

Scilab Textbook Companion for
Analog Integrated Circuits
by J. B. Gupta¹

Created by
Amit Sexana
B.Tech
Electronics Engineering
Dr. A.P.J. Abdul Kalam Technical University
College Teacher
None
Cross-Checked by
Harpreeth Singh

June 4, 2016

¹Funded 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: Analog Integrated Circuits

Author: J. B. Gupta

Publisher: S. K. Kataria & Sons, New Delhi

Edition: 4

Year: 2009

ISBN: 978-81-89757-75-5

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

Differential Amplifiers

Scilab code Exa 1.1 DC voltages and currents

```
1 // Example 1.1
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 VCC= 9; //in V
8 VEE= -9; // in V
9 RC= 3.9; //in k
10 RE= 3.3; // in k
11 VBE= 0.7; // in V
12 IE= (abs(VEE)-VBE)/(2*RE); // emitter current in mA
13 IC= IE; // collector current in mA
14 // Collector voltage ,
15 VC= VCC-IC*RC; // in V
16 disp(VC,"The collector voltage in volts is : ");
17 // Emitter voltage ,
18 VE= 0-VBE; // in V
19 disp(VE,"The emitter voltage in volts is : ");
20 // Collector-emitter voltage ,
21 VCE= VC-VE; // in V
```



```

22 disp(VCE,"The collector-emitter voltage in volts is
    : ");
23
24 // Note : There is some difference between coding
    output and the answer of the book because in the
    book the value of IE is used as 1.25mA while the
    calculated value of IE is 1.258

```

Scilab code Exa 1.2 Quiescent collector current and collector emitter voltage

```

1 // Example 1.2
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 VCC= 10; //in V
8 VEE= -10; // in V
9 RC= 10; //in k
10 RE= 9.3; // in k
11 VBE= 0.7; // in V
12 IE= (abs(VEE)-VBE)/(2*RE); // emitter current in mA
13 ICQ= IE; //quiescent collector current in mA
14 disp(ICQ,"The quiescent collector current in mA");
15 // Quiescent Collector-emitter voltage,
16 VCEQ= VCC+VBE-ICQ*RC; // in V
17 disp(VCEQ,"The quiescent collector-emitter voltage
    in volts is : ");

```

Scilab code Exa 1.3 Output voltage

```

1 // Example 1.3

```

```

2  clc;
3  clear;
4  close;
5  // Given data
6  format('v',6);
7  VCC= 12;//in V
8  VEE= -12;// in V
9  RC= 10;//in k
10 RE= 10;// in k
11 RB= 20;// in k
12 VBE= 0.7;// in V
13 // Part (a)
14 beta_dc= 75;
15 // Tail current ,  $I_T= 2*IE= VEE/RE$  (ignoring VBE) ,
    hence
16 IT= abs(VEE)/RE;// in mA
17 IC= IT/2;//collector current in mA
18 // output voltage ,
19 Vout1= VCC-IC*RC;// in V
20 IT= (abs(VEE)-VBE)/RE;// tail current in mA (on
    considering VBE)
21 IC= IT/2;//collector current in mA
22 Vout2= VCC-IC*RC;// in V
23 // Tail current ,
24 IT= (abs(VEE)-VBE)/(RE+RB/(2*beta_dc));// in mA
25 IC= IT/2;//collector current in mA
26 // output voltage ,
27 Vout3= VCC-IC*RC;// in V
28 disp("Part (a) : There are three different values
    of output voltage in volts");
29 disp(Vout1);
30 disp(Vout2);
31 disp(Vout3);
32
33 // Part (b)
34 IT= abs(VEE)/RE;// in mA
35 IC= IT/2;//collector current in mA
36 IB= IC/(beta_dc);// base current in mA

```

```

37 IB= IB*10^3; // in A
38 VB= -IB*RB; //base voltage in mV
39 VB= VB*10^-3; // in V
40 disp("Part (b) : ");
41 disp(IB,"The value of base current in A is : ");
42 disp(VB,"The value of base voltage in volts is : ");
43
44 // Part (c)
45 beta_dc1= 60;
46 beta_dc2= 80;
47 IB1= IC/beta_dc1; //base current for transistor Q1,
    in mA
48 IB1= IB1*10^3; // in A
49 disp("Part (c)")
50 disp(IB1,"The value of base current for transistor
    Q1 in A is : ");
51 VB1= -IB1*RB; // in mV
52 VB1= VB1*10^-3; // in V
53 disp(VB1,"The value of base voltage for transistor
    Q1 in volts is : ");
54 IB2= IC/beta_dc2; //base current for transistor Q2,
    in mA
55 IB2= IB2*10^3; // in A
56 disp(IB2,"The value of base current for transistor
    Q2 in A is : ");
57 VB2= -IB2*RB; // in mV
58 VB2= VB2*10^-3; // in V
59 disp(VB2,"The value of base voltage for transistor
    Q2 in volts is : ");
60
61 // Note : In the part (c), the unit of base current
    for transistor Q2 in the book is wrong it will be
    A

