, Chennai

Edition: 3

Year: 2008

ISBN: 8183711324

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.

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Chapter 1

Circuit Configuration For Linear Integrated Circuits

Scilab code Exa 1.1 Ex1

```
1  //Example 1 Page No:1.81
2  //given
3  rc=50000;//ohm
4  re=100000;//ohm
5  rs=10000;//ohm
6  rp=50000;//ohm
7  beta0=2000;
8  r0=400000;//ohm
9  //determine adm,acm,cmrr
10 rc1=(rc*r0)/(rc+r0);
11 adm=(-(beta0*rc1)/(rs+rp));//differential mode gain
12 acm=(-(beta0*rc1)/(rs+rp+2*re*(beta0+1)));//common
      mode gain
13 cmrr=20*(log10((1+((2*re*(beta0+1))/(rs+rp)))));//
      common mode rejection ratio
14 format(6);
15 disp("adm = "+string(adm));format(5);//no unit
```

```
16 disp("acm = "+string(acm));format(6);//no unit
17 disp("cmrr = "+string(cmrr)+" db");
```

Scilab code Exa 1.2 Ex2

```
1 //Example 2 Page No:1.83
2 //given
3 sr=0.000001;//volt/sec
4 freq1=100000;//hz
5 vsat=12;//volt
6 baw=100000;//hz
7 //determine vx
8
9 vx=2*(1/(sr*2*3.14*freq1));
10 format(6);
11 disp('maximum peak amplitude at 100khz = '+string(vx
   )+" volt");
```

Scilab code Exa 1.3 Ex3

```
1 //Example 3 Page No: 1.84
2 //given
3 V=20;
4 t=4;
5 //determine slew rate
6 format(6);
7 w=V/t;
8
9 disp('slew rate = '+string(w)+' volt/ sec');
```

Scilab code Exa 1.4 Ex4

```
1 //Example 4 Page No: 1.84
2 //given
3 clear
4 a=50;
5 vi=20e-3;
6 sr=0.5e6;
7 //determine max frequency
8 format(6);
9 vm=a*vi;
10 freq1=sr/(2*3.14*vm);
11 disp('max frequency of input is = '+string(freq1
     /10^3)+' Khz');
```

Scilab code Exa 1.5 Ex5

```
1 //Example 5 Page No: 1.84
2 //given
3 clear
4 sr=0.5e6;//volt/sec
5 freq1=40e3;//hz
6 a=10;format(6);
7 //determine max peak to peak input signal
8 vm=sr/(2*3.14*freq1);
9 vm=2*vm;
10 v1=vm/a;
```

```
11 disp('Max peak to peak input signal = '+string(v1)+'
       V');
```

Scilab code Exa 1.6 Ex6

```
1  //Example 6 Page No: 1.85
2  //given
3  adm=400;
4  cmrr=50;
5  vin1=50e-3;//volt
6  vin2=60e-3;//volt
7  vnoise=5e-3;//volt
8  v0=(vin2-vin1)*adm;
9  //determine noise
10 acm=adm/316.22;
11 v1=vnoise*acm;
12 disp('Noise = '+string(v1*10^3)+' mV');
```

Scilab code Exa 1.7 Ex7

```
1  //Example 7 Page No: 1.86
2  //given
3  sr=35e6;//volt/sec
4  vsat=15;//volt
5  //determine time to change from 0 to 15V
6  c=100e-12;//farad
7  i=150e-6;//A
8  w=vsat/sr;
9  w1=i/c;format(6);
```

```
10 disp('Time to change from 0 to 15 = '+string(w*1e6)+
    '  sec');
11 disp('Slew rate = '+string(w1/1000000)+' volt/ sec'
    );
```

Scilab code Exa 1.8 Ex8

```
1 //Example 8 Page No: 1.86
2 //given
3 sr=2e6;//v/sec
4 vsat=15;//volt
5 //determine bandwidth
6 format(9);
7 fmax=sr/(2*3.14*vsat);
8 bw=fmax*sqrt(2);//bandwidth=fmax*sqrt(2)
9 disp('Bandwidth = '+string(bw)+' Hz');//error in the
    book
```

Scilab code Exa 1.9 Ex9

```
1 //Example 9 Page No: 1.87
2 //given
3 iin=30e-9;//A
4 a=1e5;//gain
5 rin=1000;//ohm
6 //determine output offset voltage
7 vid=iin*rin;
8 v0=a*vid;
```

```
9 disp('Differential input voltage = '+string((vid*1e6
    ))+'  volt');
10 disp('Output offset = '+string(v0)+' V');
```

Scilab code Exa 1.10 Ex10

```
1 //Example 10 Page No: 1.86
2 //given
3 inb1=22e-6;//A
4 inb2=26e-6;//A
5 //determine input offset current input base current
6 i1=inb2-inb1;
7 i2=(inb2+inb1)/2;
8 format(10);
9 disp('Input offset current = '+string(i1*10^6)+'  A
    ');
10 disp('Input base current = '+string(i2*10^6)+'  A ')
    ;
```

