Scilab Textbook Companion for Integrated Circuits by S. Sharma[1]

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Book Description

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Scilab numbering policy used in this document and the relation to the above book.

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

AP Appendix to Example(Scilab Code that is an Appednix to a particular Example of the above book)

For example, Exa 3.51 means solved example 3.51 of this book. Sec 2.3 means a scilab code whose theory is explained in Section 2.3 of the book.

Contents

List of Scilab Codes

Chapter 1

Analog Integrated Circuit Design An Overview

Scilab code Exa 1.1 Constant current

```
// Exa 1.1
clc;
clear;
close;
// Given data
V_EE = 10;// in V
R2 = 2.4;// in k ohm
R1 = 2.4;// in k ohm
R3 = 1;// in k ohm
V_BE3 = 0.7;// in V
I = (V_EE - ((R2*V_EE)/(R1+R2)) - V_BE3)/R3;// in mA
disp(I,"The constant current in mA is");
```

Scilab code Exa 1.2 Value of RE

```
// Exa 1.2
```

```
clc;
clear;
close;
// Given data
V_CC = 50;// in V
V_BE2 = 0.7;// in V
R = 50;// in k ohm
R = 50 * 10^3;// in ohm
I_C1 = 10;// in  A
I_C1 =I_C1 * 10^-6;// in A
V_T = 26;// in mV
V_T = V_T * 10^-3;// in V
I_C2 = (V_CC - V_BE2)/R;// in A
R_E = (V_T*log(I_C2/I_C1))/I_C1;// in ohm
R_E = R_E * 10^-3;// in k ohm
disp(R_E,"The value of R_E in k  is");
```

Scilab code Exa 1.3 Collector current

```
// Exa 1.3
clc;
clear;
close;
// Given data
V = 10;// in V
V_BE = 0.715;// in V
V_R = 0-(V_BE - V);// in V
R = 5.6;// in  k ohm
I_R = V_R/R;// in  mA
bita = 100;
I_C = I_R * (bita/(1+bita));// in mA
disp(I_C,"For transistor Q1, the collector current
    in mA is");
I_C2 = I_R;// in mA
disp(I_C2,"For transistor Q2, the collector current
```

```
    in mA is");
I_C3 = I_R;// in mA
disp(I_C3,"For transistor Q3, the collector current
    in mA is");
I_C4 = I_R;// in mA
disp(I_C4,"For transistor Q4, the collector current
    in mA is");
```

Scilab code Exa 1.4 Collector current

```
// Exa 1.4
clc;
clear;
close;
// Given data
V = 10;// in V
V_BE = 0.715;// in V
R = 5.6;// in k ohm
I = (V-V_BE)/(R);// in mA
bita = 100;
I_C1 = (bita/(4+bita))*I;// in mA
disp(I_C1,"For transistor Q1, the collector current
    in mA is");
I_C2 = I_C1;// in mA
disp(I_C2,"For transistor Q2, the collector current
    in mA is");
I_C3 = I_C1;// in mA
disp(I_C3,"For transistor Q3, the collector current
    in mA is");
I_C4 = I_C1;// in mA
disp(I_C4,"For transistor Q4, the collector current
    in mA is");
```

Scilab code Exa 1.5 Output resistance

```
// Exa 1.5
clc;
clear;
close;
// Given data
I_D1 = 100;// in  A
k_n = 200;// in  A /V^2
W = 10;// in  m
l = 1;// in  m
V_A = 20;// in V
V_ov = sqrt((I_D1*2)/(k_n*(W/l)));// in V
V_t = 0.7;// in V
V_GS = V_t + V_ov;// in V
V_GS = round(V_GS);// in V
V_DD = 3;// in V
I_REF = 100;// in  A
I_REF = I_REF * 10^-3;// in mA
R = (V_DD - V_GS)/I_REF;// in k ohm
disp(R,"The value of R in k  is");
V_ov_min = V_ov ;// in volt
disp(V_ov_min,"The lowest possible value of V_o in V is");
r_o2 = V_A/I_D1;// in M ohm
disp(r_o2,"The output resistance in M  is");
V_O = V_GS;// in V
del_Io = V_O/r_o2;// in  A
disp(del_Io,"The change in output current in  A is");
```

Chapter 2

The 741 IC Op Amp

Scilab code Exa 2.2 Input bias current

```
// Exa 2.2
clc;
clear;
close;
// Given data
I_b1 = 18;// in  A
I_b2 = 22;// in  A
I_b = (I_b1+I_b2)/2;// in  A
disp(I_b,"Input bias current in  A is ");
I_ios = abs(I_b1-I_b2);// in  A
disp(I_ios,"Input offset current in  A is");
```

Scilab code Exa 2.4 Slew rate and maximum possible frequency

```
// Exa 2.4
clc;
clear;
close;
```

```
// Given data
I_CQ = 10;// in  A
I_CQ= I_CQ*10^-6;// in A
I = I_CQ;// in A
C_C = 33;// in pF
C_C=C_C*10^-12;// in F
C = C_C;// in F
S = I/C;// in V/sec
disp(S*10^-6,"The slew rate in V/  -sec is");
V_m = 12;// in V
f_m = S/(2*%pi*V_m);// in Hz
f_m = f_m * 10^-3;// in kHz
disp(f_m,"Maximum possible frequency in kHz is");
```

Scilab code Exa 2.5 Output voltage

```
// Exa 2.5
clc;
clear;
close;
// Given data
CMRR = 100;
V1 = 300;// in  V
V2 = 240;// in  V
V_id = V1-V2;// in  V
V_cm = (V1+V2)/2;// in  V
A_id = 5000;
A_cm = A_id/CMRR;
V_out = (A_id*V_id) + (A_cm*V_cm);// in  V
V_out = V_out * 10^-3;// in mV
disp("Part (i)")
disp(V_out,"The output Voltage in mV is");
disp("Part (ii)")
CMRR = 10^5;
A_cm = A_id/CMRR;
```

```
V_out = (A_id*V_id) + (A_cm*V_cm);// in  V
V_out = V_out* 10^-3;// in mV
disp(V_out,"The output voltage in mV is");
```

Scilab code Exa 2.6 CMRR

```
// Exa 2.6
clc;
clear;
close;
// Given data
R1 = 1;// in k ohm
R2 = 100;// in k ohm
A_id = R2/R1;// in k ohm
Epsilon = 1 - (90/R2);
A_cm = (R2*Epsilon)/(R1+R2)
CMMR = A_id/A_cm;
CMRR = 20*log10(CMMR);// in dB
disp(CMRR,"The value of CMRR in dB is");
```

Scilab code Exa 2.6.2 Input offset voltage

```
// Exa 2.6 Again
clc;
clear;
close;
// Given data
gm1= 1/5.26;// in mA/V
gm1= gm1*10^-3;// in A/v
I= 9.5;// in  A
I=I*10^-6;// in A
del_I= 5.5*10^-3*I;// in A
V_OS= del_I/gm1;// in V
```

```
disp(V_OS*10^3,"The offset voltage in mV is : ")
```

Scilab code Exa 2.17 Lowest value of RL

```
// Exa 2.17
clc;
clear;
close;
// Given data
V = 10;// in V
R1 = 1;// in k ohm
R1=R1*10^3;// in ohm
R2 = 9;// in  k ohm
R2= R2*10^3;// in ohm
I_out = 20;// in mA
I_out=I_out*10^-3;// in A
R_L = V/( I_out-(V/(R1+R2)) );// in ohm
disp(R_L,"The lowest value of R_L in ohm is");
```

Scilab code Exa 2.18 Slew rate and maximum possible frequency

```
// Exa 2.18
clc;
clear;
close;
// Given data
I_CQ = 10;// in  A
I_CQ= I_CQ*10^-6;// in A
I = I_CQ;// in A
C_C = 33;// in pF
C_C=C_C*10^-12;// in F
C = C_C;// in F
S = I/C;// in V/sec
```

```
disp(S*10^-6,"The slew rate in V/  -sec is");
V_m = 12;// in V
f_m = S/(2*%pi*V_m);// in Hz
f_m = f_m * 10^-3;// in kHz
disp(f_m,"Maximum possible frequency in kHz is");
```

Chapter 3

Op Amp With Negative Feedback

Scilab code Exa 3.1 Closed loop voltage gain

```
// Exa 3.1
clc;
clear;
close;
// Given data
A = 2*10^5;
R_F = 4.7*10^3;// in ohm
R1 = 470;// in ohm
K = R_F/(R1+R_F);
B = R1/(R1+R_F);
A_F = -(A*R_F)/(R1+R_F+(R1*A));
disp(A_F,"The closed loop voltage gain is");
R_in = 2;// in M ohm
R_in = R_in * 10^6;// in ohm
R_inf = R1 + ( (R_F*R_in)/(R_F+R_in + (A*R_in)) );// in ohm
disp(R_inf,"Input resistance in    is");
R_o = 75;// in ohm
R_of = R_o/(1+(A*B));// in ohm
```

```
R_of = R_of * 10^3;// in m
disp(R_of,"Output Resistance in m  is");
f_o = 5;// Hz
f_f = f_o*(1+(A*B));// in Hz
f_f = f_f *10^-3;// in kHz
disp(f_f,"Band width with feedback in kHz is");

// Note: In the book, the unit of output resistant is wrong it will be m  (not M )
```

Scilab code Exa 3.2 Inverting op amp

```
// EXa 3.2
clc;
clear;
close;
// Given data
A_F = -30;
R_F = 1;// in M ohm
R1 = -(R_F/A_F);// in Mohm
R_i = R1;// in Mohm
disp(R_i*10^3,"Input resistance in k  is");
```

Scilab code Exa 3.4 Feedback resistance

```
// Exa 3.4
clc;
clear;
close;
// Given data
A_F = 61;
R1 = 1;// in k ohm
R1 = R1 * 10^3;// in ohm
```

```
R_F = (A_F-1)*R1;// in ohm
R_F = R_F * 10^-3;// k ohm
disp(R_F,"The value of feedback resistance in k  is ");
```