```

Scilab code Exa 1.4 ICQ and VCEQ

```

1 // Example 1.4
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',7);
7 RC= 2.2;//in k
8 RE= 4.7;// in k
9 RE= RE*10^3;// in
10 Ri1= 50;// in
11 Ri2= 50;// in
12 VCC= 10;//in V
13 VEE= 10;// in V
14 VBE= 0.7;// in V
15 beta_dc= 100;
16 beta_ac= 100;
17
18 // Part (a)
19 // Formula Used :  $ICQ= IE= (VEE-VBE)/(2*RE+Ri/$ 
     $beta\_dc)$ 
20  $ICQ= (VEE-VBE)/(2*RE+Ri1/beta\_dc);$ //quiescent
    collector current in A
21  $ICQ= ICQ*10^3;$ // in mA
22  $IE= ICQ;$ // in mA
23 disp("Part (a)")
24 disp(ICQ,"The value of ICQ in mA is : ");
25 // Quiescent collector-emitter voltage,
26  $VCEQ= VCC+VBE-ICQ*RC;$ // in V
27 disp(VCEQ,"The value of VCEQ in volts is : ");
28
29 // Part (b)
30  $re\_desh= 26/IE;$ // AC emitter resistance in
31 // Formula Used :  $Ad= Vout/Vind= RC/re\_desh$ 
32  $Ad= RC*10^3/re\_desh;$ // voltage gain
33 disp("Part (b)")
34 disp(Ad,"The voltage gain is : ");
35
36 // Part (c)

```

```

37 Rin1= 2*beta_ac*re_desh;// input resistance in
38 Rin1= Rin1*10^-3;//in k
39 Rin2= Rin1;// in k
40 disp("Part (c)");
41 disp(Rin1,"The input resistance in k is : ");
42
43 // Part (d)
44 Rout1= RC;// in k
45 disp("Part (d)");
46 disp(Rout1,"The output resistance in k is : ");

```

Scilab code Exa 1.5 Voltage gain input resistance output resistance and CMRR

```

1 // Example 1.5
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',7);
7 VCC= 15;//in V
8 VEE= 15;// in V
9 RC= 1;//in M
10 RE= RC;// in M
11 beta_ac= 100;
12 VBE= 0.7;// in V
13 IE= (VEE-VBE)/(2*RE);//emitter current in A
14 IC= IE;// in collector current in A
15 re_desh= 26/IE;// ac resistance of each emitter
    diode in k
16 Ad= RC*10^3/re_desh;// Voltage gain
17 disp(Ad,"The voltage gain is : ");
18 Zin= 2*beta_ac*re_desh;// input impedance in k
19 Zin= Zin*10^-3;// in M
20 disp(Zin,"The input impedance in M is : ");

```

```

21 Zout= RC;//output impedance in M
22 disp(Zout,"The output impedance in M is : ");
23 Acm= (RC*10^3)/(2*RE*10^3+re_desh);// common-mode
    gain
24 CMRR= Ad/Acm;// common-mode rejection ratio
25 disp(CMRR,"The common-mode rejection ratio is : ");
26 // When v_in is zero
27 Vout= VCC- IC*RC;// in V
28 disp(Vout,"When v_in is zero then the total output
    voltage at the quiescent value in volts is : ");
29 // When v_in= 1mV,
30 v_in= 1*10^-3;// in V
31 Vout= Ad*v_in;// in V
32 disp(Vout,"When v_in is -1mV then the ac output
    voltage in volts is : ");
33
34 // Note : The value of CMRR in the book is wrong
    because the correct value of Acm is "0.4991" and
    in the book it is taken as "0.4225"

```

Scilab code Exa 1.6 Magnitude of differential gain

```

1 // Example 1.6
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 VEE= 5;// supply voltage in V
8 RC= 2*10^3;// collector resistance in
9 RE= 4.3;// emitter resistance in k
10 VBE= 0.7;// in V
11 VT= 26;// in mV
12 IE= (VEE-VBE)/(2*RE);//emitter current in mA
13 re_desh= VT/IE;//dynamic emitter resistance in

```

```
14 Ad= RC/(2*re_desh); // differential mode gain
15 disp(Ad,"The differential mode gain is : ");
```

Scilab code Exa 1.7 Common mode gain and CMRR

```
1 // Example 1.7
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 VEE= 5; // supply voltage in V
8 RC= 2*10^3; // collector resistance in
9 RE= 4.3; // emitter resistance in k
10 VBE= 0.7; // in V
11 VT= 26; // in mV
12 IE= (VEE-VBE)/(2*RE); //emitter current in mA
13 re_desh= VT/IE; //dynamic emitter resistance in
14 Ad= RC/(2*re_desh); // differential mode gain
15 Acm= RC/(2*RE*10^3+re_desh); // common mode gain
16 disp(Acm,"The common mode gain is : ");
17 CMRR= Ad/Acm; // common mode rejection ratio
18 disp(CMRR,"The CMRR is : ");
```

Scilab code Exa 1.8 Output voltage

```
1 // Example 1.8
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 VEE= 9; //in V
```

```

8 VCC= 9; //in V
9 RC= 47*10^3; // collector resistance in
10 RE= 43*10^3; // emitter resistance in
11 vin1= 2.5*10^-3; // in V
12 Ri1= 20*10^3; // in
13 Ri2= Ri1; // in
14 VBE= 0.7; // in V
15 VT= 26*10^-3; // in V
16 beta1= 75;
17 beta2= 75;
18 IE= (VEE-VBE)/(2*RE+Ri1/beta1); //emitter current in
    A
19 ICQ= IE; // quiescent current in A
20 VCEQ= VCC+VBE-ICQ*RC; // quiescent collector voltage
    in V
21 re_desh= VT/IE; //AC emitter resistance in
22 Ad= RC/re_desh; // voltage gain
23 vout= Ad*vin1; // output voltage in V
24 disp(vout, "The output voltage in volts is : ");