Scilab code Exa 1.11 Ex11

```
1 //Example 11 Page No: 1.86
2 //given
3 inb2=90e-9;//A
4 inb1=70e-9;//A
5 a=1e5;//gain
6 //determine input offset current
7 i1=(inb2+inb1)/2;
8 i2=inb2-inb1;
```

```
v1=((inb2-inb1)*1000)*a;
disp('Input base current = '+string(i1*10^9)+' nA');
disp('Input offset current = '+string(i2*10^9)+' nA'
   );
disp('Output offset voltage = '+string(v1)+' V');
```

Scilab code Exa 1.12 Ex12

```
//Example 12 Page No: 1.87
//given
vin1=150e-6;//volt
vin2=100e-6;//volt
a=1000;
cmrr=[100,200,450,105];
//determine output voltage
vc=(vin1+vin2)/2;
vd=(vin1-vin2);
j=1;format(6);
while j<=4
    v0=(a*vd*(1+(vc/(cmrr(j)*vd)))) ;
    disp('Output voltage CMRR for '+string(cmrr(j))+
       ' = '+string(v0*10^3)+' mV');//error in book
    j=j+1;
end
```

Scilab code Exa 1.13 Ex13

```
//Example 14 Page No: 1.89
//given
```

```
3 sr=0.5e6;//volt/sec
4 a=50;
5 freq1=20e3;//hz
6 //determine max peak to peak voltage
7 v1=sr/(2*3.14*freq1*a);format(3);
8 disp('Input voltage = '+string(v1*10^3)+' mV');
```

Scilab code Exa 1.14 Ex14

```
1 //Example 14 Page No: 1.89
2 //given
3 sr=0.5e6;//volt/sec
4 a=50;
5 freq1=20e3;//hz
6 //determine max peak to peak voltage
7 v1=sr/(2*3.14*freq1*a);format(3);
8 disp('input voltage '+string(v1*10^3)+'mV');
```

Scilab code Exa 1.15 Ex15

```
1 //Example 15 Page No: 1.90
2 //given
3 sr=50e6;//volt/sec
4 rin=2;format(5);
5 vimax=10;//volt
6 //determine max frequency
7 vm=vimax*(1+rin);
8 freq1=sr/(2*3.14*vm);
9 disp('Max frequency = '+string(freq1/10^3)+' Khz');
```

Chapter 2

Applications Of Operational Amplifier

Scilab code Exa 2.1 Ex1

```
1  //problem 1 pagenumber 2.86
2  //given
3  rf=10*10^3;//ohm
4  //vo=0.1v1+v2+10v3;                                    1
5  //determine r1,r1,r3
6  r1=rf/0.1;//from 1
7  r2=rf/1;//from 1
8  r3=rf/10;//from 1
9  format(6);
10 disp('R1 = '+string(r1/10^3)+' Kohm');
11 disp('R2 = '+string(r2/10^3)+' Kohm');
12 disp('R3 = '+string(r3/10^3)+' Kohm');
13 disp('Rf = '+string(rf/10^3)+' Kohm');
```

Scilab code Exa 2.2 Ex2

```
1 //problem 2 pagenumber 2.86
2 //given
3 format(6);
4 v1=5;//volt
5 v2=2;//volt
6 rf1=10e3;//ohm
7 r1=10e3;//ohm
8 //determine output voltage
9 v0=-((-v1*rf1/r1)-(-v2*rf1/r1));
10 disp('Output voltage = '+string(v0)+' V');
```

Scilab code Exa 2.4 Ex4

```
1 //problem 4 pagenumber 2.87
2 //given
3 format(6);
4 r1=10e3;//ohm
5 rf1=20e3;//ohm
6 r2=5e3;//ohm
7 //determine gain of amplifier
8 a1=1+rf1/r1;
9 a2=-rf1/r1;
10 disp( 'Switch off gain = '+string(a1+a2));//no unit
11 disp( 'Switch on gain = '+string(a2));//no unit
```

Scilab code Exa 2.5 Ex5

```
1 //problem 5 pagenumber 2.89
2 //given
3 format(6);
4 v1=2;//volt
5 v2=3;//volt
6 r1=1e3;//ohm
7 rf1=5e3;//ohm
8 r2=8e3;//ohm
9 //determine output voltage
10 v11=v2*r2/(r2+r1);
11 disp( 'Output voltage = '+string((1+rf1/r1)*(v2-v1))
   +' V');
```

Scilab code Exa 2.6 Ex6

```
1 //problem 6 pagenumber 2.90
2 //given
3 format(6);
4 r1=2e3;//ohm
5 rf1=8e3;//ohm
6 A=45;//open loop gain
7 a=1+(rf1/r1);//Nonverting gain
8 gain=A/(1+A/a);
9 disp( 'Gain  = '+string(gain));//no unit
```

