

Scilab Textbook Companion for
Integrated Circuits
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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.

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Chapter 1

Analog Integrated Circuit Design

Scilab code Exa 1.1 Lowest value of V_0

```
1 //Ex 1.1
2 clc;clear;close;
3 VDD=1.8;//V
4 IREF=50;//micro A
5 IO=IREF;//micro A
6 L=0.5;//micro m
7 W=5;//micro m
8 Vt=0.5;//V
9 Kn_dash=250;//micro A/V^2
10 VGS=sqrt(IO/(1/2*Kn_dash*(W/L)))+Vt;//V
11 disp(VGS," Value of VGS(V) : ");
12 R=(VDD-VGS)/(IREF*10^-6);//ohm
13 disp(R/1000," Value of R(kohm) : ");
14 VDS2=VGS-Vt;//V
15 VO=VDS2;//V
16 disp(VO," Lowest value of VO(V) : ");
```

Scilab code Exa 1.3 Design a current source

```
1 //Ex 1.3
2 clc;clear;close;
3 VDD=1.8; //V
4 Vt=0.6; //V
5 mpCox=100; //micro A/V^2
6 IREF=80; //micro A
7 V0max=1.6; //V
8 VSG=VDD-V0max+Vt; //V
9 VGS=-VSG; //V
10 VS=VDD; //V
11 VG=VGS+VS; //V
12 R=VG/(IREF*10^-6); //ohm
13 ID=IREF; //micro A
14 WbyL=2*ID*10^-6/(mpCox*10^-6)/(VGS+Vt)^2; // unitless
15 disp(VGS," Value of VGS(V) : ");
16 disp(VG," Value of VG(V) : ");
17 disp(R/1000," Value of R(kohm) : ");
18 disp(WbyL,"W/L ratio : ");
```

Scilab code Exa 1.3.1 Current gain

```
1 //Ex 1.3 at page no. 20
2 clc;
3 clear;
4 format('v',5);
5 close;
6 Beta=20; // unitless
7 IObyIREF=1/(1+2/Beta); //Current gain
8 disp(IObyIREF," Current gain : ");
```

Scilab code Exa 1.4 Current transfer ratio

```

1 //Ex 1.4
2 clc;clear;close;
3 format('v',5);
4 Beta=80;// unitless
5 disp("IREF=IC1+IC1/Beta+IO/Beta");
6 disp("IO/IREF=m implies IC1=IO/m as IC1=IREF");
7 disp("IREF=IO*(1/m+1/m/Beta+1/Beta)");
8 disp("IO/IREF=m/(1+1/Beta+m/Beta)");
9 disp("IO/IREF=m*(1-5/100);// for large Beta");
10 m=(1/(1-5/100)-1)*Beta-1;//Current transfer ratio
11 disp(m,"Largest current transfer ratio : ");

```

Scilab code Exa 1.7 Transistor ratio

```

1 //Ex 1.7
2 clc;clear;close;
3 format('v',5);
4 Beta=80;// untless
5 disp("IREF=IC1+IC1/Beta+IO/Beta");
6 disp("IO/IREF=m implies IC1=IO/m as IC1=IREF");
7 disp("IREF=IO*(1/m+1/m/Beta+1/Beta)");
8 disp("IO/IREF=m/(1+1/Beta+m/Beta)");
9 disp("IO/IREF=m*(1-5/100);// for large Beta");
10 m=(1/(1-5/100)-1)*Beta-1;//Current transfer ratio
11 disp(m,"Largest current transfer ratio : ");

```

Scilab code Exa 1.9 Current gain

```

1 //Ex 1.9
2 clc;
3 clear;
4 close;
5 format('v',5);

```

```

6 Beta=20; // unitless
7 IObyIREF=1/(1+2/Beta); // Current gain
8 disp(IObyIREF," Current gain : ");

```

Scilab code Exa 1.10 Change in IO

```

1 //Ex 1.10
2 clc;clear;close;
3 IREF=2; //mA
4 IO=IREF; //mA
5 VA2=90; //V
6 Vo1=1; //V
7 Vo2=10; //V
8 ro2=VA2/IO; //kohm
9 delV0=Vo2-Vo1; //V
10 delIO=delV0/ro2; //mA
11 Change=delIO/IO*100; // %
12 disp(Change," Change in Io (%) : ");

```

Scilab code Exa 1.11 Lowest output voltage

```

1 //Ex 1.11
2 clc;clear;close;
3 VBE3=0.7; //V
4 VBE1=0.7; //V
5 IREF1=100; //micro A
6 IC1=IREF1; //micro A
7 IREF2=1; //mA
8 IC2=IREF2; //mA
9 Beta=200; // unitless
10 //IC2/IC1=(IS*exp(VBE2/VT))/(IS*exp(VBE1/VT))
11 VT=26; //mV

```

```

12 deltaVBE=VT*10^-3*log(IC2/IC1); //V(deltaVBE=VBE2-
    VBE1)
13 deltaVx=2*deltaVBE; //V
14 IO=IREF1/(1+2/(Beta^2+Beta)); //micro A
15 delIO=IC1-IO; //micro A
16 Change=delIO/IO*100; // %
17 disp(Change,"Change in Io(%) : ");

```

Scilab code Exa 1.12 Design a current mirror circuit

```

1 //Ex 1.12
2 clc;clear;close;
3 format('v',5);
4 Iout=8; //micro A
5 VBE=0.7; //V
6 VCC=20; //V
7 Beta=80; // unitless
8 IREF=Iout*(1+2/Beta); //micro A
9 disp(IREF,"Reference current is(micro A) : ");
10 R=(VCC-VBE)/(IREF); //Mohm
11 disp(R,"Resistance is(Mohm) : ");

```

Scilab code Exa 1.13 Design a current mirror circuit

```

1 //Ex 1.13
2 clc;clear;close;
3 format('v',5);
4 Iout=1; //mA
5 VBE=0.7; //V
6 VCC=30; //V
7 Beta=100; // unitless
8 IREF=Iout*(1+2/Beta); //mA
9 disp(IREF,"Reference current is(mA) : ");

```

```
10 R=(VCC-VBE)/(IREF); //kohm
11 disp(R," Resistance is (kohm) : ");
```

Scilab code Exa 1.14 Circuit of current source

```
1 //Ex 1.14
2 clc;clear;close;
3 format('v',5);
4 Iout=0.5; //mA
5 VBE=0.7; //V
6 VCC=5; //V
7 Beta=50; // unitless
8 IREF=Iout*(1+2/Beta); //mA
9 disp(IREF," Reference current is (mA) : ");
10 R=(VCC-VBE)/(IREF); //kohm
11 disp(R," Resistance is (kohm) : ");
```