```

Scilab code Exa 1.9 Dual input unbalanced output

```

1 // Example 1.9
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',7);
7 RC= 2.2; //in k
8 RE= 4.7; // in k
9 Ri1= 50*10^-3; // in k
10 Ri2= 50*10^-3; // in k
11 VCC= 10; //in V
12 VEE= 10; // in V
13 VBE= 0.7; // in V

```



```

14 beta_dc= 100;
15 beta_ac= 100;
16
17 // Part (i)
18 // Formula Used :  $ICQ= IE= (VEE-VBE)/(2*RE+Ri/$ 
     $beta\_dc)$ 
19  $ICQ= (VEE-VBE)/(2*RE+Ri1/beta\_dc);$ //quiescent
    collector current in mA
20  $IE= ICQ;$ // in mA
21 disp("Part (i) : Dual-input , unbalanced output");
22 disp(ICQ,"The value of ICQ in mA is : ");
23 // Quiescent collector-emitter voltage ,
24  $VCEQ= VCC+VBE-ICQ*RC;$ // in V
25 disp(VCEQ,"The value of VCEQ in volts is : ");
26  $re\_desh= 26/IE;$ // AC emitter resistance in
27  $Rin1= 2*beta\_ac*re\_desh;$ // input resistance in
28  $Rin1= Rin1*10^{-3};$ //in k
29  $Rin2= Rin1;$ // in k
30 disp(Rin1,"The value of Rin1 in k is : ");
31  $Rout= RC;$ // in k
32 disp(Rout,"The value of Rout in k is : ");
33 disp(RC,"The value of RC in k is : ")
34 // Formula Used :  $Ad= Vout/Vind= RC/re\_desh$ 
35  $Ad= RC*10^3/(re\_desh*2);$ // voltage gain of dual
    input , unbalanced output
36 disp(Ad,"The value of Ad is : ");
37
38 // Part (ii)
39 disp("Part (ii) : Single-output , balanced output");
40 disp(ICQ,"The value of ICQ in mA is : ");
41 disp(VCEQ,"The value of VCEQ in volts is : ");
42 disp(Rin1,"The value of Rin1 in k is : ");
43 disp(Rout,"The value of Rout in k is : ");
44 disp(RC,"The value of RC in k is : ")
45 // Formula Used :  $Ad= Vout/Vind= RC/re\_desh$ 
46  $Ad= RC*10^3/(re\_desh);$ // voltage gain of dual input ,
    unbalanced output
47 disp(Ad,"The value of Ad is : ");

```

Scilab code Exa 1.10 Single input unbalanced output

```
1 // Example 1.10
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',7);
7 VEE= 9; //in V
8 VCC= 9; //in V
9 RC= 47*10^3; // collector resistance in
10 RE= 43*10^3; // emitter resistance in
11 vin1= 2.5*10^-3; // in V
12 Ri1= 20*10^3; // in
13 Ri2= Ri1; // in
14 VBE= 0.7; // in V
15 VT= 26*10^-3; // in V
16 beta1= 75;
17 beta2= 75;
18 IE= (VEE-VBE)/(2*RE+Ri1/beta1); //emitter current in
    A
19 ICQ= IE; // quiescent current in A
20 VCEQ= VCC+VBE-ICQ*RC; // quiescent collector voltage
    in V
21 re_desh= VT/IE; //AC emitter resistance in
22 Ad= RC/(2*re_desh); // voltage gain
23 vout= Ad*vin1; // output voltage in V
24 disp(vout,"The output voltage in volts is : ");
```

Scilab code Exa 1.11 Q point differential voltage gain and output resistance

```

1 // Example 1.11
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 VEE= 15; //in V
8 VD1= 0.7; // in V
9 VD2= 0.7; // in V
10 VBE= 0.7; // in V
11 Beta= 100;
12 VT= 26; // in mV
13 R3= 180; //in
14 RC= 470; // in
15 VB3= -VEE+VD1+VD2; //in V
16 VE3= VB3-VBE; //voltage at emitter terminal of
    transistor Q3 in V
17 IE3= (VE3-(-VEE))/R3; //emitter current through
    transistor Q3 in A
18
19 //Part (i)
20 ICQ= IE3/2; //quiescent current in A
21 ICQ= round(ICQ*10^3); //in mA
22 IE= ICQ; //emitter current in mA
23 disp(ICQ,"(i) : Quiescent current in mA is : ")
24 VCEQ= VEE+VBE-ICQ*10^-3*RC; //quiescent collector-
    emitter voltage in V
25 disp(VCEQ,"The quiescent collector-emitter voltage
    in volts is : ")
26 re_desh= VT/IE; //AC emitter resistance in
27
28 // Part (ii)
29 Ad= RC/re_desh; // differential voltage gain
30 disp(Ad,"(ii) : Differential voltage gain is : ")
31
32 // Part (iii)
33 Rin1= 2*Beta*re_desh; // in
34 Rin1= Rin1*10^-3; // in k