Scilab code Exa 2.7 Ex7

```
1 //problem 7 pagenumber 2.91
2 //given
3 format(6);
4 r1=1e3;//ohm
5 r2=100e3;//ohm
6 rf1=90e3;//ohm
7 //determine cmrr
8 ac=(r2-rf1)/(r1+r2);
9 ad=(rf1+((((rf1+r1)/r1)*r2)/(r1+r2)))/r1;format(12);
10 disp( 'CMRR = '+string(ad/(ac)));//no unit
```

Scilab code Exa 2.8 Ex8

```
1 //problem 8 pagenumber 2.92
2 //given
3 format(6);
4 ii1=2e-3;//A
5 rf1=2e3;//ohm
6 r0=2e3;//ohm
7 i0=-(ii1+(ii1*rf1)/r0)
8
9 disp('Output current = '+string(i0*10^3)+' mA');
```

Scilab code Exa 2.10 Ex10

```
1 //problem 10 pagenumber 2.94
2 //given
3 format(6);
4 v1=5;//volt
5 v2=2;//volt
6 r1=10e3;//ohm
7 rf1=r1;//ohm
8 //determine output voltage
9 v01=-v1*(rf1/r1);
10 disp('Output voltage = '+string(-(rf1/r1)*(v01+v1))+
    ' V');
```

Scilab code Exa 2.11 Ex11

```
1 //problem 11 pagenumber 2.95
2 //given
3 format(6);
4 rf1=10e3;//ohm
5 r1=2e3;//ohm
6 r2=5e3;//ohm
7 //determine output voltage
8 cof1=-rf1/r1;//coefficient of v1
9 cof2=-rf1/r2;//coefficient of v2
10 disp('Output voltage = '+string(cof1)+'v1+('+string(
    cof2)+'v2)');
```

Scilab code Exa 2.13 Ex13

```
1 //problem 13 pagenumber 2.97
2 //given
3 format(6);
4 freq1=1e3;//hz
5 c=0.1e-6;//farad
6 af=1.586;//gain
7 //determine rf ri r1
8 r1=1/(2*3.14*freq1*c);format(5);
9 disp('R1 = '+string(r1/10^3)+' Kohm');
10 disp('Ri = 10 Kohm');//assumption
11 ri=10e3;//ohm
12 rf=(af-1)*ri;format(6);
13 disp('Rf = '+string(rf/10^3)+' Kohm');
```

Scilab code Exa 2.14 Ex14

```
1 //problem 14 pagenumber 2.97
2 //given
3 format(6);
4 fc=3e3;//hz
5 q=30;//quality factor
6 af=20;//forward gain
7 c=0.1e-6;//farad
8 //determine r1 r2 r3
9 r1=q/(2*3.14*fc*c*af);
10 r2=q/(2*3.14*fc*c*(2*q*q-af));
```

```
11 r3=q/(3.14*fc*c);format(4);
12 disp( 'R1 = '+string(r1)+' ohm');format(3);
13 disp( 'R2 = '+string(r2)+' ohm');
14 disp( 'R3 = '+string(r3/10^3)+' ohm');
```

Scilab code Exa 2.16 Ex16

```
1 //problem 16 pagenumber 2.99
2 //given
3 f1=500;//hz
4 f2=2.2e3;//hz
5 a=5;
6 c=0.1e-6;//farad
7 rf1=10e3;//ohm
8 //determine r1 r2
9 R1=1/(2*3.14*f1*c);
10 R2=1/(2*3.14*f2*c);
11 Ri=2e3;//ohm assuming
12 Rf=(a-1)*Ri;format(6);
13 disp('R = '+string(R1/10^3)+' Kohm');
14 disp('R2 = '+string(R2/10^3)+' Kohm');//error in
   book
15 disp('R1 = '+string(Ri/10^3)+' Kohm');
16 disp('Rf = '+string(Rf/10^3)+' Kohm');
```

Scilab code Exa 2.17 Ex17

```
1 //problem 17 pagenumber 2.100
2 //given
```

```
3 R=100e3;//ohm
4 IB=1e-6;//A
5 Vt=25e-3;//volt
6 v0=0;//volt
7
8
9 //determine Vin
10 Vin=(v0*2.3*Vt)+(R*IB);format(6);
11 disp("Vin = "+string(Vin)+" V");
```

Scilab code Exa 2.18 Ex18

```
1 //problem 18 pagenumber 2.101
2 //given
3 format(6);
4 freq1=100;//hz
5 c=0.1e-6;//farad
6 //determine r1 r2
7 r2=29;//ohm assuming
8 r1=(0.065/(freq1*c)*10)*r2;
9 disp('R1 = '+string(r1/10^3)+' Kohm');
10 disp('R2 = '+string(r2)+' ohm');
```