Scilab code Exa 1.15 Modified current mirror circuit

```
1 //Ex 1.15
2 clc;clear;close;
3 format('v',5);
4 Iout=8; //micro A
5 VBE=0.7; //V
6 VCC=20; //V
7 Beta=100; // unitless
8 IREF=Iout*(1+2/Beta/(Beta+1)); //micro A
9 disp(IREF," Reference current is (micro A) : ");
10 R=(VCC-2*VBE)/(IREF); //Mohm
11 disp(R," Resistance is (Mohm) : ");
```

Scilab code Exa 1.16 Find Iout

```
1 //Ex 1.16
2 clc;clear;close;
3 format('v',5);
4 Beta=120;// unitless
5 VBE=0.7;//V
6 VCC=10;//V
7 R=5.6;//kohm
8 //IREF=IC1+I1; as Beta>>1
9 //I1=IC2+IB3; as Beta>>1
10 IREF=(VCC-VBE)/R;//mA
11 //IREF=IC*(2+1/Beta) or IREF=2*IC; as Beta>>1
12 IC=IREF/2;//mA
13 Iout=IC;//mA
14 disp(Iout,"Iout for the circuit is(mA) : ");
```

Scilab code Exa 1.17 Design a widlar current source

```
1 //Ex 1.17
2 clc;clear;close;
3 format('v',5);
4 Iout=6;//micro A
5 IREF=1.2;//mA
6 VBE2=0.7;//V
7 VT=26;//mV
8 VCC=20;//V
9 Beta=120;// unitless
10 R=(VCC-VBE2)/IREF;//kohm
11 IC2=(IREF-Iout/Beta)/(1+1/Beta);//mA
12 RS=VT/Iout*log(IC2*1000/Iout);//kohm
13 disp(RS,R,"Value of resistance R & Rs for widlar
    current source design is(kohm) : ");
```

Scilab code Exa 1.18 Design a widlar current source

```
1 //Ex 1.18
2 clc;clear;close;
3 format('v',5);
4 IREF=1;//mA
5 IO2=20;//micro A
6 IO3=40;//micro A
7 VBE1=0.7;//V
8 VT=26;//mV
9 VCC=10;//V
10 VEE=-VCC;//V
11 R=(VCC-VBE1-VEE)/IREF;//kohm
12 RE2=VT*10^-3/(IO2*10^-6)*log((IREF*10^-3)/(IO2
    *10^-6));//ohm
13 RE2=RE2/1000;//kohm
14 RE3=VT*10^-3/(IO3*10^-6)*log((IREF*10^-3)/(IO3
    *10^-6));//ohm
15 RE3=RE3/1000;//kohm
16 disp(RE3,RE2,R,"Value of resistance R, RE2 & RE3 for
    widlar current source design is(kohm) : ");
17 VBE2=VBE1-RE2*IO2*10^-3;//V
18 VBE3=VBE1-RE3*IO3*10^-3;//V
19 format('v',7);
20 disp(VBE3,VBE2,"Values of VBE2 & VBE3(V) : ");
```

Scilab code Exa 1.19 Calculate current

```
1 //Ex 1.19
2 clc;clear;close;
3 format('v',5);
4 Beta=100;//unitless
```

```

5 VBE=0.715; //V
6 VEE=10; //V
7 R=5.6; //kohm
8 IREF=(VEE-VBE)/R; //mA
9 IC1=IREF/(1+2/Beta); //mA
10 disp(IC1," Collector current in each transistor is
    equal as all are identical. It is(mA) : ");
11 IRC=3*IC1; //mA
12 disp(IRC," Current through resistance Rc is (mA) : ")
    ;

```

Scilab code Exa 1.20 IC1 IC2 and RC

```

1 //Ex 1.20
2 clc;clear;close;
3 format('v',6);
4 Vout=5; //V
5 Beta=180; //unitless
6 VBE=0.7; //V
7 VEE=10; //V
8 Vout=5; //V
9 R1=22; //kohm
10 R2=2.2; //kohm
11 IREF=(VEE-VBE)/R1; //mA
12 IC=(IREF-VBE/R2)/(1+2/Beta); //mA
13 IC1=IC*1000; //micro A(as VBE1=VBE2 IC1=IC2)
14 IC2=IC*1000; //micro A
15 disp(IC2,IC1," Current IC1 & IC2 (micro A) : ");
16 RC=(VEE-Vout)/(IC1*10^-3); //kohm
17 disp(RC," Value of Rc is (kohm) : ");
18 //Answer is wrong in the textbook.

```

Scilab code Exa 1.21 IC2 IC3 IC4


```

1 //Ex 1.21
2 clc;clear;close;
3 format('v',6);
4 AQ2byA1=0.5;
5 AQ3byA1=0.25;
6 AQ4byA1=0.125;
7 VBE=0.7; //V
8 VCC=15; //V
9 R=20; //kohm
10 IC1=(VCC-VBE)/R; //mA
11 IC2=IC1*AQ2byA1; //mA
12 IC3=IC1*AQ3byA1; //mA
13 IC4=IC1*AQ4byA1; //mA
14 disp(IC4,IC3,IC2," Value of current IC2, IC3 & IC4 is
      (mA) : ");
15 //Value of IC4 is displayed wrong in the textbook.

```

Chapter 2

The 741 IC OPamp

Scilab code Exa 2.1 Input reference current

```
1 //Ex 2.1
2 clc;clear;close;
3 format('v',6)
4 VCC=5;//V
5 IS=10^-14;//A
6 RS=39*1000;//ohm
7 VBE12=0.7;//V(Assumed)
8 VBE11=0.7;//V(Assumed)
9 VEE=-5;//V
10 IREF=(VCC-VBE12-VBE11-VEE)/RS*10^6;//micro A
11 disp(IREF,"Estimated input reference current , IREF(
    micro A)");
12 VT=25*10^-3;//V(Thermal Voltage)
13 VBE=VT*log(IREF*10^-6/IS);//V
14 IREF=(VCC-VBE-VBE-VEE)/RS*10^6;//micro A
15 format('v',5)
16 disp(IREF,"More precise value of reference current ,
    IREF(micro A)");
17 //Replacing Vcc by 15 V in the original design
18 VCC2=15;//V
19 VEE2=-15;//V
```

```

20 IREF=(VCC2-VBE-VBE-VEE2)/RS*10-6; //micro A
21 VBE=VT*log(IREF*10-6/IS); //V
22 R5=(VCC-VBE-VBE-VEE)/(IREF*10-6); //ohm
23 R5=round(R5/1000); //kohm
24 disp(R5," Value of R5(kohm) : ");