Scilab code Exa 3.5 Closed loop gain and input resistance

```
// Exa 3.5
clc;
clear;
close;
// Given data
A = 2*10^5;
R1 = 1;// in k ohm
R1 = R1  *10^3;// in ohm
R_F = 10;// in k ohm
R_F = R_F * 10^3;// in ohm
B = R1/(R1+R_F);
R_i = 2;// in M ohm
R_i = R_i  * 10^6;// in ohm
R_o = 75;// in ohm
A_F = A/(1+(A*B));
disp(A_F,"The closed loop gain is");
R_if = R_i * (1+(A*B));// in ohm
disp(R_if*10^-9,"Input resistance in G  is");
R_of = R_o/(1+(A*B));// in ohm
R_of = R_of * 10^3;// in m
disp(R_of,"The output resistance in m is");
f_o = 5;// in Hz
f_f = f_o*(1+(A*B));// in Hz
f_f = f_f * 10^-3;// in kHz ... correction....
disp(f_f,"Bandwidth with feedback in kHz is");
```

Scilab code Exa 3.6 Voltage gain and input resistance

```
// Exa 3.6
clc;
clear;
close;
// Given data
A =2*10^5;
R_i = 2;// in M ohm
R1 = 1;// in ohm
R_o= 75;// in ohm
R_F = 1;// in ohm
B = R1/(R1+R_F);
A_F = -1;
disp(A_F,"The voltage gain is ");
R_if = 330;// in ohm
disp(R_if,"Input resistance in     is");
R_of = R_o/(A/2);// in ohm
disp(R_of,"Output resistance in     is");
f_o = 5;// in Hz
f_F = (A/2)*f_o;// in Hz
f_F = f_F * 10^-6;// in MHz
disp(f_F,"The bandwidth in MHz is");
```

Scilab code Exa 3.7 Value of Af Rif RoF and fF

```
// Exa 3.7
clc;
clear;
close;
// Given data
A = 2*10^5;
R_i = 2;//in  M ohm
R_i = 2*10^6;// in ohm
R_o = 75;//in ohm
```

```
f_o = 5;// in Hz
V_CC = 15;// in V
V_EE = -15;// in V
R1 = 1;// in k ohm
R1 = R1 * 10^3;// in ohm
R_F = 10;// in k ohm
R_F = R_F * 10^3;// in ohm
OVS= 13;// output voltage swing in V in
B = R1/(R1+R_F);
A_B = A*B;
A_B1 = 1+(A*B);
A_F = (1+(R_F/R1));
disp("Part (i) For non-inverting amplifier")
disp(A_F,"The value of A_F is");
R_iF = R_i * (A_B1);// in ohm
disp(R_iF*10^-9,"The value of R_iF in  G is");
R_OF = R_o/(A_B1);// in ohm
disp(R_OF,"The value of R_OF in ohm is");
f_F = f_o*A_B1;// in Hz
f_F =f_F * 10^-3;// in kHz
disp(f_F,"The value of f_F in kHz is");
V_ooT= OVS/(1+A*B);// in V
disp("The value of VooT is   "+string(V_ooT)+" V or
     "+string(V_ooT*10^3)+" mV")

disp("Part (ii) For inverting amplifier")
R_F = 4.7;// in k ohm
R_F = R_F* 10^3;// in ohm
R_1 = 470;// in ohm
A_F = -(R_F)/R_1;
disp(A_F,"The value of A_F is");
R_iF = R_1// in ohm
disp(R_iF,"The value of R_iF in   is");
R_OF = R_o/(A_B1);// in ohm
disp(R_OF,"The value of R_OF in   is");
f_F = f_o*A_B1;// in Hz
f_F =f_F * 10^-3;// in kHz
disp(f_F,"The value of f_F in kHz is");
```

```
V_ooT = OVS/A_B1;// in mV
disp("The value of VooT is   "+string(V_ooT)+" V or
     "+string(V_ooT*10^3)+" mV")
```

Scilab code Exa 3.8 Voltage gain and input output resistance

```
// EXA 3.8
clc;
clear;
close;
// Given data
R1 = 5;// in  k ohm
R_F = 500;// in k ohm
V_in = 0.1;// in V
A_F = -(R_F/R1);
disp(A_F,"Voltage gain is");
R_i = R1;// in  k ohm
disp(R_i,"The Input resistance in k  is");
R_o = 0;// in ohm
disp(R_o,"Output resistance in    is");
V_out = A_F*V_in;// in V
disp(V_out,"Output voltage in V is");
I_in = V_in/(R1*10^3);// in A
I_in = I_in * 10^3;// in mA
disp(I_in,"Input current in mA is");
```

Scilab code Exa 3.9 Input impedance voltage gain and power gain

```
// Exa 3.9
clc;
clear;
close;
// Given data
```

```
R_F = 1;// in M ohm
R_in = 1;// in M ohm
V_in = 1;// in V (assumed)
V_out = -(R_F/R_in)*V_in;
A_v = V_out/V_in;
disp(A_v,"The value of A_v is");
I_in = 1;// in A
I_out = I_in;// in A
A_in = I_out/I_in;
disp(A_in,"The value of A_in is");
A_P = abs(A_v*A_in);
disp(A_P,"The value of A_P is");
```

Scilab code Exa 3.10 Inverting op amp

```
// Exa 3.10
clc;
clear;
close;
// Given data
R_F = 1;// in M ohm
R_F = R_F * 10^6;// in ohm
Av= -30;
R1 = R_F/abs(Av);// in ohm
R1 = R1 * 10^-3;// in k ohm
disp(R_F*10^-6,"The value of R_F in M  is : ")
disp(R1,"The value of R1 in k  is");
```

Scilab code Exa 3.11 Inverting op amp

```
// Exa 3.11
clc;
clear;
```

```
close;
// Given data
A_v = -8;
V_in= -1;// in V
I1 = 15;// in  A
I1 = I1 * 10^-6;// in A
R1 = -(V_in)/I1;// in ohm
R1 = R1 * 10^-3;// in k ohm
disp(R1,"Minimum value of R1 in k  is");
R_F = -(A_v)*R1;// in  k ohm
disp(R_F,"The minimum value of R_F in k  is");

// Note: There is calculation error in the book to
   find the value of R_F so the answer in the book
   is wrong.
```

Chapter 4

Linear Applications of IC Op Amps

Scilab code Exa 4.1 Output voltage

```
//Exa 4.1
clc;
clear;
close;
// Given data
R1= 1;// in k
R2= 1;// in k
R3= 1;// in k
RF= 1;// in k
Vin1= 2;// in volt
Vin2= 1;// in volt
Vin3= 4;// in volt
Vout= -(RF/R1*Vin1+RF/R2*Vin2+RF/R3*Vin3)
disp(Vout,"The output voltage in volts is : ")
```

Scilab code Exa 4.2 Design an adder circuit

```
//Exa 4.2
clc;
clear;
close;
// Given data
RF= 100;// in k
Vout= '−(V1+10∗V2+100∗V3)';// given expression
// Vout= −(RF/R1∗V1+RF/R2∗V2+RF/R3∗V3)
// Comparing the Vout with the given expression
R1= RF;// in k
R2= RF/10;// in k
R3= RF/100;// in k
disp(R1,"The value of R1 in k  is : ");
disp(R2,"The value of R2 in k  is : ");
disp(R3,"The value of R3 in k  is : ");
```

Scilab code Exa 4.3 Output voltage

```
//Exa 4.3
clc;
clear;
close;
// Given data
R1= 12;// in k
R2= 2;// in k
R3= 3;// in k
RF= 12;// in k
V1= 9;// in volt
V2= -3;// in volt
V3= -1;// in volt
Vout= -(RF/R1*V1+RF/R2*V2+RF/R3*V3)
disp(Vout,"The output voltage in volts is : ")
```

Scilab code Exa 4.4 Summing amplifier

```
//Exa 4.4
clc;
clear;
close;
// Given data
RF= 6;// in k
Vout= '-V1+2*V2-3*V3';// given expression or
Vout= '-(V1-2*V2+3*V3)';
// Vout= -(RF/R1*V1+RF/R2*V2+RF/R3*V3)
// Comparing the Vout with the given expression
R1= RF;// in k
R2= RF/2;// in k
R3= RF/3;// in k
disp(R1,"The value of R1 in k  is : ");
disp(R2,"The value of R2 in k  is : ");
disp(R3,"The value of R3 in k  is : ");
```

Scilab code Exa 4.5 Values of resistances

```
//Exa 4.5
clc;
clear;
close;
// Given data
R3= 10;// in k
Vout= '-2*V1+3*V2+4*V3';// given expression or
Vout= '-(2*V1-3*V2-4*V3)';
// Vout= -(RF/R1*V1+RF/R2*V2+RF/R3*V3)
// Comparing the Vout with the given expression , we
   get
RF= 4*R3;// in k
R2= RF/3;// in k
R1= RF/2;// in k
```

```
disp(RF,"The value of RF in k  is : ");
disp(R2,"The value of R2 in k  is : ");
disp(R1,"The value of R1 in k  is : ");
```

Scilab code Exa 4.6 Output voltage

```
//Exa 4.6
clc;
clear;
close;
// Given data
V1= 2;// in V
V2= -1;// in V
R=10;// assuming value in k
R1=R;// in k
R2= R;// in k
R3= R;// in k
R4= R;// in k
RF= 2*R;// in k
Vin1= V1*(R1*R2/(R1+R2))/(R1+(R2*R3/(R2+R3)));// in V
Vout1= Vin1*(1+RF/R1);// in V
Vin2= V2*(R3*R4/(R3+R4))/(R2+(R3*R4/(R3+R4)));// in V
Vout2= Vin2*(1+RF/R2);// in V
Vout= Vout1+Vout2;// in V
disp(Vout,"The output voltage in volts is : ")
```

Scilab code Exa 4.7 Limiting frequency

```
//Exa 4.7
clc;
clear;
```

```
close;
// Given data
R1= 10;// in  k
CF= 0.1;// in micro F
CF= CF*10^-6;// in F
RF= 10*R1;// in  k
RF= RF*10^3;// in
fa= 1/(2*%pi*RF*CF);// in Hz
disp(fa,"Limiting frequency in Hz is : ")
```

Scilab code Exa 4.8 Practical integrator circuit

```
//Exa 4.8
clc;
clear;
close;
// Given data
f=10;// in kHz
f=f*10^3;// in Hz
dcGain= 10;
fa= f/10;// in Hz
R1= 10;// in  k
// Formula dcGain= RF/R1
RF= R1*dcGain;// in  k
RF=RF*10^3;// in
R1= R1*10^3;// in
// Formula fa= 1/(2*%pi*RF*CF)
CF= 1/(2*%pi*RF*fa);// in F
CF=CF*10^9;// in nF
Rcomp= R1*RF/(R1+RF);// in
disp(CF,"The value of CF in nF is : ")
disp(Rcomp*10^-3,"The value of Rcomp in k  is : ");

// Note: There is calculation error in evaluating
   the value of CF in the book. So The value of CF
```

```
in the book is wrong.
```