```

```
35 disp(Rin1,"(iii) : The input resistance in k is :  
    ")
```

Scilab code Exa 1.12 Voltage gain input resistance and operation point

```
1 // Example 1.12  
2 clc;  
3 clear;  
4 close;  
5 // Given data  
6 format('v',6);  
7 VEE= 10;//in V  
8 VCC=10;// in V  
9 VD1= 0.715;// in V  
10 Vz= 6.2// in V  
11 VBE= VD1;// in V  
12 Izt= 41;// in mA  
13 R3= 2.7;// in k  
14 RC= 4.7;// in k  
15 VT= 26;// in mV  
16 beta_ac= 100;  
17 beta_dc= 100;  
18 VB3= -VEE+Vz+VD1;//voltage at the base of transistor  
    Q3 in V  
19 VE3= VB3-VBE;// voltage at the emitter of transistor  
    Q3 in V  
20 IE3= (VE3-(-VEE))/R3;//emitter current through  
    transistor Q3 in mA  
21 ICQ= IE3/2;//quiescent current in mA  
22 VCEQ= VCC+VBE-ICQ*RC;// in V  
23 disp("Part (a) : The Q-point values : ");  
24 disp(ICQ,"The value of ICQ in mA is : ");  
25 disp(VCEQ,"The value of VCEQ in volts is : ")  
26 re_desh= VT/ICQ;//dynamic emitter resistance in  
27 Ad= RC*10^3/re_desh;// voltage gain
```

```

28 disp(Ad,"Part (b) : The voltage gain is : ")
29 Rin= 2*beta_ac*re_desh;// differential input
    resistance in
30 Rin=Rin*10^-3;// in k
31 disp(Rin,"Part (c) : The differential input
    resistance in k is : ")

```

Scilab code Exa 1.13 Mirrored current

```

1 // Example 1.13
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 VCC= 12;// in V
8 VBE= 0.7;// in V
9 R1= 25;// in k
10 // I= I.REF= (VCC-VBE)/R1
11 I= (VCC-VBE)/R1;// mirrored current in mA
12 disp(I,"The mirrored current in mA is : ");

```

Scilab code Exa 1.14 Reference current and output current

```

1 // Example 1.14
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 VCC= 10;// in V
8 VBE= 0.7;// in V
9 R1= 15;// in k

```

```

10 Beta= 100;
11 I_REF= (VCC-VBE)/R1;//reference current in mA
12 disp(I_REF,"The reference current in mA is : ")
13 Iout= I_REF*Beta/(Beta+2);// output current in mA
14 disp(Iout,"The output current in mA is : ")

```

Scilab code Exa 1.15 Value of Current

```

1 // Example 1.15
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',5);
7 VCC= 15;// in V
8 VBE= 0.7;// in V
9 R1= 2.2;// in k
10 Beta= 220;
11 I_REF= (VCC-VBE)/R1;//reference current in mA
12 // Formula : I= IC= I_REF*(Beta/(Beta+2))
13 IC= I_REF*Beta/(Beta+2);// in mA
14 disp(IC,"The value of current in mA is : ")

```

Scilab code Exa 1.16 Value of Current

```

1 // Example 1.16
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 Vz= 1.8;// in V
8 VBE= 0.7;// in V

```

```

9 RE= 1; // in k
10 Beta= 180;
11 VB= Vz-VBE; // in V
12 IE= VB/RE; //emitter current in mA
13 // Formula : I= IC= IE*(Beta/(Beta+1))
14 IC= IE*Beta/(Beta+1); // in mA
15 disp(IC,"The value of current in mA is : ")

```

Scilab code Exa 1.17 Value of each current

```

1 // Example 1.17
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',7);
7 VCC= 9; // in V
8 R1= 12; // in k
9 VBE= 0.7; // in V
10 Beta= 100;
11 I_REF= (VCC-2*VBE)/R1; //reference current in mA
12 disp(I_REF,"The reference current in mA is : ")
13 Iout= I_REF/(1+2/(Beta*(1+Beta))); //output current
    in mA
14 disp(Iout,"The output current in mA is : ")
15 IC2= Iout; //collector current in mA
16 disp(IC2,"The collector current in mA is : ")
17 // IB3= I_REF-IC1= I_REF-IC2 (since IC1= IC2)
18 IB3= I_REF-IC2; //base current of transistor Q3 in mA
19 IB3= IB3*10-3; // in A
20 disp(IB3,"The base current of transistor Q3 in A
    is : ")
21 IB3= 0.1; // in A
22 IE3= (1+Beta)*IB3; // emitter current of transistor
    Q3 in A

```

```

23 disp(IE3,"The emitter current of transistor Q3 in
    A is : ")
24 IB1= IE3/2;//base current in A
25 IB2= IB1;// in A
26 disp(IB1,"The base current in A is : ")

```

Scilab code Exa 1.18 Collector current of each transistor

```

1 // Example 1.18
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',5);
7 VEE= 10;// in V
8 VBE= 0.715;// in V
9 beta_ac= 100;
10 beta_dc= 100;
11 R= 5.6;// in k
12 I_REF= (VEE-VBE)/R;// in mA
13 IC1= I_REF*beta_ac/(2+beta_ac);// in mA
14 // IC1= IC2= IC3 (by symmetry)
15 IC2= IC1;// in mA
16 IC3= IC2;// in mA
17 I_RC= IC1+IC2+IC3;// current through RC in mA
18 disp(I_RC,"The current through RC in mA is : ");