Scilab code Exa 2.19 Ex19

```
1 //problem 19 pagenumber 2.101
2 //given
3 freq1=15.9e3;//hz
4 a=1.5;format(3);
```

```
5 //determine rf1 r1
6 c=0.001e-6;//farad
7 R1=1/(2*3.14*freq1*c);
8 Rf1=(a-1)*(1/(2*3.14*freq1*c));
9 disp('R1 = '+string(R1/10^3)+' Kohm');
10 disp('Rf1 = '+string(Rf1/10^3)+' Kohm');
```

Scilab code Exa 2.20 Ex20

```
1 //problem 20 pagenumber 2.103
2 //given
3 v1=2;//volt
4 v2=3;//volt
5 v3=6;//volt
6 v4=8;//volt
7 rf1=50e3;//ohm
8 r1=40e3;//ohm
9 r2=25e3;//ohm
10 r3=10e3;//ohm
11 r4=20e3;//ohm
12 r5=30e3;//ohm
13 //determine output voltage
14 v0x=-(v1*rf1/r1)-(v2*rf1/r2);format(5);
15 req=r5*r4/(r5+r4);//combination of r4 and r5
16 re1=(r3*r5)/(r3+r5);//combination of r3 and r5
17 vn=req*v3/(r3+req)+(re1*v4/(r4+re1));
18 v0y=(1+rf1/(r1*r2/(r1+r2)))*vn;
19 disp('Output voltage = '+string(v0x+v0y)+' V');
```

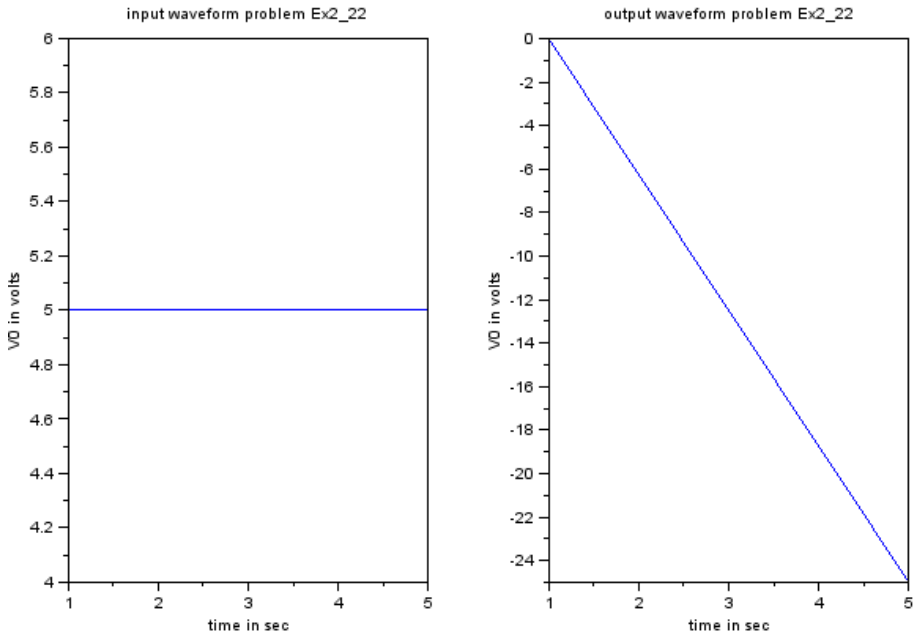

Figure 2.1: Ex22

Scilab code Exa 2.22 Ex22

```
1 //problem 22 pagenumber 2.105
2 //given
3 rc1=1;format(3);clf();
4 vi=5;//volt
5 c=1e-6;//farad
6 r=1e6;//ohm
7 x0=0;x1=1:1:5;
8 //determine output voltage
9 v0=integrate('5','t',x0,x1);
10 disp('Output voltage = -'+string(v0(5))+" V");
11 subplot(1,2,1);
12 x=linspace(1,5,5);
13 y=5;
14 plot(x,y);
15 xtitle('input waveform problem Ex2_22','time in sec'
   ,'Vi in volts');
16 subplot(1,2,2);
17 x=linspace(1,5,5);
18 y=linspace(0,-25,5);
19 plot(x,y);
20 xtitle('output waveform problem Ex2_22','time in sec
   ','V0 in volts');
```

Scilab code Exa 2.23 Ex23

```
1 //problem 23 paenumber 2.106
2 //given
3 vi=[10e-3,100e-3,1];format(6);
```

```
r1=10e3;//ohm
i1=1e-13;//A
//determine output voltage
w=1;
while w<=3
      disp('Output voltage for vi '+string(vi(w))+' =
          '+string(((-0.02571)*(log(vi(w)/(i1*r1))))
         *10^3)+' mV');//error in book
      w=w+1;
 end
```

Scilab code Exa 2.24 Ex24

```
//problem 24 pagenumber 2.107
//given
format(6);
k1=1.38e-23;//j/k
t1=298;//k
q=1.6e-19;//columb
vi=10e-3;//volt
ri=10e3;//ohm
//determine output voltage
v0=-(k1*t1/q)*0.4343*log10(vi/ri);
disp('Output voltage = '+string(v0*10^3)+' mV');
```