Scilab code Exa 4.9 Maximum change in output voltage

```
//Exa 4.9
clc;
clear;
close;
// Given data
Vin=5;// in V
R1= 1;// in  k
R1= R1*10^3;// in
CF= 0.1;// in   F
CF= CF*10^-6;// in F
f= 1;// in kHz
f= f *10^3;// in Hz
T= 1/f;// in sec
delta_Vout= Vin*T/(2*R1*CF);// in V
disp(delta_Vout,"The maximum change in output
    voltage in volts is : ")
S= 2*%pi*f*Vin;// in V/sec
disp(S*10^-6,"The minimum slew rate required in V/
    micro-sec is : ")
```

Scilab code Exa 4.10 Safe frequency and dc gain

```
// Exa 4.10
clc;
clear;
close;
// Given data
R_F = 1.2;// in M ohm
R_F = R_F * 10^6;// in ohm
```

```
C_F = 10;// in nF
C_F = C_F * 10^-9;// in F
f_a = 1/(2*%pi*R_F*C_F);// in Hz
disp(f_a,"The safe frequency in Hz is");
R1 = 120;// in k ohm
R1 = R1 * 10^3;// in ohm
A = R_F/R1;
AindB= 20*log10(A);// in dB
disp(AindB,"The d.c gain in dB is");
f = 10;// in kHz
f = f * 10^3;// in Hz
A = (R_F/R1)/(sqrt( 1+ ((f/f_a)^2) ));
V_in_peak = 5;// in V
V_out_peak = V_in_peak*A;// in V
disp(V_out_peak*10^3,"The peak of output voltage in
    mV is");
```

Scilab code Exa 4.11 Output voltage

```
// Exa 4.11
clc;
clear;
close;
// Given data
Vrms= 10;// in mV
f= 2*10^3;// in kHz
C= 2*10^-6;// in F
R= 50*10^3;// in ohm
SF= -1/(C*R);// scale factor
//Vout= -1/(R*C)*sqrt(2)*Vrms*integrate('sind(2*%pi*
    f*t)','t',0,t);// in mV
//Vout= 1/(R*C)*sqrt(2)*Vrms/(2*%pi*f)*(cos(4000*t)
    -1);// in mV
V= 1/(R*C)*sqrt(2)*Vrms/(2*%pi*f);// (assumed)
disp("Output voltage in mV is : "+string(V)+"*(cos
```

```
(4000 *t)-1)) mV")
```

Scilab code Exa 4.12 Closed loop time constant

```
//Exa 4.12
clc;
clear;
close;
// Given data
Vin=10;// in V
R= 2.2;// in k
R= R*10^3;// in
T= 1;// in ms
T= T*10^-3;// in sec
C= 1;// in  F
C= C*10^-6;// in F
gain= 10^5;// differential voltage gain
I= Vin/R;// in A
V= I*T/C;// in V
disp(V,"The capacitor voltage at the end of the
    pulse in volts is : ")
RC_desh= R*C*gain;// in sec
disp(RC_desh,"The closed loop time constant in sec
    is : ")
```

Scilab code Exa 4.13 Values of R1 and RF

```
//Exa 4.13
clc;
clear;
close;
// Given data
omega= 10000;// in rad/sec
```

```
GaindB= 20;// peak gain in dB
Gain= 10^(GaindB/20);
C= 0.01;// in  F
C= C*10^-6;// in F
// Formula omega= 1/(C*RF)
RF= 1/(C*omega);// in
R1= RF/Gain;// in
disp(RF*10^-3,"The value of RF in k  is : ")
disp(R1*10^-3,"The value of R1 in k  is : ")
```

Scilab code Exa 4.14 Sketch of output voltage

```
//Exa 4.14
clc;
clear;
close;
// Given data
R= 40*10^3;// in
C= 0.2*10^-6;// in F
Vin= 5;// in V
V1=3;// in V
V2= V1;// in V
Vout= V2;// in V
t= 0:0.1:50;// in ms
Vout= -1/(R*C)*integrate('Vin-V1','t',0,t)/10^3+Vout
    ;// in volts
plot(t,Vout);
xlabel("Time in milliseconds")
ylabel("Output voltage in volts")
title("Vout Graph")
disp("The Vout graph shown in figure")
```

Scilab code Exa 4.15 Time duration for saturation

```
// Exa 4.15
clc;
clear;
close;
// Given data
R = 500;// in k  ohm
R = R * 10^3;// in ohm
C = 10;// in   F
C = C * 10^-6;// in F
V= -0.5;// in V
Vout= 12;// in V
// Vout= -1/RC*integrate('V*t','t',0,t)= -1/(R*C)*V*t
t= Vout/(-1/(R*C)*V);// in sec
disp(t,"Time duration required for saturation of output voltage in second is : ")
```

Scilab code Exa 4.16 Values of resistors

```
// Exa 4.16
clc;
clear;
close;
// Given data
C_F = 10;// in   F
C_F = C_F * 10^-6;// in F
R1 = 1/C_F;// in ohm
R1 = R1 * 10^-3;// in k ohm
disp(R1,"The value of R1 in k   is");
R2 = 1/(C_F*2);// in ohm
R2 = R2 * 10^-3;// in k ohm
disp(R2,"The value of R2 in k   is");
R3 = 1/(C_F*5);// in ohm
R3 = R3 * 10^-3;;// in k ohm
disp(R3,"The value of R3 in k   is");
```

Scilab code Exa 4.17 Practical differentiator circuit

```
// Exa 4.17
clc;
clear;
close;
// Given data
f_max = 150;// in Hz
f_a = f_max;// in Hz
disp(f_a,"The value of f_a in Hz is : ")
C1 = 1;// in  F
C1 = C1 * 10^-6;// in F
R_F = 1/(2*%pi*f_a*C1);// in ohm
disp(R_F*10^-3,"The value of R_F in k  is");
f_b = 10*f_a;// in Hz
R1 = 1/(2*%pi*f_b*C1);// in ohm
C_F = (R1*C1)/R_F;// in F
disp(C_F*10^6,"The value of C_F in  F is");
R_comp = (R1*R_F)/(R1+(R_F));// in ohm
disp(R_comp,"The value of R_comp in  is");
```

Scilab code Exa 4.18 Output voltage

```
// Exa 4.18
clc;
clear;
close;
// Given data
Vmax= 10;// in  V
f= 2*10^3;// in kHz
//Vin= Vmax*sin(2*%pi*f*t);// in  V
```

```
disp("The input voltage is "+string(Vmax)+"*sin ("+
    string(2*f)+"%pi*t)  V")
```

Scilab code Exa 4.19 Values of ROM and Vout

```
// Exa 4.19
clc;
clear;
close;
// Given data
Vp= 1.5;// in V
f= 200;// in Hz
f_a= 1*10^3;// in Hz
C= 0.1*10^-6;// in F
// Formula f_a= 1/(2*%pi*f_a*C)
R= 1/(2*%pi*f_a*C);// in ohm
R= 1.5;// in k  (standard value)
f_b= 20*f_a;// in Hz
// Formula f_b= 1/(2*%pi*R_desh*C)
R_desh= 1/(2*%pi*f_b*C);// in ohm
R_desh= 82;// in ohm (standard value)
R_OM= R;// in kohm
disp(R_OM,"The value of R_OM in k  is : ")
omega= 2*%pi*f;// in radian
// Vin= Vp*sin(omega*t) and Vout= -R*C*dv_in/dt
// Vout= -R*C*Vp*omega*cos(400*%pi*t)
V= -R*10^3*C*Vp*omega;// (assumed)
//Vout= V*cos(400*%pi*t)
disp("Output voltage is "+string(V)+" *cos(400*%pi*t
    ) volts")
disp("Output voltage waveforms shown in figure")
x= -%pi/2:0.1:2*%pi;
plot(x,V*cos(x));
title("Output Voltage waveforms")
xlabel("Time")
```

```
ylabel("Vout")
```

Scilab code Exa 4.20 Range of gain

```
// Exa 4.20
clc;
clear;
close;
// Given data
R2 = 100;// in ohm
R1 = 200;// in ohm
R_F = 100;// in k ohm
R_F = R_F * 10^3;// in ohm
R_G = 100;// in ohm
Gain_max = ( 1+((2*R_F)/R_G) ) * (R2/R1);
R = 100;// in  k ohm
R_G1 = 0.01+R;// in k ohm
R_G1 = R_G1 * 10^3;// in ohm
Gain_min = ( 1+((2*R_F)/R_G1) ) * (R2/R1);
disp("The gain can be varied from "+string(Gain_min)
   +" to "+string(Gain_max))
```

Scilab code Exa 4.21 Value of RG

```
// EXa 4.21
clc;
clear;
close;
// Given data
R1 = 100;// in k ohm
R2 = 100;// in k ohm
R_F = 470;// in k ohm
Gain = 100;
```

```
R_G = (2*R_F)/(Gain-1);// in ohm
disp(R_G,"The value of R_G in ohm is");
```

Scilab code Exa 4.22 Transconductance resistance

```
// Exa 4.22
clc;
clear;
close;
// Given data
R = 100;// in ohm
T = 25;// in degree C
alpha = 0.00392;
R1 = R*(1+(alpha*T));// in ohm
expression= 'R_T= Ro*[1+alpha*T]';
disp(expression,"The expression for the resistance
    at T C is : ")
disp(R1,"The transducer resistance at 25 C in     is
    ");
T = 100;// in degree C
R2 = R*(1+(alpha*T));// in ohm
disp(R2,"The transducer resistance at 100 C in
    is");
```

Scilab code Exa 4.23 Instrumentation amplifier

```
// Exa 4.23
clc;
clear;
close;
// Given data
R3 = 1;// in k ohm
R4 = 1;// in k ohm
```

```
R_min = R4/R3;
R_4 = 50;// in k ohm
R_max = (R_4+R4)/R3;
R2 = 10;// in k ohm
A_F = 5;
R1 = (((A_F/R_min)-1)*R2)/2;// in k ohm
disp(R1,"The value of R1 in k  is");
disp(R2,"The value of R2 in k  is : ")
```