```

Scilab code Exa 2.2 Design a widlar current source

```

1 //Ex 2.2
2 clc;clear;close;
3 format('v',5);
4 IC10=20*10-6; //A
5 IREF=0.5*10-3; //A
6 IS=10-14; //A
7 VT=25*10-3; //V(Thermal Voltage)
8 R4=VT/IC10*log(IREF/IC10); //ohm
9 disp(R4/1000,"For Widlar current source design, the
   value of R4(kohm) : ");

```

Scilab code Exa 2.3 Slew rate

```

1 //Ex 2.3
2 clc;clear;close;
3 format('v',5)
4 Gm1=10; //mA/V
5 Gm1=Gm1/1000; //A/V
6 Cc=50; //pF
7 Cc=Cc*10-12; //F
8 Rt=108; //ohm(Shunting resistance with Cc)
9 Ao=Gm1*Rt; // unitless
10 fp=1/(2*%pi*Rt*Cc); //Hz
11 ft=Gm1/(2*%pi*Cc)/106; //MHz

```

```
12 disp(fp,"Frequency at which gain is maximum, fp in
    Hz");
13 disp(ft,"Unity gain frequency, ft (MHz)");
14 //Bode plot can not be plotted with the given data
    in the question by using scilab functions.
```

Scilab code Exa 2.4 Full power Bandwidth

```
1 //Ex 2.4
2 clc;clear;close;
3 format('v',6);
4 SR=10/10^-6; //V/s
5 Vout=10; //V(magnitude of output voltage)
6 fm=SR/(2*pi*Vout)/1000; //kHz
7 disp(fm,"Full power bandwidth(kHz)");
8 VT=25/1000; //V(Thermal voltage)
9 ft=SR/(2*pi*4*VT)/10^6; //MHz
10 disp(ft,"Unity gain bandwidth(MHz)");
```

Scilab code Exa 2.5 Output voltage limits

```
1 //Ex 2.5
2 clc;clear;close;
3 VCC=5; //V
4 VEE=-5; //V
5 VBE=0.6; //V
6 VCE23=0.6; //V
7 VCE_sat=0.2; //V
8 Vo_max=VCC-VCE_sat-VBE; //V
9 Vo_min=VEE+VCE_sat+VBE+VCE23; //V
10 disp(Vo_max,"Maximum output voltage (V)");
11 disp(Vo_min,"Minimum output voltage (V)");
```

Chapter 3

Linear Applications of IC OPamp

Scilab code Exa 3.1 Value of Rf

```
1 //Ex 3.1
2 clc;clear;close;
3 R1=2.2;//kohm
4 G=-100;//Voltage gain
5 Rf=-G*R1;//kohm
6 disp(Rf,"Value of Rf(kohm) : ");
```

Scilab code Exa 3.2 Output Voltage

```
1 //Ex 3.2
2 clc;clear;close;
3 Vin=2.5;//mV
4 R1=2;//kohm
5 Rf=200;//kohm
6 G=-Rf/R1;//Gain
7 Vo=G*Vin/1000;//V
```

```
8 disp(Vo,"Output Voltage(V) : ");
```

Scilab code Exa 3.3 Design invertin amplifier

```
1 //Ex 3.3
2 clc;clear;close;
3 G=-10;//Gain
4 Ri=100;//kohm(input resistance)
5 R1=Ri;//kohm
6 R2=-G*R1;//kohm
7 disp(R1,"Value of R1(kohm)");
8 disp(R2/1000,"Value of R2(Mohm)");
```

Scilab code Exa 3.4 Approximate values of attenuation

```
1 //Ex 3.4
2 clc;clear;close;
3 format('v',6);
4 FT1=1;//Filter Transmission
5 FT2=0.99;//Filter Transmission
6 FT3=0.9;//Filter Transmission
7 FT4=0.1;//Filter Transmission
8 A1=-20*log10(FT1);//dB
9 A2=-20*log10(FT2);//dB
10 A3=-20*log10(FT3);//dB
11 A4=-20*log10(FT4);//dB
12 disp(A1,"For filter transmission=1, Attenuation(dB)");
13 disp(A2,"For filter transmission=0.99, Attenuation(dB)");
14 disp(A3,"For filter transmission=0.9, Attenuation(dB)");
```

```
15 disp(A4,"For filter transmission=0.1, Attenuation(dB
    )");
16 //Answer in the book is wrong for 0.99 filter
    transmission.
```

Scilab code Exa 3.5 First order low pass filter

```
1 //Ex 3.5
2 clc;clear;close;
3 format('v',5);
4 fo=2;//kHz
5 Ap=10;//Band pass gain
6 C=0.1;//micro F(have to choose C, 0.01<C<1)
7 R2=1/(2*%pi*fo*10^3*C*10^-6);//ohm
8 R1=R2/Ap;//ohm
9 disp("Design values are :");
10 disp(C,"Capacitance(micro F)");
11 disp(R1,"Resistance R1(ohm)");
12 disp(R2/1000,"Resistance R2(kohm)");
13 //Answer in the book is wrong.
```

Scilab code Exa 3.6 Second order low pass filter

```
1 //Ex 3.6
2 clc;clear;close;
3 format('v',6);
4 fo=1;//kHz
5 Ap=1.586;//Band pass gain
6 C1=0.005;C2=0.005//micro F(Assumed)
7 R=1/(2*%pi*fo*10^3*C1*10^-6);//ohm
8 Rf=10;//kohm(Assumed)
9 Ri=Rf/(Ap-1);//kohm
10 disp("Design values are :");
```

```

11 disp(R/1000," Resistance in kohm, R1=R2=");
12 disp(Ri," Resistance Ri(kohm)");
13 disp(Rf," Resistance Rf(kohm)");
14 disp(C1," Capacitance(micro F), C1=C2=");

```

Scilab code Exa 3.7 Second order Butterworth filter

```

1 //Ex 3.7
2 clc;clear;close;
3 format('v',6);
4 fo=3;//kHz
5 Ap=4;//Band pass gain
6 alfa=1.414;//for butterworth filter
7 C1=0.01;//micro F(Assumed)
8 C2=alfa^2*C1/4;//micro F
9 R=1/(2*pi*fo*10^3*sqrt(C1*10^-6*C2*10^-6))/1000;//
   kohm
10 Rf=2*R;//kohm(Assumed)
11 disp("Design values are :");
12 disp(C1," Capacitance C1(micro F)");
13 disp(C2," Capacitance C2(micro F)");
14 disp(R," Resistance R(kohm)");
15 disp(Rf," For offset minimization , Resistance Rf(kohm
   )");
16 ///For additional pass band gain
17 Ri=10;//kohm(Assumed)
18 Rf=(Ap-1)*Ri;//kohm
19 disp("For additional band pass gain:");
20 disp(Ri," Resistance Ri(kohm)");
21 disp(Rf," Resistance Rf(kohm)");
22 //Answer in the book is not accurate.