```

Scilab code Exa 1.19 Differential input resistance

```

1 // Example 1.19
2 clc;
3 clear;
4 close;

```



```

5 // Given data
6 format('v',8);
7 VCC= 5; // in V
8 VBE= 0.7; // in V
9 VEE= -5; // in V
10 VT= 26; // in mV
11 R= 18.6; // in k
12 Beta= 100;
13 I2= (VCC-VBE-VEE)/R; // in mA
14 IC3= I2; // in mA (due to current mirror action)
15 IE= IC3/2; // emitter current of transistor Q1 and Q2
16 re_desh= VT/IE; // AC emitter resistance of transistor
    in
17 Rin1= 2*Beta*re_desh; // in
18 Rin1= Rin1*10^-3; // in k
19 disp(Rin1,"The differential input resistance in k
    is : ")

```

Scilab code Exa 1.20 Voltage gain

```

1 // Example 1.20
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 VCC= 18; // in V
8 R1= 4.7; // in k
9 R2= 5.6; // in k
10 R3= 6.8; // in k
11 RE= 1.1; // in k
12 VBE= 0.7; // in V
13 VT= 26; // in mV
14 RC= 1.8*10^3; // in
15 IE1= (VCC*R1/(R1+R2+R3)-VBE)/RE; // in mA

```

```
16 re_desh= VT/IE1;//dynamic resistance of each
    transistor in
17 Av= -RC/re_desh;// voltage gain of the cascode
    amplifier
18 disp(Av,"The voltage gain of the cascode amplifier
    is : ")
```

Chapter 2

Operational Amplifiers and Their Parameters

Scilab code Exa 2.2 Output voltage

```
1 // Example 2.2
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 // Part (i)
8 Vin1= 5;// in V
9 Vin1= Vin1*10^-6;// in V
10 Vin2= -7;//in V
11 Vin2= Vin2*10^-6;// in V
12 Av= 2*10^5;// unit less
13 Rin= 2;// in M
14 Vout= (Vin1-Vin2)*Av;// in V
15 disp(Vout,"The output voltage in volts is : ")
```

Scilab code Exa 2.4 Input resistance

```
1 // Example 2.4
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',5);
7 Rs= 2;// in k
8 RL= 5;// in k
9 A= 10^5;// unit less
10 Rin= 100;//in k
11 Rout= 50;// in
12 Vout= 10;// in V
13 // For Vout = 10 V, V1= V2 = Vout
14 V1= Vout;// in V
15 V2= V1;// in V
16 // From equation V1= Vs*Rin/(Rin+Rs)
17 Vs= V1*(Rin+Rs)/Rin;// in V
18 Vout_by_Vs= Vout/Vs;// value of Vout/Vs
19 disp(Vs,"The value of Vs in volts is :");
20 disp(Vout_by_Vs,"The value of Vout/Vs is :");
21 disp(Rin,"The input resistance of the circuit in k
    is :");
```

Scilab code Exa 2.6 CMRR in dB

```
1 // Example 2.6
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',5);
7 Ad= 100;// differential mode gain
8 Acn= 0.01;// common mode gain
```

```
9 CMRR= Ad/Acm;
10 CMRR_desh= 20*log10(CMRR); // CMRR in dB
11 disp(CMRR_desh,"CMRR in dB is : ");
```

Scilab code Exa 2.7 Common mode gain

```
1 // Example 2.7
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',5);
7 Ad= 10^5; // differential mode gain
8 CMRR= 10^5;
9 // Common-mode gain ,
10 Acm= Ad/CMRR;
11 disp(Acm,"The common-mode gain is : ");
```

Scilab code Exa 2.8 Percentage error in the output voltage

```
1 // Example 2.8
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 V1= 10; // in mV
8 V2= 9; // in mV
9 Ad= 60; // differential voltage gain in dB
10 Ad= 10^(Ad/20);
11 CMRR= 80; // in dB
12 CMRR= 10^(CMRR/20);
13 Vd= V1-V2; // difference signal in mV
```

```

14 Vcm= (V1+V2)/2; // common-mode signal in mV
15 // Output voltage ,
16 Vout= Ad*Vd*(1+1/CMRR*Vcm/Vd); // in mV
17 AdVd= Ad*Vd; // in mV
18 // Error voltage
19 Verror= Vout-AdVd; // in mV
20 Per_error= Verror/Vout*100; // percentage error
21 disp(Verror,"The error voltage in mV is : ")
22 disp(Per_error,"The percentage error in the output
    voltage is : ")

```

Scilab code Exa 2.9 Output voltage and percentage error

```

1 // Example 2.9
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',9);
7 V1= 745; // in V
8 V2= 740; // in V
9 Ad= 5*10^5; // differential voltage gain
10 CMRR= 80; // in dB
11 CMRR= 10^(CMRR/20);
12 Vd= V1-V2; // difference signal in V
13 Vcm= (V1+V2)/2; // common-mode signal in V
14 // Output voltage ,
15 Vout= Ad*Vd*(1+1/CMRR*Vcm/Vd); // in V
16 AdVd= Ad*Vd; // in V
17 // Error voltage
18 Verror= Vout-AdVd; // in V
19 Vout= Vout*10^-6; // in V
20 Verror= Verror*10^-6; // in V
21 Per_error= Verror/Vout*100; // percentage error
22 disp(Vout,"The output voltage in volts is : ")

```

```
23 disp(Per_error,"The percentage error in the output
    voltage is : ")
```