Scilab code Exa 4.24 Expression for output voltage

```
// Exa 4.24
clc;
clear;
close;
// Given data
R1= 100;// in  k
R2=200;// in  k
R3= 20;// in  k
R4=40;// in  k
//Vout= [1+R2/R1]*[R4/(R3+R4)]*Vin1-R2/R1*Vin2
A=[1+R2/R1]*[R4/(R3+R4)];// (assumed)
disp("Output voltage is "+string(A)+"*(Vin1-Vin2)")
```

Scilab code Exa 4.25 Gain of instrumentation amplifier

```
// Exa 4.25
clc;
clear;
close;
// Given data
R_F = 5;// in  k ohm
R_G = 1;// in  k ohm
```

```
R1 = 10;// in  k ohm
R2 = 20;// in  k ohm
A = (1 + ((2*R_F)/R_G))*(R2/R1);
disp(A,"The gain of instrumentaion amplifier is");
```

Scilab code Exa 4.27 Output voltage

```
// EXa 4.27
clc;
clear;
close;
// Given data
R_F = 10;// in  k ohm
R_G = 5;// in  k ohm
R1 = 1;// in  k ohm
R2 = 2;// in  k ohm
A = (1+ ((2*R_F)/R_G))*(R2/R1);
V_in2 = 2;// in mV
V_in1 = 1;// in mV
V_out = A*(V_in2-V_in1);// in mV
disp(V_out,"The output voltage in mV is");
```

Scilab code Exa 4.28 Value of RG

```
// Exa 4.28
clc;
clear;
close;
// Given data
V_out = 3;// in V
V_in2 = 5;// in mV
V_in1 = 2;// in mV
V1 = V_in2-V_in1;// in mV
```

```
V1 = V1 * 10^-3;// in V
A = V_out/V1;
R_F = 15;// in  k ohm
R1 = 1;// in  k ohm
R2 = 2;// in  k ohm
R = R2/R1;// in k  ohm
R_G = (2*R_F)/((A/R)-1);//in  k ohm
R_G = R_G * 10^3;// in ohm
disp(R_G,"The value of R_G in    is");
```

Scilab code Exa 4.31 Three op amp instrumentation amplifier

```
//Exa 4.31
clc;
clear;
close;
// Given data
A=10000;
R1= 100;// in  k
A2= 1/5;// (assumed value)
R2= R1/A2;// in  k
// A= A1*A2 and A1= 1+2*RF/R_GB
RFbyR_GB= (A/A2-1)/2;
// [1+2*RF/RG]*A2= 1 and RG= RGB+100  k
R_G= (1-1/A2)/2*100/[(1/A2-1)/2-RFbyR_GB];// in  k
R_F= RFbyR_GB*R_G;// in  k
disp(R_F,"The value of R_F in  k   is : ")
disp(R_G*10^3,"The value of R_G in    is : ")
disp("This is the base resistance required in series
    with the pot of 100  k  ")
```

Chapter 5

Filters

Scilab code Exa 5.1 Cut off frequency and passband voltage gain

```
// Exa 5.1
clc;
clear;
close;
// Given data
R = 10;// in k ohm
R = R * 10^3;// in ohm
C = 0.001;// in  F
C = C * 10^-6;// in F
f_c = 1/(2*%pi*R*C);// Hz
f_c = f_c * 10^-3;// in kHz
disp(f_c,"Cutoff frequency in kHz is");
R_F = 100;// in k ohm
R1 = 10;// in k ohm
A_F = 1+(R_F/R1);
disp(A_F,"The passband voltage gain is");
```

Scilab code Exa 5.2 First order low pass filter

```
// Exa 5.2
clc;
clear;
close;
// Given data
R1 = 10;// in k ohm
R_F = R1;// in k ohm
disp(R_F,"The value of R_F in k  is");
C = 0.001;// in  F
C = C  *10^-6;// in F
f_c = 10;// in kHz
f_c = f_c * 10^3;// in Hz
R = 1/(2*%pi*f_c*C);// in ohm
R  = R * 10^-3;// in k ohm
disp(R,"The value of R in k  is");
```

Scilab code Exa 5.3 Low pass filter

```
// Exa 5.3
clc;
clear;
close;
// Given data
f_c = 2;// in kHz
f_c = f_c * 10^3;// in Hz
C = 0.01;// in  F
C = C * 10^-6;// in F
R = 1/(2*%pi*f_c*C);// in ohm
R = R * 10^-3;// in k ohm
R = 8.2;// in k ohm(Practical value)
A_F = 2.5;
R1 = (A_F*R)/1.5;// in k ohm
R_F = 1.5*R1;// in k ohm
disp(R1,"The value of R1 in k  is : ")
disp(R_F,"The value of R_F in k  is : ")
```

Scilab code Exa 5.4 Second order low pass filter

```
// Exa 5.4
clc;
clear;
close;
// Given data
f_c = 1;// in kHz
f_c = f_c * 10^3;// in Hz
C = 0.005*10^-6;// in F
R3 = 1/(2*%pi*f_c*C);// in ohm
R3 = R3 * 10^-3;// in k ohm
R2 = R3;// in k ohm
R1 = 33;// in k ohm (standard value)
R_F = 0.586*R1;// in k ohm
disp(R1,"The value of R1 in k  is : ")
disp(R3,"The value of R2 and R3 in k  is");
disp(R_F,"The value of R_F in k  is : ")
disp(C*10^6,"The value of C2 and C3 in  F is :")
```

Scilab code Exa 5.5 Second order low pass filter

```
// Exa 5.5
clc;
clear;
close;
// Given data
R1 = 12;// in k ohm
R_F = 7;// in k ohm
R2 = 33;// in k ohm
R3 = R2;// in k ohm
```

```
R = R2;// in k ohm
R = R * 10^3;// in ohm
C1 = 0.002;// in  F
C1 = C1 * 10^-6;// in F
C2 = C1;// in F
C = C1;// in F
f_c = 1/(2*%pi*R*C);// in Hz
f_c = f_c * 10^-3;// in kHz
disp(f_c,"Cut off frequency in kHz is");
A_F = 1+(R_F/R1);
disp(A_F,"Pass band voltage gain is");
```

Scilab code Exa 5.6 Second order low pass filter

```
// Exa 5.6
clc;
clear;
close;
// Given data
f_c = 2;// in kHz
f_c = f_c * 10^3;// in Hz
C2 = 0.033;// in  F
C2 = C2 * 10^-6;// in F
C3 = C2;// in F
C = C2;// in F
R2 = 1/(2*%pi*f_c*C);// in ohm
R2 = R2 * 10^-3;// in k ohm
R3=R2;// in kohm
disp(R2,"The value of R2 and R3 in k  is : ");
//R_F= 0.586*R1
R1= 2*R2*(1+0.586)/0.586;// in k ohm
disp(R1,"The value of R1 in k  is : ")
R1= 15;// in k ohm
R_F = 0.586 * R1;// in k ohm
disp(R_F,"The value of R_F in k  is : ");
```

```
disp("R_F may be taken as a pot of 10 k ")
```

Scilab code Exa 5.7 Second order low pass filter

```
// Exa 5.7
clc;
clear;
close;
// Given data
f_c = 1;// in kHz
f_c = f_c * 10^3;// in Hz
C2 = 0.0047;// in  F
C2 = C2 * 10^-6;// in F
C3 = C2;// in F
C = C2;// in F
R2 = 1/(2*%pi*f_c*C);// in ohm
R2 = R2 * 10^-3;// in k ohm
R3= R2;// in kohm
// Let
R1=30;// in kohm
R_F= R1*0.586;// in kohm
disp(floor(R2),"The value of R2 and R3 in k  is : ")
disp(R1,"The value of R1 in k  is : ")
disp(R_F,"The value of R_F in k  is : ")
disp("The standard value of R_F is 20 k ")
```

Scilab code Exa 5.8 Second order Butterworth filter

```
// Exa 5.8
clc;
clear;
close;
```

```
// Given data
f_c = 1.5;// in kHz
f_c = f_c * 10^3;// in Hz
alpha = sqrt(2);
R_F = (2-alpha);// in ohm
disp(R_F,"The value of R_F in    is : ");
R_i = 1;// in ohm
A_F = 1+(R_F/R_i);
disp(A_F,"The pass band gain is");
Omega_c = 2*%pi*f_c;// in rad/sec
C = 1;// in F
R = 1/Omega_c;// in ohm
R = R * 10^7;// in ohm
R=R*10^-3;// in kohm
R1 = R;// in k ohm
R2=R1;// in kohm
disp(R1,"The value of R1 and R2 in k  is");
C = C/10^7;// in  F
C = C * 10^9;// in nF
C1=C;// in nF
C2= C1;// in nF
disp(C1,"The value of C1 and C2 in nF is");

//Note: The unit of R1 and R2 is wrong in the book
```

Scilab code Exa 5.9 Second order Butterworth filter

```
// Exa 5.9
clc;
clear;
close;
// Given data
alpha = 1.414;
f_c = 1.5;// in kHz
f_c = f_c * 10^3;// in Hz
```

```
C1 = 2/alpha;// in F
C2 = alpha/2;// in F
R1 = 1;// in ohm
R2 = R1;// in ohm
R_F = 2;// in ohm
Omega_c = 2*%pi*f_c;// in rad/sec
R = 1/Omega_c;// in ohm
R = R * 10^7;// in ohm
R1 = R;// in ohm
R2= R1;// in ohm
R_F = 2*R;// in ohm
C1 = C1/10^7;// in F
C2 = C2/10^7;// in F
disp(R1*10^-3,"The value of R1 and R2 in k ohm");
disp(C1*10^9,"The value of C1 in nF is");
disp(C2*10^9,"The value of C2 in nF is");
disp(R_F*10^-3,"The value of R_F in k ohm");
```