Scilab code Exa 2.25 Ex25

```
//problem 25 pagenumber 2.108
//given
```

```
format(7);
rf1=10e3;//ohm
vi=1e-2;//volt
vt=0.0257;//volt
//determine output voltage
vi=exp(vi/vt);
v0=-vi*rf1;
disp('Output voltage = '+string(v0)+' V');
```

Scilab code Exa 2.26 Ex26

```
//problem 26 pagenumber 2.109
//given
freq1=1.5e3;//hz
bw=450;//hz
//determine qualityfactor f1 f2
q=freq1/bw;format(7);
f1=freq1*sqrt(1+(1/(4*q*q)))-freq1/(2*q);
f2=freq1*sqrt(1+(1/(4*q*q)))+bw/2;format(4);
disp('Quality factor = '+string(q));format(7);//no
    unit
disp('Lower frequency = '+string(f1)+' Hz');
disp('Upper frequency = '+string(f2)+' Hz');
```

Scilab code Exa 2.27 Ex27

```
//problem 27 pagenumber 2.109
```

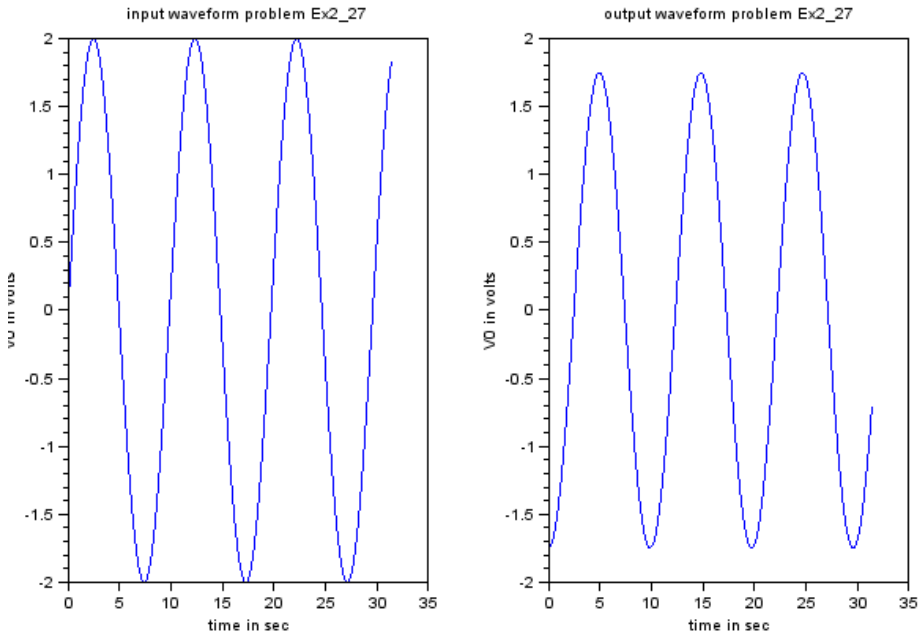

Figure 2.2: Ex27

```
2  //given
3  format(6);
4  fa=200;//hz
5  vi=2;//volt
6  c1=0.1e-6;//farad
7  //determine cf1 rf1 r1
8  rf1=1/(2*3.14*fa*c1);clf();
9  r1=1/(2*3.14*c1*fa*10);//fb=10*fa
10 cf1=r1*c1/rf1;
11 disp('Rf = '+string(rf1/1e3)+' Kohm');
12 disp('R1 = '+string(r1)+' ohm');
13 disp('Cf = '+string(cf1*10^6)+'  farad');//error in
       book
14 subplot(1,2,1);
15 x=0:0.1:10*%pi;
16 y=-2*sin(2*fa*3.14*x);
17 plot(x,y);
18 xlabel('time in sec');
19 ylabel('Vi in volts');
20 title('input waveform problem Ex2_27');
21 subplot(1,2,2);
22 x=0:0.1:10*%pi;
23 y=-1.75*cos(2*fa*3.14*x);
24 plot(x,y);
25 xlabel('time in sec');
26 ylabel('V0 in volts');
27 title('output waveform problem Ex2_27');
```

Chapter 4

Analog to Digital and Digital to Analog converters

Scilab code Exa 4.1 Ex1

```
1 //problem 1 pagenumber 4.38
2 //given
3 z='0101';format(6);
4 n=4;
5 vof=15;//volt
6 r=vof/(2^n-1);
7 v0=r*base2dec(z,2);
8
9 disp('Output voltage = '+string(v0)+' volt');
```

Scilab code Exa 4.2 Ex2

```
1 //problem 2 pagenumber 4.38
2 //given
3 r=20e-3;format(6);
4 z='11000000';
5 n=8;
6 vof=r*(2^n-1);
7 v0=r*base2dec(z,2);
8 disp('Output offset = '+string(vof)+' volt');
9 disp('Output voltage = '+string(v0)+' volt');
```