```

Scilab code Exa 3.8 Second order low pass filter


```

1 //Ex 3.8
2 clc;clear;close;
3 format('v',6);
4 fo=2;//kHz
5 alfa=1.414;//for butterworth filter
6 Ap=3-alfa;//band pass gain
7 RfBYRi=(Ap-1);//op-amp gain
8 C=0.05;//micro F(Assumed)
9 R=1/(2*pi*fo*10^3*C*10^-6)/1000;//kohm
10 //For offset minimization 2*R=Rf|| Ri
11 Rf=2*R*RfBYRi+2*R;//kohm
12 Ri=Rf/RfBYRi;//kohm
13 disp("Design values are :");
14 disp(C,"Capacitance C(micro F)");
15 disp(R,"Resistance R(kohm)");
16 disp(Rf,"Resistance Rf(kohm)");
17 disp(Ri,"Resistance Ri(kohm)");

```

Scilab code Exa 3.9 Second order low pass filter

```

1 //Ex 3.9
2 clc;clear;close;
3 format('v',6);
4 fo=1.2;//kHz
5 alfa=1.414;//for butterworth filter
6 Ap=3-alfa;//band pass gain
7 RfBYRi=(Ap-1);//op-amp gain
8 C=0.03;//micro F(have to choose C, 0.01<C<1)
9 R=1/(2*pi*fo*10^3*C*10^-6)/1000;//kohm
10 //For offset minimization 2*R=Rf|| Ri
11 Rf=2*R*RfBYRi+2*R;//kohm
12 Ri=Rf/RfBYRi;//kohm
13 disp("Design values are :");
14 disp(C,"Capacitance(micro F)");
15 disp(R,"Resistance R(kohm)");

```

```
16 disp(Rf," Resistance Rf(kohm)");
17 disp(Ri," Resistance Ri(kohm)");
```

Scilab code Exa 3.10 Design a band pass filter

```
1 //Ex 3.10
2 clc;clear;close;
3 format('v',5);
4 fL=200;//Hz
5 fH=1*1000;//Hz
6 Ap=4;//band pass gain
7 BW=fH-fL;//Hz
8 f0=sqrt(fH*fL);//Hz
9 fc=sqrt(fH*fL);//Hz
10 Q=fc/BW;//Quality factor
11 disp(Q," Quality factor");
12 disp("As Q<12 ; it is wide band filter");
13 disp(fL," Design values for high pass section with
    Ap1=2 & fL(Hz) :");
14 Ap1=2;//band pass gain for high pass section
15 C=0.033;//micro F(have to choose C, 0.01<C<1)
16 R=1/(2*%pi*fL*C*10^-6)/1000;//kohm
17 RfBYRi=(Ap-1);//op-amp gain
18 Rf=2*R;//kohm
19 Ri=2*R;//kohm
20 disp(C," Capacitance(micro F)");
21 disp(R," Resistance R(kohm)");
22 disp(Rf," Resistance Rf(kohm)");
23 disp(Ri," Resistance Ri(kohm)");
24 disp(fH," Design values for low pass section with Ap2
    =2 & fH(Hz) :");
25 Ap2=2;//band pass gain for low pass section
26 C=0.033;//micro F(have to choose C, 0.01<C<1)
27 k=fL/fH;//scaling factor
28 Rdash=0.2*R;//kohm
```

```

29 Ri=2*Rdash;//kohm
30 Rf=Ri;//kohm(for Ap2=2)
31 disp(C,"Capacitance(micro F)");
32 disp(Rdash,"Resistance Rdash(kohm)");
33 disp(Rf,"Resistance Rf(kohm)");
34 disp(Ri,"Resistance Ri(kohm)");
35 disp("For design purpose use rounded value 10 kohm
      for Rf & Ri");

```

Scilab code Exa 3.11 Design a band pass filter

```

1 //Ex 3.11
2 clc;clear;close;
3 format('v',5);
4 fL=200;//Hz
5 fH=1*1000;//Hz
6 Ap=4;//band pass gain
7 BW=fH-fL;//Hz
8 f0=sqrt(fH*fL);//Hz
9 fc=sqrt(fH*fL);//Hz
10 Q=fc/BW;//Quality factor
11 disp(Q,"Quality factor");
12 disp("As Q<10 ; it is wide band filter");
13 disp(fH,"Design values for low pass section with Ap2
      =2 & fH(Hz) :");
14 Ap2=2;//band pass gain for low pass section
15 C=0.03;//micro F(have to choose C, 0.01<C<1)
16 Rdash=1/(2*%pi*fH*C*10^-6)/1000;//kohm
17 disp(C,"Capacitance(micro F)");
18 disp(Rdash,"Resistance Rdash(kohm)");
19 disp("Value of Resistance Rf & Ri can be choosen as
      10 kohm for filter design.");
20 disp(fL,"Design values for high pass section with
      Ap1=2 & fL(Hz) :");
21 Ap1=2;//band pass gain for high pass section

```

```

22 C=0.05; //micro F(have to choose C, 0.01<C<1)
23 R=1/(2*%pi*fL*C*10^-6)/1000; //kohm
24 RfBYRi=(Ap-1); //op-amp gain
25 disp(C,"Capacitance(micro F)");
26 disp(R,"Resistance R(kohm)");
27 disp("Value of Resistance Rf & Ri can be choosen as
      10 kohm for filter design.");

```

Scilab code Exa 3.12 Design a band pass filter

```

1 //Ex 3.12
2 clc;clear;close;
3 format('v',6);
4 fo=1.2*1000; //Hz
5 Q=4; //Quality factor
6 Ap=10; //band pass gain
7 C=0.05; //micro F(have to choose C, 0.01<C<1)
8 R2=2*Q/(2*%pi*fo*C*10^-6)/1000; //kohm
9 R1=R2/2/Ap; //kohm
10 R3=R1/(4*%pi^2*R1*1000*R2*1000*(C*10^-6)^2*fo^2-1);
    //kohm
11 disp("Design values are :");
12 disp(C,"Capacitance(micro F)");
13 disp(R1,"Resistance R1(kohm)");
14 disp(R2,"Resistance R2(kohm)");
15 disp(R3*1000,"Resistance R3(ohm)");
16 //Answer in the book is wrong for R3 & value of C is
    0.05 instead of 0.5.