Scilab code Exa 5.12 Second order low pass filter

```
// Exa 5.12
clc;
clear;
close;
// Given data
f_c = 10;// in kHz
f_c = f_c * 10^3;// in Hz
omega_c= 2*%pi*f_c;// in rad/sec
C = 0.01;// in  F
C= C*10^-6;// in F
Ri= 10*10^3;// in
n=2;
Q= 1/1.414;
R= 1/(2*%pi*f_c*C);// in
Af= 3-1/Q;
```

```
Rf= (Af-1)*Ri;// in
disp(C*10^6,"The value of C in  F is : ")
disp(R*10^-3,"The value of R in k  is : ")
disp(Rf*10^-3,"The value of Rf in k  is : ")
disp("Frequency versus gain magnitude shown in following table:")
disp("      Frequency in Hz      Gain Magnitude in dB |H(s)|")
f= 1000;// in Hz
omega= 2*%pi*f;// in rad/sec
HsdB= 20*log10(Af/sqrt(1+(omega/omega_c)^4))
disp("            "+string(f)+"                  "+string(HsdB))
f= 2000;// in Hz
omega= 2*%pi*f;// in rad/sec
HsdB= 20*log10(Af/sqrt(1+(omega/omega_c)^4))
disp("            "+string(f)+"                  "+string(HsdB))
f= 5000;// in Hz
omega= 2*%pi*f;// in rad/sec
HsdB= 20*log10(Af/sqrt(1+(omega/omega_c)^4))
disp("            "+string(f)+"                  "+string(HsdB))
f= 10000;// in Hz
omega= 2*%pi*f;// in rad/sec
HsdB= 20*log10(Af/sqrt(1+(omega/omega_c)^4))
disp("           "+string(f)+"                  "+string(HsdB))
f= 50000;// in Hz
omega= 2*%pi*f;// in rad/sec
HsdB= 20*log10(Af/sqrt(1+(omega/omega_c)^4))
disp("           "+string(f)+"                 "+string(HsdB))
```

```
f= 100000;// in Hz
omega= 2*%pi*f;// in rad/sec
HsdB= 20*log10(Af/sqrt(1+(omega/omega_c)^4))
disp("            "+string(f)+"                              "+string(HsdB))
```

Scilab code Exa 5.13 Fourth order Butterworth filter

```
// Exa 5.13
clc;
clear;
close;
// Given data
f_c = 1;// in kHz
f_c = f_c * 10^3;// in Hz
C = 0.1;// in  F
disp(C,"The value of C in  F is");
C = C * 10^-6;// in F
R = 1/(2*%pi*f_c*C);// in ohm
disp(R*10^-3,"The value of R in k  is");
Q1 = 1/0.765;
alpha1 = 1/Q1;
Q2 = 1/1.848;
alpha2 = 1/Q2;
A_F1 = 3-alpha1;
A_F2 = 3-alpha2;
R_i =10*10^3;// in ohm
R_F = (A_F1-1)*R_i;// in ohm
disp(R_F*10^-3,"For first stage the value of R_F in k  is");
R_i = 100*10^3;// ohm
R_F = (A_F2-1)*R_i;// in ohm
disp(R_F*10^-3,"For second stage the value of R_F in k  is");
```

Scilab code Exa 5.14 Value of Resistance

```
// Exa 5.14
clc;
clear;
close;
// Given data
f_c = 10;// in kHz
f_c = f_c *10^3;// in Hz
C = 0.0047;// in   F
C = C * 10^-6;// in F
R = 1/(2*%pi*f_c*C);// in ohm
R = R * 10^-3;// in k ohm
disp(R,"The value of R in k   is");
```

Scilab code Exa 5.15 Passband gain

```
// Exa 5.15
clc;
clear;
close;
// Given data
R = 15;// in k ohm
R = R *10^3;// in ohm
C = 0.01;// in   F
C = C * 10^-6;// in F
f_c = 1/(2*%pi*R*C);// in Hz
f_c= round(f_c);
disp(f_c,"Cut off frequency in Hz is");
Omega_c = 2*%pi*f_c;// in rad/sec
disp(Omega_c*10^-3,"The value of omega_c in k rad/
   sec is");
```

```

// Note: There is calculation error to find the
   value of omega_c. So the answer in the book is
   wrong
```

Scilab code Exa 5.16 Cut off frequency and passband voltage gain

```
// Exa 5.16 printed as 5.13
clc;
clear;
close;
// Given data
R1 = 27;// in k ohm
R1 = R1 * 10^3;// in ohm
R2 = R1;// in ohm
R3 = R2 ;// in ohm
R = R1;// in ohm
R_L = 10;// in k ohm
R_F = 16;// in k ohm
C2 = 0.005;// in  F
C2 = C2 * 10^-6;// in F
C3 = C2;// in F
C = C3;// in F
f_c = 1/(2*%pi*R*C);// in Hz
f_c = f_c * 10^-3;// in kHz
R1= R1*10^-3;// in kohm
disp(f_c,"Cut off frequency in kHz is");
A_F = 1+(R_F/R1);
disp(A_F,"Voltage gain is");
```

Scilab code Exa 5.17 Second order Bessel Filter

```
// Exa 5.17
```

```
clc;
clear;
close;
// Given data
alpha = 1.732;
k_f = 1.274;
C1 = 1;// in F
C2 = C1;// in F
R1 = alpha/2;// in ohm
R2 = 2/alpha;// in ohm
R_F = R2;// in ohm
f_3dB = 2;// in kHz
f_3dB = f_3dB * 10^3;// in Hz
f_c = f_3dB/k_f;// in Hz
Omega_c = 2*%pi*f_c;// in rad/sec
R1 = R1/Omega_c;// in ohm
R1 = R1 * 10^8;// in ohm
R2 = R2/Omega_c;// in ohm
R2 = R2 * 10^8;// in ohm
R_F = R2;// in ohm
C1 = C1/10^8;// in F
disp(R1*10^-3,"The value of R1 in k  is : ")
disp(R2*10^-3,"The value of R2 and R_F in k  is : ")
disp(C1*10^9,"The value of C1 and C2 in nF is : ")
```

Scilab code Exa 5.18 Wide band pass filter

```
// Exa 5.18 printed as 5.15
clc;
clear;
close;
// Given data
Cdesh = 0.01;// in  F
Cdesh= Cdesh* 10^-6;// in F
```

```
f_H = 1;// in kHz
f_H = f_H * 10^3;// in Hz
Rdesh= 1/(2*%pi*f_H*Cdesh);// in ohm
A_F2 = 2;
R1desh = 10*10^3;// in ohm
Rdesh_F= R1desh;// in ohm
disp("(i) Low-pass Filter Components : ")
disp(R1desh*10^-3,"The value of R1desh in k  is");
disp(Rdesh*10^-3,"The value of Rdesh in k  is : ");
disp(Rdesh_F*10^-3,"The value of Rdesh_F in k  is : ");
disp(Cdesh*10^6,"The value of C in  F is ");
C = 0.05;// in  F
C = C * 10^-6;// in F
f_L = 100;// in Hz
R = 1/(2*%pi*f_L*C);// in ohm
A_F1 = 2;
R1 = 10*10^3;// in ohm
R_F = R1;// in ohm
disp("(ii) High pass Filter Components")
disp(R1*10^-3,"The value of R1 in k  is");
disp(R*10^-3,"The value of R in k  is");
disp(R_F*10^-3,"The value of R_F in k  is");
disp(C*10^6,"The value of C in  F is ");
Q = sqrt(f_H*f_L)/(f_H-f_L);
disp(Q,"The quality factor is");

// Note : In High pass filter components, the value of R is calculated 31.83 k  but at last it is writter as 3.183 k  so the answer of R in High pass filter components is wrong.
```

Scilab code Exa 5.19 Narror band pass filter

```
// Exa 5.19
```

```
clc;
clear;
close;
// Given data
f_c = 2;// in kHz
f_c = f_c * 10^3;// in Hz
A_F = 10;
Q = 4;
C = 0.01;// in  F
C = C * 10^-6;// in F
R1 = Q/(2*%pi*f_c*C*A_F);// in ohm
R1 = R1 * 10^-3;// in k ohm
disp("The value of R1 is "+string(R1)+" k  (standard value 3.3 k )");
R2 = Q/(2*%pi*f_c*C*(2*Q^2-A_F));// in ohm
R2 = R2 * 10^-3;// in k ohm
disp("The value of R2 is "+string(R2)+" k  (standard value 1.5 k )");
R3 = Q/(%pi*f_c*C);// in ohm
R3 = R3 * 10^-3;// in k ohm
disp("The value of R3 is "+string(R3)+" k  (standard value 63 k )");
f_c1 = 1;// in kHz
Rdesh2 = R2*(((f_c*10^-3)/f_c1)^2);// in k ohm
disp("The value of Rdesh_2 is "+string(Rdesh2)+" k (standard value 5.8 k )");
```

Scilab code Exa 5.20 Wide band reject Filter

```
// Exa 5.20 Printed as 5.17
clc;
clear;
close;
// Given data
f_H = 100;// in Hz
```

```
f_L = 2;// in kHz
f_L = f_L * 10^3;// in Hz
C = 0.01;// in  F
C = C * 10^-6;// in F
R = 1/(2*%pi*f_L*C);// in ohm
R = R * 10^-3;// in k ohm
A_F = 2;
R1 = 10;// in k ohm
// A_F= 1+R_F/R1 or
R_F= (A_F-1)*R1;// in k ohm
disp("(i) High-pass Section Components : ")
disp(C*10^6,"The value of C in  F is : ")
disp(R,"The value of R in k  is");
disp(R_F,"The value of R_F and R1 in k  is");
Cdesh = 0.1;// in  F
Cdesh= Cdesh* 10^-6;// in F
Rdesh = 1/(2*%pi*f_H*Cdesh);// in ohm
Rdesh= Rdesh * 10^-3;// in k ohm
Rdesh1 = 10;// in k ohm
Rdesh_F= Rdesh1;// in k ohm
disp("(ii) Low-pass Section components : ")
disp(Cdesh*10^6,"The value of Cdesh in  F is : ")
disp(Rdesh,"The value of Rdesh in k  is");
disp(Rdesh_F,"The value of Rdesh_F and Rdesh1 in k
    is");
R2 = 10;// in k ohm
R3 = R2;// in k ohm
R4 = R2;// in k ohm
R_OM = (R2*R3*R4)/(R2*R3+R3*R4+R4*R2);// in k ohm
disp("(iii) Summing Amplifier component")
disp(R_OM,"The value of R_OM in k  is");
```

Scilab code Exa 5.21 Active notch filter

```
// Exa 5.21
```

```
clc;
clear;
close;
// Given data
f_N = 50;// in Hz
C = 0.47;// in  F
C = C * 10^-6;// in F
R = 1/(2*%pi*f_N*C);// in ohm
R = R * 10^-3;// in k ohm
disp(R,"Resistance in k ohm is");
```

Scilab code Exa 5.22 Phase shift between input and output voltages

```
// EXa 5.22
clc;
clear;
close;
// Given data
R = 10;// in k ohm
R = R * 10^3;// in ohm
C = 0.01;// in  F
C = C * 10^-6;// in F
f = 2;// in kHz
f = f * 10^3;// in Hz
Phi = -2*atand(2*%pi*R*C*f);// in degree
disp(Phi,"The phase shift in degree is");
```