Scilab code Exa 4.3 Ex3

```
1 //problem 3 pagenumber 4.38
2 //given
3 n=4;format(6);
4 z=['0111','1111'];
5 vref=5;//volt
6 //determine v0
7 r=vref/(2^n-1);
8 i=1;
9 while i<3
10     v0=r*base2dec(z(i),2);
11     disp('Output voltage '+string(z(i))+' = '+string
          (v0)+' volt');
12     i=i+1;
13 end
```

Scilab code Exa 4.4 Ex4

```
1 //problem 4 pagenumber 4.39
2 //given
3 n=12;format(6);
4 r=8e-3;//volt
5 z='011101110001';
6 //determine output voltage
7 vof=r*(2^n-1);res=r/vof;
8 v0=r*base2dec(z,2);
9 disp('Output voltage = '+string(v0)+' volt');
10 disp('Fullscale Output Voltage = '+string(vof)+'
     volt');
11 disp('Resolution = '+string(res*1e2)+' percent');
```

Scilab code Exa 4.5 Ex5

```
1 //problem 5 pagenumber 4.39
2 //given
3 fs=1e3;//hz
4 r=0.01;format(6);
5 vref=10;//volt
6 //determine n vmin rms fs1 t1 z
7 r=0.01/100;
8 n=14;
9 mbit=2^n;
10 disp('Minumum number of bits = '+string((mbit)));
11 vm=vref/2^n;
12 disp('Minmum voltage = '+string(vm*10^6)+' volt');
13 eq=vref/(2^n*2*sqrt(3));
14 disp('Quantization error = '+string(eq*10^6)+'
     volt');
15 fs1=5*fs;
16 disp('Sampling rate = '+string(fs1)+' Hz');
17 t1=1/(2*%pi*fs*2^n);
```

```
18 disp('Aperture time = '+string(t1*10^6)+' milisecond
   ');//error in book
19 disp('Converter = '+string(6*n)+' dB');
```

Scilab code Exa 4.6 Ex6

```
1 //problem 6 pagenumber 4.40
2 //given
3 vref=10;//volt
4 is=1.875e-3;//A
5 z=['1111' '1100'];format(6);
6 //determine R I
7 n=4;
8 v0=vref/2^n*(1*2^(n-1)+1*2^(n-2)+1*2^(n-3)+1*2^(n-4)
   );
9 r=v0/is;
10 disp('R = '+string(r/10^3)+' Kohm');
11 v0=vref/2^n*(1*2^(n-1)+1*2^(n-2))/r;
12 disp('I at 1100 = '+string(v0*10^3)+' mA');
```

Scilab code Exa 4.7 Ex7

```
1 //problem 7 pagenumber 4.41
2 vmin=1e-3;//volt
3 vref=10;//volt
4 q=0.01;format(6);
5 //determine n
6 n=log10(((0.5)/0.01)+1)/log10(2);format(2);
7 disp('N = '+string(n));//no unit
```

Scilab code Exa 4.8 Ex8

```
1 //problem 8 pagenumber 4.42
2 //given
3 n=8;
4 //determine R
5 r=1/(2^n-1)*100;format(6);
6 disp('R in percent = '+string(r)+'%');
```

Scilab code Exa 4.9 Ex9

```
1 //problem 9 pagenumber 4.42
2 //given
3 n=5;
4 //determine resolution
5 r=1/(2^n-1)*100;format(6);
6 disp('Resolution in percent = '+string(r)+'%');
```

Scilab code Exa 4.10 Ex10

```
1 //problem 10 pagenumber  4.42
2 //given
3 z=['111111','100110'];
```

```
4 vref1=20;//volt
5 e=1/base2dec(z(1),2)*vref1;format(6);
6 disp('Minimum voltage each bit = '+string(e)+' volt'
    );
7 e=base2dec(z(2),2)/base2dec(z(1),2)*vref1;
8
9 disp('Output voltage at '+string(z(2))+' = '+string(
    e)+' volt');
```

Scilab code Exa 4.11 Ex11

```
1 //problem 11 pagenumber  4.43
2 //given
3 n=12;
4 vref1=50;//volt
5 vref2=-50;//volt
6 r=(vref1-vref2)/(2^n-1);format(6);
7 disp('Resolution  = '+string(r)+' volt');
8 r=100/(2^n-1);
9 disp('Resolution in percent = '+string(r)+'%');
```

Scilab code Exa 4.12 Ex12

```
1 //problem 12 pagenumber  4.43
2 //given
3 n=10;
4 vref1=-10;//volt
5 vref2=10;//volt
6 r=(vref2-vref1)/(2^n-1);format(6);
```

```
7 disp('Resolution = '+string(r*1e3)+' milivolt');
8 r=100/(2^n-1);
9 disp('Resolution in percent = '+string(r)+'%');
```