```

Scilab code Exa 3.13 Wide band stop filter

```

1 //Ex 3.13
2 clc;clear;close;

```

```

3 format('v',6);
4 fH=100;//Hz
5 fL=1*1000;//Hz
6 disp("This filter is a combination of -:");
7 disp("High pass filter having fH=100 Hz");
8 disp("Low pass filter having fL=1 kHz");
9 disp("And a summing amplifier");
10 //High pass filter
11 disp("Design values for high pass section :");
12 C=0.05;//micro F(have to choose C, 0.01<C<1)
13 R=1/(2*pi*fL*C*10^-6)/1000;//kohm
14 Ap=2;//assumed
15 //Rf=Ri;//for gain=2
16 Rf=10;//kohm(assumed)
17 Ri=10;//kohm(assumed)
18 disp(C,"Capacitance(micro F)");
19 disp(R,"Resistance R(kohm)");
20 disp("Value of Resistance Rf & Ri can be chosen as
      10 kohm for filter design.");
21 //Low pass filter
22 disp("Design values for low pass section :");
23 C=0.1;//micro F(have to choose C, 0.01<C<1)
24 Rdash=1/(2*pi*fH*C*10^-6)/1000;//kohm
25 Ap=2;//assumed
26 //Rfdash=Ridash;//for gain=2
27 Rf_dash=10;//kohm(assumed)
28 Ri_dash=10;//kohm(assumed)
29 disp(C,"Capacitance(micro F)");
30 disp(Rdash,"Resistance Rdash(kohm)");
31 disp("Value of Resistance Rf_dash & Ri_dash can be
      chosen as 10 kohm for filter design.");

```

Scilab code Exa 3.14 Active notch filter

```
1 //Ex 3.14
```

```

2  clc; clear; close;
3  format('v',6);
4  fN=50; //Hz
5  C=0.5; //micro F(have to choose C, 0.01<C<1)
6  R=1/(2*%pi*fN*C*10^-6)/1000; //kohm
7  disp("Design values are :");
8  disp(C, "Capacitance(micro F)");
9  disp(R, "Resistance R(kohm)");

```

Scilab code Exa 3.15 Low pass filter

```

1  //Ex 3.15
2  clc; clear; close;
3  format('v',6);
4  fo=1*1000; //Hz
5  fo_dash=1.5*1000; //Hz
6  C=0.01; //micro F(have to choose C, 0.01<C<1)
7  R=1/(2*%pi*fo*C*10^-6)/1000; //kohm
8  K=1.2*1000/fo_dash; //scaling factor
9  Rdash=K*R; //kohm
10 disp("Design values are :");
11 disp(C, "Capacitance(micro F)");
12 disp(R, "Resistance R(kohm)");
13 disp(Rdash, "Resistance Rdash(kohm)");

```

Scilab code Exa 3.16 Minimum Gain

```

1  //Ex 3.16
2  clc; clear; close;
3  Vf=0.0125; //V
4  Vo=0.5; //V
5  Beta=Vf/Vo; //unitless
6  //A*Beta=1 for oscillation

```

```
7 A=1/Beta; //gain
8 disp(A,"Minimum Gain");
```

Scilab code Exa 3.17 Frequency of oscillation

```
1 //Ex 3.17
2 clc;clear;close;
3 format('v',6);
4 R=50; //kohm(R1=R2=R3=R)
5 C=60; //pF(C1=C2=C3=C)
6 f=1/(2*%pi*R*1000*C*10^-12*sqrt(6)); //Hz
7 disp(f/1000,"Frequency of oscillation(kHz)");
```

Scilab code Exa 3.18 Wein Bridge Oscillator

```
1 //Ex 3.18
2 clc;clear;close;
3 format('v',5);
4 f=2*1000; //Hz
5 R=10; //kohm(Assumed)(R1=R2=R)
6 C=1/(2*%pi*R*1000*f); //F
7 disp("Value of resistance R1=R2 can be choosen as 10
      kohm");
8 disp(C*10^9,"Capacitance(nF)");
9 disp("Value of resistance R4 can be choosen as 10
      kohm & R3=2*R4=20 kohm for Beta to be 1/3");
```

Scilab code Exa 3.19 Frequency of oscillation

```
1 //Ex 3.19
```

```

2  clc;clear;close;
3  format('v',6);
4  R=200;//kohm(R1=R2=R)
5  C=200;//pF(C1=C2=C)
6  f=1/(2*%pi*R*1000*C*10^-12);//Hz
7  disp(f*10^-3,"Frequency of oscillation(kHz)");
8  //Answer in the book is wrong

```

Scilab code Exa 3.20 First order low pass filter

```

1  //Ex 3.20
2  clc;clear;close;
3  format('v',6);
4  omegaBYomega0=[0 0.5 1 5 10 100];
5  //T=omega0/sqrt(omega0^2+omega^2);//Gain
6  for i=1:6
7  T(i)=1/sqrt(1^2+omegaBYomega0(i)^2);//Gain
8  end
9  G=20*log10(T);//dB
10 A=-20*log10(T);//dB
11 fi=-atand(omegaBYomega0);//degree
12 disp("omega/omega0      T(j*omega)      (G(dB))
      A(dB)      fi")
13 table=[omegaBYomega0' T G A fi'];
14 disp(table);

```

Scilab code Exa 3.21 Value of T and FI

```

1  //Ex 3.21
2  clc;clear;close;
3  format('v',6);
4  omega1=0.1;//rad/s
5  omega2=1;//rad/s

```



```

6 omega3=10; //rad/s
7 T1=1/sqrt(1+omega1^6); // Transfer function
8 T2=1/sqrt(1+omega2^6); // Transfer function
9 T3=1/sqrt(1+omega3^6); // Transfer function
10 fi1=-atand((2*omega1-omega1^3)/real(1-2*omega1^2));
    //degree
11 fi2=-atand((2*omega2-omega2^3)/real(1-2*omega2^2));
    //degree
12 fi3=-atand((2*omega3-omega3^3)/real(1-2*omega3^2));
    //degree
13 disp(fi1,T1," Value of T & fi for 0.1 rad/s: ");
14 disp(fi2-180,T2," Value of T & fi for 1 rad/s: ");
15 disp(fi3,T3," Value of T & fi for 10 rad/s: ");

```

Scilab code Exa 3.22 First order opamp RC low pass filter

```

1 //Ex 3.22
2 clc;clear;close;
3 format('v',6);
4 f0=10*1000; //Hz(3-dB frequency)
5 DCgain=10;
6 R1=10; //kohm
7 R2=DCgain*R1; //kohm
8 C=1/(2*pi*f0*R2*1000)*10^9; //nF
9 disp("Design values are :");
10 disp(R2," Resistance R2(kohm): ");
11 disp(C," Capacitance C(nF): ");

```

Scilab code Exa 3.23 First order opamp high pass filter

```

1 //Ex 3.23
2 clc;clear;close;
3 format('v',6);