Scilab code Exa 5.23 Center frequency and quality factor

```
// Exa 5.23
clc;
clear;
close;
```

```
// Given data
f_L = 200;// in Hz
f_H = 1;// in kHz
f_H = f_H * 10^3;// in Hz
f_c = sqrt(f_H*f_L);// in Hz
disp(f_c,"The center frequency in Hz is");
Q = f_c/(f_H-f_L);
disp(Q,"Quality factor is");
```

Scilab code Exa 5.24 Wide bandpass Filter

```
// Exa 5.24
clc;
clear;
close;
// Given data
f1 = 5;// in kHz
f1 = f1 * 10^3;// in Hz
f2 = 15;// in kHz
f2 = f2 * 10^3;// in Hz
Cdesh = 0.01;// in  F
Cdesh= Cdesh * 10^-6;// in F
Rdesh = 1/(2*%pi*f2*Cdesh);// in ohm
A_F1 = 1.414;
A_F2 = A_F1;
Rdesh1 = 10;// in k ohm
Rdesh_F = (A_F1-1)*Rdesh1;// in k ohm
disp("(i) Low pass Filter components : ")
disp(Rdesh1,"The value of Rdesh1 in k  is : ")
disp(Rdesh*10^-3,"The value of Rdesh in k  is : ")
disp(Rdesh_F,"The value of Rdesh_F in k  is : ")
disp(Cdesh*10^6,"The value of Cdesh in  F is");
C = 0.05;// in  F
C = C * 10^-6;// in F
R = 1/(2*%pi*f1*C);//in ohm
```

```
R1 = 10;// in k ohm
R_F = (A_F1-1)*R1;// in k ohm
disp("(ii) High pass Filter components : ")
disp(R1,"The value of R1 in k   is : ");
disp(R,"The value of R in    is : ");
disp(R_F,"The value of R_F in k   is : ");
disp(C*10^6,"The value of C in  F  is : ");
```

Chapter 6

Sinusoidal Oscillators

Scilab code Exa 6.3 Frequency of oscillaitor

```
// Exa 6.3
clc;
clear;
close;
// Given data
R3 = 6;// in k ohm
R4 = 2;// in k ohm
A = 1+(R3/R4);
if A>3 then
    disp("The circuit will work as the oscillator")
end
R = 5.1;// in k ohm
R = R * 10^3;// in ohm
C = 0.001;// in  F
C = C * 10^-6;// in F
f = 1/(2*%pi*R*C);// in Hz
f = f * 10^-3;// in kHz
disp(f,"The frequency of oscillations in kHz is");
```

Scilab code Exa 6.4 Wien Bridge Oscillator

```
// Exa 6.4
clc;
clear;
close;
// Given data
C = 0.05;// in  F
C = C * 10^-6;// in F
f = 1;// in kHz
f = f * 10^3;// in Hz
R = 1/(2*%pi*f*C);// in ohm
R = R * 10^-3;// in k ohm
disp(R,"The value of R1 and R2 in k  is");
R4 = 10;// in k ohm
disp(R4,"The value of R3 in k  is");
R3 = 2*R4;// in k ohm
disp(R3,"The value of R4 in k  is");
```

Chapter 8

CMOS Realization Of Inverters

Scilab code Exa 8.2 Value of RL ans WbyL

```
// Exa 8.2
clc;
clear;
close;
// Given data
NMH= 1;// in V
VIH= 2;// in V
VTon= 0.5;// in V
VOL= 0.2;// in V
VDD= 3;// in V
KP= 30*10^-6;// in A/V^2
PD= 100*10^-6;// power dissipation in W
// Formula VIH= VTon +2*sqrt(2*VDD/(3*kn*RL))-1/(kn*RL) (i)
// Let x= 1/(kn*RL), putting the values in (i), we get
// x^2-5*x+2.25=0
x= [1 -5 2.25];
x= roots(x);
x=x(2);
// Formula PD= VDD*(VDD-VOL)/(2*RL)
```

```
RL= VDD*(VDD-VOL)/(2*PD);// in
disp(RL,"The value of RL in     is : ")
kn= 1/(x*RL);// in A/V^2
// Formula kn= KP*(W/L)
WbyL= kn/KP;
disp(WbyL,"The value of (W/L)n is : ")
```

Scilab code Exa 8.4 CMOS Inverter

```
// Exa 8.4
clc;
clear;
close;
// Given data
unCox= 40;// in   A /V^2
upCox= 20;// in   A /V^2
Ln= 0.5;// in   m
Lp= 0.5;// in   m
Wn= 2.0;// in   m
Wp= unCox*Wn/upCox;// in   m
disp(Wp,"The value of Wp in   m is : ")
```

Scilab code Exa 8.5 Value of VOH VOL and Vth

```
// Exa 8.5
clc;
clear;
close;
// Given data
VTO= 0.43;// in V
VDD= 2.5;// in V
g=0.4; // value of gamma
W1= 0.375;
```

```
L1=0.25;
W2= 0.75;
L2=0.25;
//VDD−VOUT−VT= VDD−VOUT−(VTO+g*(sqrt(0.6+VOUT)−sqrt
    (0.6)))=0
//VOUTˆ2+VOUT*(2*A−gˆ2)+(A−0.6*gˆ2)=0, where
A=VTO-VDD-g*sqrt(0.6);// assumed
B= (2*A-g^2);// assumed
C=(A^2-0.6*g^2);//assumed
VOUT= [1 B C];
VOUT= roots(VOUT);// in V
VOUT= VOUT(2);// in V
VOH= VOUT;// in V
disp(VOH,"The value of VOH in volts is : ")
Vout=(W1+3*L2)-(VDD-VTO)*(W2*L1/(W1*L2)-1)+ (VDD)/(
    VDD-VTO)
VOL= Vout;// in V
disp(VOL,"The value of VOL in volts is : ")
Vth= (VDD+VTO-L1)/(VDD*VTO)*(1-W1*L2/(W2*L1))+(L1*L2
    /VDD)
disp(Vth,"The value of Vth for circuit A in volts is
     : ")
W4= 0.365;
L4=0.25;
W3= 0.75;
L3=0.15;
Vth=(L3*L4/VDD)+(VDD/(W3*L4*VDD))-(VDD)/(1-W4*L3/(W3
    *L4))-2*W4
disp(Vth,"The value of Vth for circuit B in volts is
     : ")
```

Scilab code Exa 8.6 Value of Vx

```
// Exa 8.6
clc;
```

```
clear;
close;
// Given data
VTO= 0.43;// in V
VDD= 2.5;// in V
g=0.5; // value of gamma
//VDD-Vx-VT= VDD-Vx-(VTO+g*(sqrt(0.6+Vx)-sqrt(0.6)))
   =0
//Vx^2+Vx*(2*A-g^2)+(A-0.6*g^2)=0, where
A=VTO-VDD-g*sqrt(0.6);// assumed
B= (2*A-g^2);// assumed
C=(A^2-0.6*g^2);//assumed
Vx= [1 B C];
Vx= roots(Vx);// in V
Vx= Vx(2);// in V
disp(Vx,"The value of Vx in volts is : ")
```

Chapter 10

Nonlinear Applications of IC Op Amps

Scilab code Exa 10.1 Threshold voltages

```
// Exa 10.1
clc;
clear;
close;
// Given data
V_CC = 15;// in V
V_sat = V_CC;// in V
R1 = 120;// in ohm
R2 = 51;// in k ohm
R2 = R2 * 10^3;// in ohm
V_in = 1;// in V
V_UT = (V_sat*R1)/(R1+R2);//in V
disp(V_UT*10^3,"When supply voltage is +15V then
    threshold voltage in mV is");
V_ULT = ((-V_sat)*R1)/(R1+R2);// in V
V_ULT = V_ULT;// in V
disp(V_ULT*10^3,"When supply voltage is -15V then
    threshold voltage in mV is");
```

Scilab code Exa 10.2 Value of R1 and R2

```
// EXa 10.2
clc;
clear;
close;
// Given data
V_sat = 12;// in V
V_H = 6;// in V
R1 = 10;// in k ohm
R1 = R1 * 10^3;// in ohm
// Formula V_H= R1/(R1+R2)*(V_sat-(-V_sat)) and Let
V = V_H/(V_sat-(-V_sat));// in V (assumed)
R2= (R1-V*R1)/V
disp(R1*10^-3,"The value of R1 in k  is");
disp(R2*10^-3,"The value of R2 in k  is");
```

Scilab code Exa 10.3 Time duration

```
// Exa 10.3
clc;
clear;
close;
// Given data
V_P = 5;// in V
V_LT = -1.5;// in V
V_H = 2;// in V
f = 1;// in kHz
f = f * 10^3;// in Hz
V_UT = V_H-V_LT;// in V
V_m = V_P/2;// in V
// Formula V_LT= V_m*sind(theta)
```

```
theta= asind(-V_LT/V_m);
T = 1/f;// in sec
theta1 = theta+180;// in degree
T1 = (T*theta1)/360;// in sec
T2 = T-T1;// in sec
disp(T1*10^3,"The value of T1 in ms is : ")
disp(T2*10^3,"The value of T2 in ms is : ")
```

Scilab code Exa 10.4 Value of R1 and R2

```
// Exa 10.4
clc;
clear;
close;
// Given data
V_H = 10;// in V
V_L = -10;// in V
I_max = 100;// in  A
I_max = I_max * 10^-6;// in A
V_HV = 0.1;// in V
V_sat = 10;// in V
R2 = 1;// in k ohm
R1 = 199;// in  k ohm
R = (R1*R2)/(R1+R2);// in k ohm
disp(R*10^3,"The resistance in   is");

// Note: The unit of the answer in the book is wrong
```

Scilab code Exa 10.6 values of VLT VUT and VH

```
// Exa 10.6
clc;
clear;
```

```
close;
// Given data
V_sat = 12;// in V
R1 = 1;// in k ohm
R2 = 3;// in k ohm
V_LT = ((-V_sat)*R1)/R2;// in V
disp(V_LT,"The value of V_LT in V is");
V_UT = (-(-V_sat) * R1)/R2;// in V
disp(V_UT,"The value of V_UT in V is");
V_H = (R1/R2)*(V_sat - (-V_sat));// in V
disp(V_H,"The value of V_H in V is");
```