Scilab code Exa 2.10 Output voltage

```
1 // Example 2.10
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',9);
7 Vd= 25;//differential input voltage in V
8 Vd= Vd*10^-6;// in V
9 A= 200000;// open loop gain
10 // Output voltage ,
11 Vout= A*Vd;// in V
12 disp("The output voltage is : "+string(Vout)+ "V"
    )
```

Scilab code Exa 2.11 Slew rate

```
1 // Example 2.11
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',9);
7 dVout= 20;// change in output voltage in V
8 dt= 4;// change in time in s
9 SR= dVout/dt;// slew rate in V/ s
10 disp(SR,"The slew rate in V/ s is : ")
```

Scilab code Exa 2.12 Input bias current and input offset current

```
1 // Example 2.12
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',9);
7 IB1= 10;// in A
8 IB2= 7.5;// in A
9 // Input bias current,
10 I_in_bias= (IB1+IB2)/2;// in A
11 // Input offset current,
12 I_in_offset= IB1-IB2;// in A
13 disp(I_in_bias,"The input bias current in A is : ")
14 disp(I_in_offset,"The input offset current in A is : ")
```

Scilab code Exa 2.13 Limiting frequency

```
1 // Example 2.13
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 SR= 6;// slew rate in V/ s
8 SR= 6*10^6;// in V/s
9
10 // Part (i) For Vmax= 1V
11 Vmax= 1;// in V
```



```

12 fmax= SR/(2*%pi*Vmax);// limiting frequency in Hz
13 fmax= fmax*10^-6;// in MHz
14 disp(fmax,"Part (i) : The limiting frequency for
    maximum voltage of 1V in MHz is : ");
15
16 // Part (ii) For Vmax= 10V
17 Vmax= 10;// in V
18 fmax= SR/(2*%pi*Vmax);// limiting frequency in Hz
19 fmax= fmax*10^-3;// in kHz
20 disp(fmax,"Part (ii) : The limiting frequency for
    maximum voltage of 10V in kHz is : ");

```

Scilab code Exa 2.14 Required slew rate

```

1 // Example 2.14
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 Vpp= 3;// output voltage in V
8 del_t= 4;// in s
9 del_V= 90*Vpp/100-10*Vpp/100;// in V
10 // Required slew rate,
11 SR= del_V/del_t;// in V/ s
12 disp(SR,"The required slew rate in V/ s is : ");

```

Chapter 3

Op Amps With Negative Feedback

Scilab code Exa 3.1 Non inverting amplifier

```
1 // Example 3.1
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 Af= 10; // voltage gain
8 R1= 3; // in
9 Rf= (Af-1)*R1; // From Af= 1+Rf/R1
10 disp(R1,"The value of R1 in      is : ");
11 disp(Rf,"The value of Rf in      is : ");
```

Scilab code Exa 3.2 Minimum and maximum closed loop voltage gains

```
1 // Example 3.2
2 clc;
```

```

3 clear;
4 close;
5 // Given data
6 format('v',6);
7 R1= 2;// in k
8 Rf_min= 0;
9 Rf_max= 100;// in k
10 // Formula Used : Af= 1+Rf/R1
11 Af_max= 1+Rf_max/R1;// maximum closed loop voltage
    gain
12 Af_min= 1+Rf_min/R1;// minimum closed loop voltage
    gain
13 disp(Af_max,"The maximum closed loop voltage gain is
    : ");
14 disp(Af_min,"The minimum closed loop voltage gain is
    : ");

```

Scilab code Exa 3.3 Voltage gain input resistance output resistance and bandwidth

```

1 // Example 3.3
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 R1= 100;// in
8 Rf= 100*103;// in
9 A= 2*105;//unit less
10 Rin= 2*106;// in
11 Rout= 75;// in
12 f0= 5;// in Hz
13 B= R1/(R1+Rf);// feedback fraction
14 AB= A*B;// feedback factor
15 Af= 1+Rf/R1;// voltage gain

```

```

16 Rin_f= Rin*(1+AB); // input resistance in
17 Rout_f= Rout/(1+AB); // output resistance in
18 f_f= f0*(1+AB); // bandwidth in Hz
19 Rin_f= Rin_f*10^-6; // in M
20 disp(Af,"The voltage gain is : ");
21 disp(Rin_f,"The input resistance in M is : ");
22 disp(Rout_f,"The output resistance in is : ");
23 disp(f_f,"The bandwidth in Hz is : ");

```

Scilab code Exa 3.4 Voltage gain input resistance output resistance and bandwidth

```

1 // Example 3.4
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',9);
7 Rin= 2*10^6; // in
8 Rout= 75; // in
9 f0= 5; // in Hz
10 A= 2*10^5; //unit less
11 B=1; // for voltage follower
12 Rf= 0;
13 Af= 1; // voltage gain (since Rf=0)
14 Rin_f= A*Rin; // input resistance in
15 Rin_f= Rin_f*10^-9; // in G
16 Rout_f= Rout/A; //output resistance in
17 f_f= f0*A; // bandwidth in Hz
18 f_f= f_f*10^-6; // in MHz
19 disp(Af,"The voltage gain is : ");
20 disp(Rin_f,"The input resistance in G is : ");
21 disp(Rout_f,"The output resistance in is : ");
22 disp(f_f,"The bandwidth in MHz is : ");