```

```

4 f0=100; //Hz(3-dB frequency)
5 Ri_inf=100; //kohm(High frequency input resistance)
6 Tinf=1; //high frequency gain
7 R1=Ri_inf; //kohm
8 R2=Tinf*R1; //kohm
9 C=1/(2*pi*f0*R2*1000)*10^9; //nF
10 disp("Design values are :");
11 disp(R2,"Resistance R1=R2 in kohm : ");
12 disp(C,"Capacitance C(nF): ");

```

Scilab code Exa 3.24 Cascading components

```

1 //Ex 3.24
2 clc;clear;close;
3 format('v',6);
4 Ap=12; //dB(Pass band gain)
5 G=round(10^(Ap/20)); //gain(unitless)
6 Ri=100; //kohm(as high input impedance required)
7 R1=Ri; //kohm
8 //Low pass filter design
9 ALP=-1;AHP=-4; //(to satisfy R2<=100; //kohm)
10 R2=-ALP*R1; //kohm
11 f0=10*1000; //Hz(3-dB frequency)
12 C=1/(2*pi*f0*R2*1000)*10^9; //nF
13 disp("Design values for low pass filter :");
14 disp(R2,"Resistance R1=R2 in kohm : ");
15 disp(C,"Capacitance C(nF): ");
16 //High pass filter design
17 R3=25; //kohm(Assumed)
18 R4=-AHP*R3; //kohm
19 f0=100; //Hz(3-dB frequency)
20 C=1/(2*pi*f0*R3*1000)*10^9; //nF
21 disp("Design values for high pass filter :");
22 disp(R4,R3,"Resistance R3 & R4 in kohm : ");
23 disp(C,"Capacitance C(nF): ");

```

Scilab code Exa 3.25 Value of R

```
1 //Ex 3.25
2 clc;clear;close;
3 format('v',6);
4 omega=10^4;//rad/s
5 C=10;//nF
6 fi1=-30;fi2=-90;fi3=-120;fi4=-150;//degree
7 R1=tand(-fi1/2)/(C*10^-9*omega)/1000;//kohm
8 R2=tand(-fi2/2)/(C*10^-9*omega)/1000;//kohm
9 R3=tand(-fi3/2)/(C*10^-9*omega)/1000;//kohm
10 R4=tand(-fi4/2)/(C*10^-9*omega)/1000;//kohm
11 disp(R1,"For phase shift=-30 degree , Resistance(kohm
    ) : ");
12 disp(R2,"For phase shift=-90 degree , Resistance(kohm
    ) : ");
13 disp(R3,"For phase shift=-120 degree , Resistance(
    kohm) : ");
14 disp(R4,"For phase shift=-150 degree , Resistance(
    kohm) : ");
```

Scilab code Exa 3.26 Resulting shift

```
1 //Ex 3.26
2 clc;clear;close;
3 omega1=0;//rad/s
4 omega2=%inf;//rad/s
5 omega0=10^4;//rad/s(Assumed)
6 fi1=atand(omega2/omega0)-atand(omega2/-omega0);//
    degree
7 fi2=atand(omega1/omega0)-atand(omega1/-omega0);//
    degree
```

```
8 disp(fi1," For omega=0, phase shift (degree)");
9 disp(fi2," For omega=infinity , phase shift (degree)");
```

Scilab code Exa 3.28 Design the KHN circuit

```
1 //Ex 3.28
2 clc;clear;close;
3 f0=1*1000; //Hz
4 BW=2*%pi*50; //Hz
5 C=10; //nF
6 Q=2*%pi*f0/BW; //quality factor
7 R=1/(2*%pi*f0*C*10^-9)/1000; //kohm
8 R1=10; //kohm (Assumed)
9 RF=10; //kohm (Assumed)
10 R3BYR2=2*Q-1;
11 R2=10; //kohm (Assumed)
12 R3=R3BYR2*R2; //kohm
13 disp(" Design values for KHN circuit :");
14 disp(RF,R1," Use Resistance R1 & RF in kohm : ");
15 disp(R2," Use Resistance R2 in kohm : ");
16 disp(R3," Resistance R3 in kohm : ");
17 K=2-1/Q; //scaling factor
18 CenterFrequency=K*Q;
19 disp(CenterFrequency," CenterFrequency ");
```

Chapter 4

Digital Integrated Circuit Design

Scilab code Exa 4.3 Gain in transition region

```
1 //Ex 4.3
2 clc;clear;close;
3 VDD=3; //V(Supply Voltage)
4 VOH=VDD; //V
5 VOL=0; //V
6 Vth=VDD/2; //V
7 VIL=VDD/2; //V
8 VIH=VDD/2; //V
9 NMH=VOH-VIH; //V
10 NML=VIL-VOL; //V
11 disp(Vth,"Vth(V)");
12 disp(VIL,"VIL(V)");
13 disp(VIH,"VIH(V)");
14 disp(VOL,"VOL(V)");
15 disp(VOH,"VOH(V)");
16 disp(NML,"NML(V)");
17 disp(NMH,"NMH(V)");
18 //Gain=(VOH-VOL)/(VIH-VIL)=infinity as VIH=VIL; //
    Gain in the transition region
```

```
19 Gain=%inf; //
20 disp(Gain,"Gain in the transition region");
21 //Answer in the book is wrong for the gain.
```

Chapter 5

Non Linear Applications of IC OPamps

Scilab code Exa 5.1 Find VUT and VLT

```
1 //Ex 5.1
2 clc;clear;close;
3 format('v',5);
4 R1=100;//kohm
5 R2=86;//kohm
6 Vsat=15;//V
7 VUT=R2/(R1+R2)*Vsat;//V
8 VLT=R2/(R1+R2)*-Vsat;//V
9 disp(VUT,"VUT(V) : ");
10 disp(VLT,"VLT(V) : ");
```

Scilab code Exa 5.2 Period of multivibrator and frequency

```
1 //Ex 5.2
2 clc;clear;close;
3 Rf=100;//kohm
```

```

4 C=0.1; //micro F
5 T=2*Rf*1000*C*10^-6; //s
6 disp(T*10^3, "Time period(ms)");
7 f=1/T; //Hz
8 disp(f, "Frequency(Hz) : ");

```

Scilab code Exa 5.3 Frequency of oscillation

```

1 //Ex 5.3
2 clc;clear;close;
3 R=100; //kohm
4 C=0.01; //micro F
5 f=1/(2*R*10^3*C*10^-6); //Hz
6 disp(f, "Frequency(Hz) : ");