Scilab code Exa 4.13 Ex13

```
1 //problem 13 pagenumber  4.43
2 //given
3 n=12;
4 r=1/(2^n-1);format(6);
5 r=r*100;
6 disp('Resolution in percent = '+string(r)+'%');
```

Scilab code Exa 4.14 Ex14

```
1 //problem 14 pagenumber  4.44
2 //given
3 n=7;format(6);
4 vmax=25.4;//volt
5 r=1/(2^n-1);
6 disp('Change in voltage = '+string(r*vmax)+' volt');
```

Scilab code Exa 4.15 Ex15

```
1 //problem 15 pagenumber  4.44
2 //given
3 r=5e-3;//volt
4 vref=8;//volt
5 format(3);
6 //determine N
7 n=log10(1/(r/vref)+(1))/log10(2);
8 disp('N = '+string(n));//no unit
```

Scilab code Exa 4.16 Ex16

```
1 //problem 16 pagenumber  4.44
2 //given
3 fs=1e6;//hz
4 format(6);
5 n=8;
6 tc=(1/fs)*(n+1);
7 disp('Conversion time = '+string(tc*10^6)+'   s ');
```

Scilab code Exa 4.17 Ex17

```
1 //problem 17 pagenumber 4.45
2 //given
3 vref=10;//volt
4 vin=100e-3;//volt
5 v0=vref*vin/10^-3;format(6);
6 disp('Output voltage = '+string(v0)+' counts');
```

Scilab code Exa 4.18 Ex18

```
1 //problem 18 pagenumber 4.45
2 //given
3 n=4;z='1111';format(6);
4 r=10e3;//ohm
5 r1=20e3;//ohm
6 vref=10;//volt
7 //determine Resolution and output current
8 r=(1/2^n)*vref/r;
9 disp('Resolution of 1th = '+string(r*10^6)+'  A ');
10 disp('Iout = '+string(r*1e6)+' x D');
11 iout=r*base2dec(z,2);
12 disp('Output current = '+string(iout*10^6)+'  A ');
   //error in book
```

Scilab code Exa 4.19 Ex19

```
1 //problem 19 pagenumber 4.45
2 //given
3 n=8;format(6);
4 vref=10;//volt
5 vmin=vref/2^n;
6 D=133;
7 disp('Minimum input voltage = '+string(vmin*1e3)+'
   milivolt');
8 vif=vref-vmin;
```

```
9  disp('Input voltage make 1s = '+string(vif)+' volt')
     ;
10 vin=5.2;
11 format(3);z=dec2base(D,2);format(6);
12 disp('Decimal at '+string(vin)+' volt = '+string(D))
     ;//no unit
```

Scilab code Exa 4.20 Ex20

```
1  //problem 20 pagenumber 4.46
2  //given
3  vref=10;//volt
4  z=['01','0111','10111100'];format(6);
5  n=2;
6  v0=vref*(1/2^2);
7  disp('Output voltage at '+string(z(1))+' = '+string(
     v0)+' volt');
8  n=4
9  v0=vref*(1/2^2+1/2^3+1/2^4);
10 disp('Output voltage at '+string(z(2))+' = '+string(
     v0)+' volt');
11 v0=vref*(1/2+1/2^3+1/2^4+1/2^5+1/2^6+1/2^8);
12 disp('Output voltage at '+string(z(2))+' = '+string(
     v0)+' volt');
```

Scilab code Exa 4.21 Ex21

```
1  //problem 21 pagenumber 4.46
2  //given
```

```
3 n=4;format(6);
4 z='0110';
5 vref=10;//volt
6 v0=vref*(1/2^2+1/2^3);
7 disp('Output voltage at '+string(z)+' = '+string(v0)
    +' volt');
```

Scilab code Exa 4.22 Ex22

```
1 //problem 22 pagenumber 4.47
2 //given
3 n=10;format(6);
4 vfs=10.24;//volt
5 distortion=56;//dB
6 //determine ENOB SNRmax
7 q=vfs/(2^n*sqrt(12));
8 snrmax=(6.02*n+1.76);//formula for SNRmax
9 disp('SNRmax = '+string(snrmax)+' dB');
10 format(2);
11 en=(distortion-1.76)/6.02;
12 disp('ENOB = '+string(en));//no unit
```

Chapter 5

Special Function Integrated Circuits

Scilab code Exa 5.1 Ex1

```
1 //problem 1 pagenumber 5.95
2 //given
3 clear
4 w=8e-3;//second
5 c1=0.1e-6;//farad
6 //determine r1
7 r1=w/(1.11*c1);format(3);
8 disp('R1 = '+string(r1/10^3)+' Kohm');format(6);
9 disp('C1 = '+string(c1*1e6)+'  f a r a d ');
```

Scilab code Exa 5.2 Ex2

```
1 //problem 2 pagenumber 5.95
2 //given
3 ra=5e3;//ohm
4 rb=ra;format(6);
5 c1=0.01e-6;//farad
6 //determine frequency dutycycle
7 freq1=1.44/((ra+2*rb)*c1);
8 w=(ra+rb)/(ra+2*rb);format(5);
9 disp('frequency = '+string(freq1)+' Hz');
10 disp('dutycycle = '+string(w));//no unit
```