```

Scilab code Exa 3.5 Voltage gain input resistance output resistance and bandwidth

```
1 // Example 3.5
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',8);
7 Rin= 2*10^6; // in
8 Rout= 75; // in
9 f0= 5; // in Hz
10 R1= 330; //in
11 Rf= 3.3*10^3; // in
12 A= 2*10^5; //unit less
13 B= R1/(R1+Rf); // feedback fraction
14 AB= A*B; // feedback factor
15 Af= -Rf/R1; // colsed-loop voltage gain
16 Rin_f= R1; // input resistance with feedback in
17 Rout_f=Rout/(1+AB); // output resistance with
    feedback in
18 f_f= f0*(1+AB); // closed-loop bandwidth in Hz
19 f_f= f_f*10^-3; // in kHz
20 disp(Af,"The closed-loop voltage gain is : ");
21 disp(Rin_f,"The input resistance in      is : ");
22 disp(Rout_f,"The output resistance in    is : ");
23 disp(f_f,"The bandwidth in kHz is : ");
```

Scilab code Exa 3.6 Voltage gain input resistance output resistance and bandwidth

```
1 // Example 3.6
```

```

2  clc;
3  clear;
4  close;
5  // Given data
6  format('v',8);
7  Rin= 2*10^6;// in
8  Rout= 75;// in
9  f0= 5;// in Hz
10 A= 2*10^5;//unit less
11 B= 1/2;// feedback fraction (since R1=Rf)
12 Af= -1;// voltage gain
13 R1= 330;//in      (assume)
14 Rin_f= R1;// input resistance with feedback in
15 Rout_f= Rout/(A/2);// output resistance in
16 f_f= A/2*f0;// in Hz
17 f_f= f_f*10^-6;// in MHz
18 disp(Af,"The closed-loop voltage gain is : ");
19 disp(Rin_f,"The input resistance in      is : ");
20 disp(Rout_f,"The output resistance in    is : ");
21 disp(f_f,"The bandwidth in kHz is : ");

```

Scilab code Exa 3.7 Value of Af RIF Rof ff and VooT

```

1  // Example 3.7
2  clc;
3  clear;
4  close;
5  // Given data
6  format('v',8);
7  Rin= 2*10^6;// in
8  Rout= 75;// in
9  f0= 5;// in Hz
10 A= 200000;//unit less
11 VCC= 15;// in V
12 VEE= -15;// in V

```

```

13 Vout_swing= 13; // in V
14 // Part (i) : Non-inverting Amplifier
15 R1= 1*10^3; // in
16 Rf= 10*10^3; //in
17 B= R1/(R1+Rf); // feedback fraction
18 AB= A*B; // feedback factor
19 Af= 1+Rf/R1; // voltage gain
20 Rin_f= Rin*(1+AB); // input resistance in
21 Rin_f=Rin_f*10^-9; // in G
22 Rout_f= Rout/(1+AB); // output resistance in
23 f_f= f0*(1+AB); // bandwidth in Hz
24 f_f=f_f*10^-3; // in kHz
25 VooT= Vout_swing/(1+AB); //in V
26 VooT= VooT*10^3; // in mV
27 disp("Part (i) : Non-inverting Amplifier :- ");
28 disp(Af,"The closed-loop voltage gain is : ");
29 disp(Rin_f,"The input resistance in G is : ");
30 disp(Rout_f,"The output resistance in is : ");
31 disp(f_f,"The bandwidth in kHz is : ");
32 disp("The output offset voltage with feedback is :
      "+string(VooT)+" mV")
33
34 // Part (ii) : Inverting Amplifier
35 R1= 470; // in
36 Rf= 4.7*10^3; //in
37 B= R1/(R1+Rf); // feedback fraction
38 AB= A*B; // feedback factor
39 Af= -Rf/R1; // voltage gain
40 Rin_f= R1; // input resistance in
41 Rout_f= Rout/(1+AB); // output resistance in
42 f_f= f0*(1+AB); // bandwidth in Hz
43 f_f=f_f*10^-3; // in kHz
44 VooT= Vout_swing/(1+AB); //in V
45 VooT= VooT*10^3; // in mV
46 disp("Part (ii) : Inverting Amplifier :- ");
47 disp(Af,"The closed-loop voltage gain is : ");
48 disp(Rin_f,"The input resistance in G is : ");
49 disp(Rout_f,"The output resistance in is : ");

```

```

50 disp(f_f,"The bandwidth in kHz is : ");
51 disp("The output offset voltage with feedback is :
      "+string(VooT)+" mV")

```

Scilab code Exa 3.8 Voltage gain input resistance and output resistance

```

1 // Example 3.8
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',8);
7 Rf= 500*10^3;// in
8 R1= 5*10^3;//in
9 Vin= 0.1;// input voltage in V
10 Af= -Rf/R1;// voltage gain
11 Rin= R1;// input resistance in
12 Rin= Rin*10^-3;// in k
13 Rout= 0;// in
14 Vout= Af*Vin;// output voltage in V
15 I_in= Vin/R1;// input current in A
16 I_in= I_in*10^3;// in mA
17 disp(Af,"The amplifier circuit voltage gain is : ");
18 disp(Rin,"The amplifier circuit input resistance in
      k is : ");
19 disp(Rout,"The amplifier circuit output resistance
      in is : ");
20 disp(Vout,"The output voltage in volts is : ");
21 disp(I_in,"The input current in mA is : ");