```

Scilab code Exa 5.4 Design a square wave oscillator

```

1 //Ex 5.4
2 clc;clear;close;
3 f=1*1000; //HZ
4 Vs=15; //V
5 C=0.1; //micro F(Assumed)
6 R=1/(2*f*C*10^-6); //Hz
7 disp(R/1000, "For the required design value of R(kohm
   ) : ");
8 disp("R1 & R2 can be choosen as 10 kohm");
9 ///Answer in the book is wrong

```

Scilab code Exa 5.5 Maximum diode current


```

1 //Ex 5.5
2 clc;clear;close;
3 Vo=0.7; //V
4 Vsat=12; //V
5 R1=10; //kohm
6 R2=60; //kohm
7 Vth=R1/(R1+R2)*Vo; //V
8 iDmax=(Vsat-Vo)/R1-Vo/(R1+R2); //mA
9 disp(iDmax,"Maximum current (mA) : ");

```

Scilab code Exa 5.7 Frequency of oscillation

```

1 //Ex 5.7
2 clc;clear;close;
3 format('v',6);
4 R1=10; //kohm
5 R2=16; //kohm
6 C=10; //nF
7 R=62; //kohm
8 Beta=R1/(R1+R2); // unitless
9 T=2*R*1000*C*10-9*log((1+Beta)/(1-Beta)); //seconds
10 f=1/T; //Hz
11 disp(f,"Frequency of oscillations (Hz) : ");

```

Scilab code Exa 5.8 Average output voltage

```

1 //Ex 5.8
2 clc;clear;close;
3 format('v',5);
4 //vo/v1=1+R2/R1; //
5 //For v2/v1 i.e. gain=2, R1 & R2 should be equal
6 Vpp=10; //V
7 R1=10; //kohm

```

```

8 R2=10; //kohm
9 //Avg=1/T*integrate('Vpp*sin(2*%pi*t/T)', 't', 0, T/2);
10 Avg=-Vpp/(2*%pi)*[cos(%pi)-cos(0)];
11 disp(Avg, "Average output voltage(V) : ");

```

Scilab code Exa 5.9 Design of rectifier

```

1 //Ex 5.9
2 clc;clear;close;
3 format('v',5);
4 //vo/v1=-2;//Gain for -ve inputs
5 voBYvi=-2;//Gain for -ve inputs
6 //vo/v1=0;//Gain for non -ve inputs
7 Rin=100; //kohm
8 R1=100; //kohm(R1=Rin)
9 R2=-R1*voBYvi; //kohm
10 disp(R2,R1, "Values of R1 & R2(kohm) are : ");

```

Scilab code Exa 5.11 Triangular wave generator

```

1 //Ex 5.11
2 clc;clear;close;
3 format('v',5);
4 f0=1.5; //kHz
5 Vopp=6; //V
6 Vsat=13.5; //V
7 //Let R2=10kohm
8 R2=10; //kohm
9 R3=R2*2*Vsat/Vopp; //kohm
10 //Let C1=0.05 micro F
11 C1=0.05; //micro F
12 R1=R3/(4*f0*1000*R2*1000*C1*10^-6); //kohm
13 disp(R3,R2,R1, "Values of R1, R2 & R3(kohm) are : ");

```

```
14 disp(C1," Value of C1(micro F)");
```

Scilab code Exa 5.12 Frequency of oscillation

```
1 //Ex 5.12
2 clc;clear;close;
3 format('v',4);
4 tau=1;//ms
5 //R1/R2=1.8:9;given range
6 //Let R1/R2=1.8
7 R1BYR2=1.8;//ratio
8 Beta1=1/(R1BYR2+1);
9 R1BYR2=9;//ratio
10 Beta2=1/(R1BYR2+1);//unitless
11 Beta=Beta1:Beta2;//Range of Beta
12 //For fmin
13 Tmax=2*log((1+Beta1)/(1-Beta1));//ms
14 fmin=1000/Tmax;//Hz
15 //For fmax
16 Tmin=2*log((1+Beta2)/(1-Beta2));//ms
17 fmax=1/Tmin;//kHz
18 disp("Frequency range is "+string(fmin)+" Hz to "+
      string(fmax)+" kHz");
```

Chapter 6

Integrated circuit timer and phase locked loops

Scilab code Exa 6.1 Output change per bit Full scale output

```
1 //Ex 6.1
2 clc;clear;close;
3 n=8;//no. of bits
4 V1=0;//V
5 V2=5.12;//V
6 Res=2^n;//resolution
7 disp(Res,"(a) Resolution=");
8 delVo=(V2-V1)/Res*1000;//mV/bit
9 disp(delVo,"(b) Output change per bit(mV/bit)");
10 VFS=V2*(1-1/2^n);//V
11 disp(VFS,"(c) Full scale Output voltage(V)");
```

Scilab code Exa 6.2 Produced output

```
1 //Ex 6.2
2 clc;clear;close;
```

```

3 format('v',5);
4 step=10.3; //mV
5 reading='101101111'; //reading
6 Vo=step*bin2dec(reading)/1000; //V
7 disp(Vo,"Output voltage(V)");

```

Scilab code Exa 6.3 LSB MSB and full scale output

```

1 //Ex 6.3
2 clc;clear;close;
3 format('v',5)
4 n=8; //no. of bits
5 Range=0:10; //range
6 LSB=max(Range)/2^n; //V
7 MSB=max(Range)/2^0; //V
8 VFS=MSB-LSB; //V
9 disp(LSB*1000,"LSB(mV)");
10 disp(MSB,"MSB(V)");
11 disp(VFS,"VFS(V)");

```

Scilab code Exa 6.4 Produced output

```

1 //Ex 6.4
2 clc;clear;close;
3 format('v',5);
4 Range=0:10; //range
5 //(i)2-bit DAC
6 n=2; //no. of bits
7 step=max(Range)/2^n; //V
8 reading='10'; //input in binary
9 Vo=step*bin2dec(reading); //V
10 disp(Vo,"(i) Output Voltage(V)");
11 //(ii)4-bit DAC

```

```

12 n=4; //no. of bits
13 step=max(Range)/2^n; //V
14 reading='0110'; //input in binary
15 Vo=step*bin2dec(reading); //V
16 disp(Vo,"(ii) Output Voltage(V)");
17 //(i)8-bit DAC
18 n=8; //no. of bits
19 step=max(Range)/2^n; //V
20 reading='10111100'; //input in binary
21 Vo=step*bin2dec(reading); //V
22 disp(Vo,"(iii) Output Voltage(V)");

```

Scilab code Exa 6.5 Analog output voltage

```

1 //Ex 6.5
2 clc;clear;close;
3 n=8; //no. of bits
4 Res=20; //mV/bit (Resolution)
5 reading='00010110'; //input in binary
6 Vo=Res*bin2dec(reading); //V
7 disp(Vo/1000,"(a) Output Voltage(V)");
8 reading='10000000'; //input in binary
9 Vo=Res*bin2dec(reading); //V
10 disp(Vo/1000,"(b) Output Voltage(V)");