Scilab code Exa 5.3 Ex3

```
1 //problem 3 pagenumber 5.96
2 //given
3 freq1=2e3;//hz
4 w=0.75;format(6);
5 c1=0.1e-6;//farad
6 //determine ra rb
7 //for 0.75 dutycycle rb=0.5*ra
8 ra=1.44/freq1*(1/(c1*2));
9 rb=0.5*ra;
10 disp('Ra = '+string(ra)+' ohm');
11 disp('Rb = '+string(rb)+' ohm');
12 disp('C1 = '+string(c1*1e6)+'  farad');
```

Scilab code Exa 5.4 Ex4

```
1 //problem 4 pagenumber 5.97
```

```
2 //given
3 ra=2.2e3;//ohm
4 rb=6.8e3;//ohm
5 c1=0.01e-6;//farad
6 //determine ontime offtime frequency dutycycle
7 t1=0.69*(ra+rb)*c1;format(6);
8 t2=0.69*rb*c1;
9 freq1=1.45/((ra+2*rb)*c1);
10 w=ra/(ra+2*rb);format(6);
11 disp('on time = '+string(t1*10^6)+' second');
12 disp('tof = '+string(t2*10^6)+' second');
13 disp('frequency = '+string(freq1)+' Hz');
14 disp('duty cycle = '+string(w));//no unit
```

Scilab code Exa 5.5 Ex5

```
1 //problem 5 pagenumber 5.97
2 //given
3 t1=4;//second
4 t2=2;//second
5 c1=1e-6;//farad
6 //detemine ra rb
7 t12=t1+t2;
8 w=t1/t12;
9 //ra=0.97*rb
10 rb=(t1/(0.693*c1))/(1+0.97);
11 ra=0.97*rb;format(5);
12 disp('Ra = '+string(ra/10^6)+' Mohm');
13 disp('Rb = '+string(rb/10^6)+' Mohm');
```

Scilab code Exa 5.6 Ex6

```
1 //problem 6 pagenumber 5.100
2 //given
3 c=10e-6;//farad
4 w=6;format(6);
5 //determine R
6 r=w/(1.11*c);
7 format(6);
8 disp('R = '+string(r/10^3)+' Kohm');
9 disp('C1 = '+string(c*1e6)+'  farad');
```

Scilab code Exa 5.7 Ex7

```
1 //problem 7 pagenumber 5.100
2 //given
3 enw=20e-9;//volt/hz
4 fce=200;//hz
5 inw=0.5e-12;//A
6 fci=2e3;//hz
7 //determine RMS voltage
8 z=fce*log(20e3/20)+(20e3-20);
9 en=nthroot(enw,z);
10 format(5);
11 disp("Rms Input Voltage = "+string(en)+' volt');//
   error in book
```

Scilab code Exa 5.8 Ex8

```
1 //problem 8 pagenumber 5.99
2 //given
3 r1=9e3;//ohm
4 k1=1.38*10^-23;format(6);
5 t1=298;//k
6 //determine voltage current spectraldensities
     rmsnoise
7 r1=r1;
8 er=sqrt(4*k1*t1*r1);
9 i1=er/r1;
10 er12=1/er;
11 w=20e3-20;
12 er1=nthroot(er,w);
13 disp('voltage = '+string(er*10^9)+' nanovolt/    (Hz)
     ');format(5);
14 disp('current = '+string(i1*10^12)+' pA/    (Hz)');
15 disp('rms voltage = '+string(er1)+' volt');//error
     in book
```

Scilab code Exa 5.9 Ex9

```
1 //problem 9 pagenumber 5.101
2 //given
3 fh=2e6;//hz
4 id=[1e-6,1e-9];format(6);
5 i=1;
```

```
while i<3
    In=sqrt(2*1.62e-19*id(i)*fh);
    disp('signal to noise id '+string(id(i)*10^6)+'
       = '+string(20*log10(id(i)/In))+' dB');
    i=i+1;
end
```

Scilab code Exa 5.10 Ex10

```
//problem 10 pagenumber 5.101
//given
r1=100e3;format(6);
rf=250e3;
r3=70e3;//ohm
fce=200;//hz
fci=2e3;//hz
ft=1e6;//hz
enw=20e-9;
inw=0.5e-12;
f1=0.1;
fa=ft/(1+(rf/r1));
rn=r1*rf/(r1+rf);
p=fce*log(fa/f1)+1.57*fa-f1;
q=(r3^2+rn^2)*(fci*log(fa/f1)+1.5*fa-f1);
r=1.65e-20*(r3+rn)*(1.57*fa-f1);
en=(1+rf/r1)*(enw^2+p+inw^2*q+r);
disp('rms voltage = '+string(sqrt(en))+'  volt rms'
   );//error in book
```