Scilab code Exa 10.7 Threshold voltages and hysteresis voltage

```
// Exa 10.7
clc;
clear;
close;
// Given data
R1 = 80;// in k ohm
R2 = 20;// in k ohm
V_sat = 12.5;// in V
V_UT = (R2/(R1+R2))*V_sat;// in V
disp(V_UT,"Upper threshold voltage in V is");
V_LT = (R2/(R1+R2))*(-V_sat);// in V
disp(V_LT,"Lower threshold voltage in V is");
V_HV = (R2/(R1+R2))*(2*V_sat);// in V
disp(V_HV,"The hysteresis voltage in V is");
```

Scilab code Exa 10.10 Values of VUT VLT and oscillation frequency

```
// Exa 10.10
clc;
```

```
clear;
close;
// Given data
R1 = 86;// in k ohm
V_sat = 15;// in V
R2 = 100;// in k ohm
V_UT = (R1/(R1+R2))*V_sat;// in V
disp(V_UT,"The value of V_UT in V is ");
V_LT = (R1/(R1+R2))*(-V_sat);// in V
disp(V_LT,"The value of V_LT in V is");
R_F = 100;// in k ohm
R_F= R_F*10^3;// in ohm
C = 0.1;// in  F
C = C * 10^-6;// in F
f_o = 1/(2*R_F*C*log( (V_sat-V_LT)/(V_sat-V_UT) ));
   // in Hz
disp(f_o,"Frequency of oscillation in Hz is");
```

Scilab code Exa 10.12 Change in output voltage

```
// Exa 10.12
clc;
clear;
close;
// Given data
del_Vin = 5;// in V
FRR = 80;// in dB
// Formula FRR= 20*log10(del_Vin/del_Vout)
del_Vout=del_Vin/(10^(FRR/20));// in V
disp(del_Vout*10^3,"Change in output voltage in mV
   is : ")
```

Chapter 12

Digital to Analog and Analog to Digital Converters

Scilab code Exa 12.1 Resolution

```
// Exa 12.1
clc;
clear;
close;
// Given data
n = 8;
Resolution = 2^n;
disp(Resolution,"The resolution is");
disp("That is, the output voltage can have "+string(
    Resolution)+" different values including zero")
V_OFS = 2.55;// in V
Resolution= V_OFS/(2^n - 1)*10^3;
disp("Resolution is : "+string(Resolution)+" mV/1LSB
    ")
disp("That is, an input change of 1 LSB causes the
    output to change by "+string(Resolution)+" mV")
```

Scilab code Exa 12.2 Final output voltage

```
// Exa 12.2
clc;
clear;
close;
// Given data
n = 4;
V_OFS = 15;// in V
digital_input = '0110';// in binary
D= bin2dec(digital_input);
Resolution = V_OFS/((2^n)-1);// in V/LSB
V_out = Resolution*D;// in V
disp(V_out,"Final output voltage in V is");
```

Scilab code Exa 12.3 VoFS and Vout

```
// Exa 12.3
clc;
clear;
close;
// Given data
n = 8;
Resolution = 20;// in mV/LSB
digital_input= '10000000';// in binary
D= bin2dec(digital_input);// in decimal
Resolution=Resolution*10^-3;// in V/LSB
V_OFS = Resolution * ((2^n)-1);// in V
disp(V_OFS,"The value of V_OFS in V is");
V_out = Resolution*D;// in V
disp(V_out,"The value of V_out in V is");
```

Scilab code Exa 12.4 Step size and analog output

```
// Exa 12.4
clc;
clear;
close;
// Given data
n = 4;
V_OFS = 5;// in V
digital_input= '1000';// in binary
D= bin2dec(digital_input);// in decimal
Resolution = V_OFS/((2^n)-1);
V_out = Resolution * D;// in V
disp(V_out,"When input is 1000 then, the output in V
    is");
// When
digital_input= '1111';// in binary
D= bin2dec(digital_input);// in decimal
V_out= Resolution * D;// in V
disp(V_out,"When input is 1111 then , the output in
   V is");
```

Scilab code Exa 12.5 Full scale output voltage and percentage resolution

```
// Exa 12.5
clc;
clear;
close;
// Given data
n=12;
digital_input= '010101101101';// in binary
D= bin2dec(digital_input);// in decimal
step_size= 8;// in mV
step_size=step_size*10^-3;// in V
VoFS= step_size*(2^n-1);// in V
disp(VoFS,"The full scale output voltage in V is : "
   )
```

```
Per_resolution= step_size/VoFS*100;// in %
disp(Per_resolution,"Percentage resolution is :")
Vout= step_size*D;// in V
disp(Vout,"The output voltage in V is : ")
```

Scilab code Exa 12.6 Values of resistors

```
// EXa 12.6
clc;
clear;
close;
// Given data
V_R = 10;// in V
n = 4;
Resolution = 0.5;// in V
R_F = 10;// in k ohm
R = (1/2^n)*(V_R/Resolution)*R_F;// in k ohm
disp(R,"The value of resistor in k  is");
```

Scilab code Exa 12.7 Resolution and digital output

```
// Exa 12.7
clc;
clear;
close;
// Given data
V_i = 5.1;// in V
n = 8;
Re = 2^n;
Resolution = V_i/(2^n-1);// in V/LSB
disp(Resolution*10^3,"The Resolution in mV/LSB is");
// When
V_i = 1.28;// in V
```

```
D = round(V_i/Resolution);
D_in_binary= dec2bin(D);// in binary
disp(D_in_binary,"The digital output is :")
```

Scilab code Exa 12.8 Quantizing error

```
// Exa 12.8
clc;
clear;
close;
// Given data
V_i = 4.095;//input voltage in V
n = 12;
Q_E = V_i/( ((2^n)-1)*2 );// in V
Q_E = Q_E * 10^3;// in mV
disp(Q_E,"The quantizing error in mV is");
```

Scilab code Exa 12.9 The value of t2

```
// Exa 12.9
clc;
clear;
close;
// Given data
disp("Part (i)")
V_i = 100;// in mV
V_R = 100;// in mV
t1 = 83.33;// in ms
t2 = (V_i/V_R)*t1;// in ms
disp(t2,"The value of t2 in ms is");
disp("Part (ii)")
Vi = 200;// in mV
t_2 = (Vi/V_R)*t1;// in ms
```

```
disp(t_2,"The value of t_2 in ms is");
```

Scilab code Exa 12.10 Digital output

```
// Exa 12.10
clc;
clear;
close;
// Given data
C_F = 12;//clock frequency in kHz
C_F = C_F * 10^3;// in Hz
V_i = 100;// in mV
V_R = 100;// in mV
t1 = 83.33*10^-3;// in sec
D = C_F * t1*(V_i/V_R);// in counts
disp("The Digital output is : "+string(round(D))+"
    counts");
```

Scilab code Exa 12.11 Conversion time

```
// Exa 12.12
clc;
clear;
close;
// Given data
n = 8;
T_C = 9;//in  sec
T_C = T_C * 10^-6;// in sec
f_max = 1/(2*%pi*T_C*(2^n));// in Hz
disp(f_max,"Maximum frequency in Hz is");
```

Scilab code Exa 12.12 Maximum frequency

```
// Exa 12.12
clc;
clear;
close;
// Given data
n = 8;
T_C = 9;//in  sec
T_C = T_C * 10^-6;// in sec
f_max = 1/(2*%pi*T_C*(2^n));// in Hz
disp(f_max,"Maximum frequency in Hz is");
```

Chapter 13

Integrated Circuit Timer

Scilab code Exa 13.1 Frequency and duty cycle

```
// Exa 13.1
clc;
clear;
close;
// Given data
C = 0.01;// in  F
C = C *10^-6;// in F
R_A = 2;// in  k ohm
R_A = R_A * 10^3;// in ohm
R_B = 100;// in k ohm
R_B = R_B * 10^3;// in ohm
T_HIGH = 0.693*(R_A+R_B)*C;// in s
T_HIGH = T_HIGH;// in sec
T_LOW = 0.693*R_B*C;// in s
T_LOW = T_LOW ;// in sec
T = T_HIGH + T_LOW;// in sec
f = 1/T;// in Hz
disp(f,"Frequency in Hz is");
D = (T_HIGH/T)*100;// in %
disp(D,"Duty cycle in % is");
```

Scilab code Exa 13.2 Positive and negative pulse width

```
// Exa 13.2
clc;
clear;
close;
// Given data
C = 1;// in  F
C = C * 10^-6;// in F
R_A = 4.7;// in k ohm
R_A = R_A * 10^3;// in ohm
R_B = 1;// in k ohm
R_B = R_B * 10^3;// in ohm
T_on = 0.693*(R_A+R_B)*C;// in s
T_on = T_on;// in sec
disp(T_on * 10^3,"Positive pulse width in ms is");
T_off = 0.693*R_B*C;// in s
T_off = T_off;// in ms
disp(T_off * 10^3,"Negative pulse width in ms is");
f = 1.4/((R_A+2*R_B)*C);// in Hz
disp(f,"Free running frequency in Hz is");
D = ((R_A+R_B)/(R_A+(2*R_B)))*100;// in %
disp(D,"The duty cycle in % is");
```

Scilab code Exa 13.3 Resistor required

```
// Exa 13.3
clc;
clear;
close;
// Given data
C = 0.01;// in  F
```

```
C = C * 10^-6;// in F
f = 1;// in kHz
f = f * 10^3;// in Hz
R_A = 1.44/(2*f*C);// in ohm
R_A = R_A * 10^-3;// in k ohm
R_B= R_A;// in kohm
disp(R_A,"The value of both the resistors required in k is");
```

Scilab code Exa 13.4 A 555 timer

```
// Exa 13.4
clc;
clear;
close;
// Given data
f = 700;// in Hz
C = 0.01;// in F
C = C * 10^-6;// in F
a = 1.44;
R_A = a/(2*f*C);// in ohm
R_A = R_A * 10^-3;// in k ohm
R_B =R_A;// in k ohm
disp(C*10^6,"The the value of C in F is : ")
disp(R_A,"The value of both the resistors in k is");
disp("(Standard value of resistor is 100 k )")
```

Scilab code Exa 13.5 Frequency and duty cycle

```
// Exa 13.5
clc;
clear;
```

```
close;
// Given data
C = 0.01;// in   F
C = C *10^-6;// in F
R_A = 2;// in  k ohm
R_A = R_A * 10^3;// in ohm
R_B = 100;// in k ohm
R_B = R_B * 10^3;// in ohm
T_HIGH = 0.693*(R_A+R_B)*C;// in s
T_HIGH = T_HIGH;// in sec
T_LOW = 0.693*R_B*C;// in s
T_LOW = T_LOW ;// in sec
T = T_HIGH + T_LOW;// in sec
f = 1/T;// in Hz
disp(f,"Frequency in Hz is");
D = (T_HIGH/T)*100;// in %
disp(D,"Duty cycle in % is");
```