```

Scilab code Exa 6.6 Offset voltage

```

1 //Ex 6.6
2 clc;clear;close;
3 n=12; //no. of bits
4 Eoff=0.05; //%%//maximum offset error
5 Vref=10.24; //V
6 Voffset=Eoff/100*Vref; //V

```

```

7 disp(round(Voffset*1000),"(a) Offset voltage (mV)");
8 delVo=Vref/2^n;//V/bit
9 Voff_dash=Voffset/delVo;//in terms of LSB
10 disp(round(Voff_dash),"(b) Offset voltage in terms
    of LSB");

```

Scilab code Exa 6.7 Minimum output voltage

```

1 //Ex 6.7
2 clc;clear;close;
3 format('v',4);
4 n=8;//no. of bits
5 E=0.2;//%//maximum gain error
6 Vref=5.1;//V
7 V11=(100-E)*Vref/100;//V
8 disp(V11,"Minimum output voltage (V)");

```

Scilab code Exa 6.8 Input voltage and digital output

```

1 //Ex 6.8
2 clc;clear;close;
3 format('v',5);
4 n=8;//no. of bits
5 Range=0:10;//V
6 Vin=5.2;//V
7 oneLSB=max(Range)/2^n;//V
8 disp(oneLSB*1000,"(a) Minimum voltage for 1 LSB in
    mV");
9 Vifs=max(Range)-oneLSB;//V
10 disp(Vifs,"(b) For all ones input voltage should be
    (V)");
11 D=Vin/oneLSB;//Digital output in decimal
12 D=dec2bin(round(D));//Digital output in binary

```

```
13 disp(D,"(c) Digital Output");
```

Scilab code Exa 6.9 Conversion time

```
1 //Ex 6.9
2 clc;clear;close;
3 n=8;//no. of bits
4 f=1*10^6;//Hz(Clock frequency)
5 TC=1/f*(n+1);//seconds
6 disp(TC*10^6,"Conversion time in micro seconds");
```

Chapter 7

Integrated circuit timer and phase locked loops

Scilab code Exa 7.1 tHIGH tLOW and free running frequency

```
1 //Ex 7.1
2 clc;clear;close;
3 RA=6.8;//kohm
4 RB=3.3;//kohm
5 C=0.1;//micro F
6 VCC=5;//V
7 t_high=0.695*(RA+RB)*C;//ms
8 disp(t_high,"(a) t_high (ms)");
9 t_low=0.695*RB*C;//ms
10 disp(t_low,"(b) t_low (ms)");
11 f=1.44/(RA+2*RB)/(C);//kHz
12 disp(f,"(c) Frequency of oscillation (kHz)");
```

Scilab code Exa 7.2 Calculate timing interval

```
1 //Ex 7.2
```

```

2  clc; clear; close;
3  RA=10; //kohm
4  C=0.1; //micro F
5  t=1.1*RA*C; //ms
6  disp(t, "Timing interval(ms)");

```

Scilab code Exa 7.3 Loop lock

```

1  //Ex 7.3
2  clc; clear; close;
3  fc=500; //kHz(Free running frequency)
4  fi=600; //kHz(Input signal frequency)
5  BW=10; //kHz
6  out1=fi+fc; //kHz(Phase detector output)
7  out2=fi-fc; //kHz(Phase detector output)
8  disp(out2, out1, "Output of phase detector will be(kHz
   )");
9  disp("Both components are not lying in the passband(
   i.e. 10 kHz). Hence loop will not acquire lock.")
   ;
10 //fi+fc is calculated wrong in the book.

```

Scilab code Exa 7.4 Capture range

```

1  //Ex 7.4
2  clc; clear; close;
3  format('v', 6);
4  fo=10; //kHz
5  V=12; //V
6  fL=8*fo/(V-(-V)); //kHz(both +ve & -ve value)
7  C=10; //micro F(Assumed)
8  fC=sqrt(fL*103/(2*%pi*3.6*103*C*10-6)); //Fz(both
   +ve & -ve value)

```

```

9  disp(fC,fL,"Frequency fL & fC in kHz");
10 LR=2*fL;//kHz(Lock Range)
11 disp(LR,"Lock Range(kHz)");
12 CR=2*fC;//kHz(Capture rage)
13 disp(CR,"Capture Range(Hz)");

```

Scilab code Exa 7.5 Design components of PLL

```

1  //Ex 7.5
2  clc;clear;close;
3  format('v',5);
4  fo=100;//kHz(Free running frequency)
5  V=6;//V(both +ve & -ve value)
6  C=1;//micro F(Demodulation capacitor)
7  fL=8*fo/(V-(-V));//Hz(both +ve & -ve value)
8  fC=sqrt(fL*1000/(2*pi*3.6*10^3*C*10^-6));//kHzz(
    both +ve & -ve value)
9  LR=2*fL;//kHz(Lock range)
10 disp(LR,"Lock Range(kHz)");
11 CR=2*fC/1000;//kHz(Capture range)
12 disp(CR,"Capture Range(kHz)");
13 RT=10;//kohm(Assumed)
14 CT=1.2/(4*RT*1000*fo*10^3);//F
15 disp("Design values are : ");
16 disp("Resistance RT can be choosen as 10 kohm.");
17 format('v',9);
18 disp(CT,"Capacitance CT(F)");

```

Scilab code Exa 7.7 Value of R and Vth

```

1  //Ex 7.7
2  clc;clear;close;
3  C=1;//nF

```

```

4 T=10; //micro seconds(Output pulse duration)
5 R=T*10^-6/(C*10^-9*log(3))/1000; //kohm
6 disp(R,"(a) Value of R(kohm)");
7 VCC=15; //V
8 T=20; //micro seconds(Output pulse duration)
9 VTH=VCC*(1-exp(-T*10^-6/(R*1000*C*10^-9))); //V
10 disp(VTH,"(b) Value of VTH(V)");

```

Scilab code Exa 7.8 Design astable circuit

```

1 //Ex 7.8
2 clc;clear;close;
3 format('v',6);
4 C=680; //pF
5 f=50; //kHz(Square wave frequency)
6 D=75/100; //duty cycle
7 T=1/f*1000; //micro seconds
8 tHIGH=D*T; //micro seconds
9 tLOW=T-tHIGH; //micro seconds
10 RB=(tLOW*10^-6)/(0.69*C*10^-12); //ohm
11 RA=(tHIGH*10^-6)/(0.695*C*10^-12)-RB; //ohm
12 disp(RA/1000," Value of RA(kohm)");
13 disp(RB/1000," Value of RB(kohm)");

```