Scilab code Exa 13.6 Positive and negative pulse width

```
// Exa 13.6
clc;
clear;
close;
// Given data
C = 1;// in   F
C = C * 10^-6;// in F
R_A = 4.7;// in k ohm
R_A = R_A * 10^3;// in ohm
R_B = 1;// in k ohm
R_B = R_B * 10^3;// in ohm
T_on = 0.693*(R_A+R_B)*C;// in s
T_on = T_on;// in sec
disp(T_on * 10^3,"Positive pulse width in ms is");
T_off = 0.693*R_B*C;// in s
```

```
T_off = T_off;// in ms
disp(T_off * 10^3,"Negative pulse width in ms is");
f = 1.4/((R_A+2*R_B)*C);// in Hz
disp(f,"Free running frequency in Hz is");
D = ((R_A+R_B)/(R_A+(2*R_B)))*100;// in %
disp(D,"The duty cycle in % is");
```

Scilab code Exa 13.7 Value of resistor required

```
// Exa 13.7
clc;
clear;
close;
// Given data
C = 0.01;// in  F
C = C * 10^-6;// in F
f = 1;// in kHz
f = f* 10^3;// in Hz
a = 1.44;
R_A = a/(2*f*C);// in ohm
R_A = R_A * 10^-3;// in k ohm
R_B = R_A;// in k ohm
disp(R_A,"The value of both the resistors required in k  is");
```

Scilab code Exa 13.8 A 555 timer

```
// Exa 13.8
clc;
clear;
close;
// Given data
f = 700;// in Hz
```

```
C = 0.01;// in  F
C = C * 10^-6;// in F
a = 1.44;
R_A = a/(2*f*C);// in ohm
R_A = R_A * 10^-3;// in k ohm
R_B =R_A;// in k ohm
disp(C*10^6,"The the value of C in  F is : ")
disp(R_A,"The value of both the resistors in k  is");
disp("(Standard value of resistor is 100 k )")
```

Scilab code Exa 13.9 A 555 timer

```
// Exa 13.9
clc;
clear;
close;
// Given data
f = 800;// in Hz
C = 0.01;// in  F
C =C * 10^-6;// in F
R_A = 1.44/(5*f*C);// in ohm
R_A = R_A * 10^-3;// in k ohm
disp(R_A,"The value of R_A in k  is");
R_B = 2*R_A;// in k ohm
disp(R_B,"The value of R_B in k  is ");
```

Scilab code Exa 13.10 Resistor required

```
// Exa 13.10
clc;
clear;
close;
```

```
// Given data
C = 10;// in   F
C = C*10^-6;// in F
T_ON = 5;// in sec
R = T_ON/(1.1*C);// in ohm
disp(R,"The resistor value in  ohm is");
```

Scilab code Exa 13.11 Resistor required

```
// EXa 13.11
clc;
clear;
close;
// Given data
C = 10;// in   F
C = C * 10^-6;// in F
T_off = 1;// in sec
//Formula T_off= 0.693*R2*C
R2 = T_off/(0.693*C);// in ohm
disp(R2,"The value of R2 in     is");
T_on = 3;// in sec
// Formula T_on= 0.693*(R1+R2)*C
R1 =T_on/(C*0.693)-R2;// in ohm
disp(R1,"The value of R1 in     is");
```

Scilab code Exa 13.12 Value of RLED

```
// Exa 13.12
clc;
clear;
close;
// Given data
C = 0.22;// in   F
```

```
C=C*10^-6;// in F
T_on = 10;// in ms
T_on = T_on * 10^-3;// in s
V_CC = 15;// in V
V_BE = 0.7;// in V
V_EC = 0.2;// in V
V_LED= 1.4;// in V
I_LED= 20*10^-3;// in A
R = T_on/(C*1.1);// in ohm
R = R *10^-3;// in k ohm
disp("Values for first circuit : ")
disp(R,"The value of R in k  is");
V_o = V_CC-(2*V_BE) - V_EC;// in V
disp(V_o,"The output voltage in V is");
R_LED = (V_o - V_LED)/(I_LED);// in ohm
disp(R_LED,"The value of R_LED in    is : ")
// Part (ii)
f= 1*10^3;// in Hz
C=0.01*10^-6;// in F
D= 95/100;// duty cycle
// Formula f= 1.44/((R1+2*R2)*C)
// R1+2*R2= 1.44/(f*C)                    (i)
// D= (R1+R2)/(R1+2*R2) or
// R2= (1-D)/(2*D-1)*R1                (ii)
// From eq (i) and (ii)
R1= 1.44/(f*C*(1+2*((1-D)/(2*D-1))));// in ohm
R2=  (1-D)/(2*D-1)*R1;// in ohm
disp("Values for second circuit : ")
disp(R1*10^-3,"The value of R1 in k  is : ");
disp(R2*10^-3,"The value of R2 in k  is : ");
```

Scilab code Exa 13.13 Resistor required

```
// Exa 13.13
clc;
```

```
clear;
close;
// Given data
T = 5;// in msec
T = T * 10^-3;// in sec
C = 0.1;// in  F
C = C * 10^-6;// in F
R = T/(C*1.1);// in ohm
R = R * 10^-3;// in k ohm
disp(R,"The resistor in k  is");
```

Scilab code Exa 13.14 A 555 based square wave generator

```
// Exa 13.14
clc;
clear;
close;
// Given data
f = 1;// in kHz
f = f * 10^3;// in Hz
T = 1/f;// in s
T = T * 10^3;// in msec
T_d = T/2;// in msec
T_d = T_d * 10^-3;// in sec
C = 0.1;// in  F
C = C * 10^-6;// in F
R2 = T_d/(0.69*C);// in ohm
R2 = R2 * 10^-3;// in k ohm
disp(C*10^6,"The value of C in  F is : ")
disp(R2,"The value of R2 in k  is");
disp("The value of R1 will be 100  +10 k  pot");
```

Scilab code Exa 13.15 A 555 timer

```
// Exa 13.15
clc;
clear;
close;
// Given data
f = 800;// in Hz
D = 0.6;
C = 0.1;// in  F
C = C * 10^-6;// in F
// Formula f= 1.44/((R_A+2*R_B)*C)
// R_A+2*R_B= 1.44/(f*C)                    (i)
// D= (R_A+R_B)/(R_A+2*R_B) or
// R_B= (1-D)/(2*D-1)*R_A              (ii)
// From eq (i) and (ii)
R_A= 1.44/(f*C*(1+2*((1-D)/(2*D-1))));// in ohm
R_B=  (1-D)/(2*D-1)*R_A;// in ohm
disp(R_A*10^-3,"The value of R_A in k  is : ");
disp(R_B*10^-3,"The value of R_B in k  is : ");
```

Scilab code Exa 13.16 A 555 timer

```
// Exa 13.16
clc;
clear;
close;
// Given data
f = 700;// in Hz
D = 0.5;
C = 0.1;// in  F
C = C * 10^-6;// in F
// Formula f= 1.44/((R_A+2*R_B)*C)
// R_A+2*R_B= 1.44/(f*C)                    (i)
// D= (R_A+R_B)/(R_A+2*R_B) or
// R_A+R_B=D*1.44/(f*C)
// From eq (i) and (ii)
```

```
R_B=round(1.44/(f*C))*(1-D);
R_A= round(D*1.44/(f*C))-R_B;
//R_A= 1.44/(f*C*(1+2*((1-D)/(2*D-1))));// in ohm
//R_B=  (1-D)/(2*D-1)*R_A;// in ohm
disp(round(R_A),"The value of R_A in     is : ");
disp((R_B*10^-3),"The value of R_B in k   is : ");
```

Scilab code Exa 13.17 Output pulse width

```
// Exa 13.17
clc;
clear;
close;
// Given data
R_A = 20;// in k ohm
R_A = R_A * 10^3;// in ohm
C = 0.1;// in   F
C = C*10^-6;// in F
pulse_width = 1.1*R_A*C;// in s
disp(pulse_width*10^3,"The output pulse width in ms
   is");
```

Scilab code Exa 13.18 Relationship between tp and T

```
// Exa 13.18
clc;
clear;
close;
// Given data
n=4;
// t_p= X*T, where
X= [0.2+(n-1)];// (assumed)
disp("The relation between t_p and T is :")
```

```
disp("t_p = "+string(X)+"*T");
```

Scilab code Exa 13.19 Value of RA

```
// Exa 13.19
clc;
clear;
close;
// Given data
C = 0.02;// in  F
C = C * 10^-6;// in F
f=2*10^3;//frequency in Hz
T = 1/f;// in sec
n = 5;
t_p = (0.2+(n-1))*T;// in sec
R_A = t_p/(1.1*C);// in ohm
disp(R_A*10^-3,"The value of R_A in k  is");
```

Chapter 14

Phase Locked Loops

Scilab code Exa 14.1 Free running frequency and Lock range

```
// Exa 14.1
clc;
clear;
close;
// Given data
R_T = 10;// in k ohm
R_T = R_T * 10^3;// in ohm
C_T = 0.005;// in  F
C_T = C_T * 10^-6;// in F
C=10*10^-6;// in F
f_out = 0.25/(R_T*C_T);// in Hz
disp("Free Running frequency is : "+string(f_out
   *10^-3)+" kHz");
// Part (ii)
V=20;// in V
f_L= 8*f_out/V;// in Hz
disp("Lock range in kHz is :   "+string(f_L*10^-3)+"
    kHz")
// Part (iii)
f_C= sqrt(f_L/(2*%pi*3.6*10^3*C));// in Hz
disp("Capture range is :    "+string(f_C)+" Hz")
```

Scilab code Exa 14.2 Frequency and number of bits

```
// Exa 14.2
clc;
clear;
close;
// Given data
f_out_max = 200;// in kHz
f_out_min = 4;// in Hz
f_CLK = 2.2*f_out_max;// in kHz
disp(f_CLK,"Frequency of reference oscillation in
   kHz is");
f_CLK= f_CLK*10^3;// in Hz
// Formula f_out_min= f_CLK/2^n
n=log(f_CLK/f_out_min)/log(2);
disp(round(n),"The number of bits required in the
   phase accumulator is : ")
```