```

Scilab code Exa 3.9 Input impedance voltage gain and power gain

```

1 // Example 3.9

```



```

2  clc;
3  clear;
4  close;
5  // Given data
6  format('v',8);
7  Rf= 1*10^6;// in
8  Rin= 1*10^6;// in
9  Vout_by_Vin= -Rf/Rin;// (since Vout= -Rf/Rin*Vin)
10 Av= Vout_by_Vin;// voltage gain
11 disp(Av,"The voltage gain is : ");
12 // I_in= Iout (As it is a unity gain inverter)
13 Ain= 1;//input impedance (since I_in= Iout)
14 disp(Ain,"The input impedance is : ");
15 Ap= abs(Av*Ain);// power gain
16 disp(Ap,"The power gain is : ");

```

Scilab code Exa 3.10 Designing of an Inverting op amp circuit

```

1  // Example 3.10
2  clc;
3  clear;
4  close;
5  // Given data
6  format('v',4);
7  Av= -30;// voltage gain
8  Rf= 1*10^6;// in
9  //Since , Av= Vo/Vi=-Rf/R1, so
10 R1= -Rf/Av;// in
11 R1= R1*10^-3;// in k
12 Rf= Rf*10^-6;// in M
13 disp(Rf,"The value of Rf in M is : ")
14 disp(R1,"The value of R1 in k is : ");

```

Scilab code Exa 3.11 Designing of an Inverting op amp circuit

```
1 // Example 3.11
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 Av= -8;// voltage gain
8 Vi= 1;// input voltage in V
9 I1= 15;//maximum current in A
10 I1= I1*10^-6;// in A
11 R1= Vi/I1;// in
12 R1= R1*10^-3;// in k
13 disp(R1,"The value of R1 in k is : ");
14 disp("The standard value of R1 is 68 k ");
15 R1= 68;// in k
16 Rf= -Av*R1;// in k
17 disp(Rf,"The value of Rf in k is : ");
18
19 // Note : The calculated value of Rf in the book is
    wrong  $[-(-8)*68$  is not equal to 384], it will be
    544 k
```

Scilab code Exa 3.14 Gain of the amplifier circuit

```
1 // Example 3.14
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 Rf= 20*10^3;// in
8 R1= 10*10^3;// in
9
```

```

10 //Part (i) When switch S is off ,
11 Aoff_non_inv= 1+Rf/R1;// non-inverting amplifier
    circuit gain
12 Aoff_inv= -Rf/R1;// inverting amplifier gain
13 Aoff= Aoff_non_inv+Aoff_inv;// amplifier circuit
    gain
14 disp(Aoff,"Part (i) : When switch S is off , the
    gain of the amplifier circuit is : ");
15
16 // Part (ii) When switch S is on ,
17 Aon= -Rf/R1;// amplifier circuit gain
18 disp(Aon,"Part (ii) : When switch S is on , the gain
    of the amplifer circuit is : ");

```

Scilab code Exa 3.17 Output voltage

```

1 // Example 3.17
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 R1= 1*10^3;// in
8 R2= 1*10^3;// in
9 Rf= 10*10^3;// in
10 R3= 10*10^3;// in
11 Vd= 5;// in mV
12 Vcm= 2;// in mV
13 CMRR_dB= 90;// in dB
14 CMRR= 10^(CMRR_dB/20);
15 Ad= Rf/R1;// differential voltage gain
16 // Part (i)
17 Vout= Ad*Vd;// output voltage in mV
18 disp(Vout,"Part (i) : The output voltage in mV is :
    ");

```

```

19 // Part (ii)
20 Acm= Ad/CMRR;// common mode gain
21 AcmVcm= Acm*Vcm;// magnitude of the induced 60Hz
    noise at the output in mV
22 AcmVcm= AcmVcm*10^3;// in V
23 disp(AcmVcm,"The magnitude of the induced 60Hz noise
    at the output in V is : ")

```

Scilab code Exa 3.18 Voltage gain output voltage and internal resistance

```

1 // Example 3.18
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 R1= 540;// in
8 R3= 540;// in
9 R2= 5.4*10^3;// in
10 Rf= 5.4*10^3;// in
11 Vin1= -2.5;// in V
12 Vin2= -3.5;//in V
13 Rin= 2*10^6;//input impedance in
14 A= 2*10^5;// open loop voltage gain
15 Ad= (1+Rf/R1);// voltage gain
16 disp(Ad,"The voltage gain is : ");
17 Vout=Ad*(Vin1-Vin2);// output voltage in V
18 disp(Vout,"The output voltage in volts is : ");
19 Rin_f1= Rin*(1+A*R1/(R1+Rf));// in
20 Rin_f2= Rin*(1+A*R2/(R1+Rf));// in
21 format('e',10);
22 disp(Rin_f1,"The value of Rin_f1 in is : ")
23 disp(Rin_f2,"The value of Rin_f2 in is : ")

```

Scilab code Exa 3.19 Gain of the circuit

```
1 // Example 3.19
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',4);
7 Vin= 100*10^-3;// in V
8 Vout= 4.25;// in V
9 R1= 100;// in
10 // Formula Used :  $V_{out} = (1+2*R_f/R_f)*V_{in}$ 
11 Rf= (Vout/Vin-1)*R1/2;// in
12 Rf= Rf*10^-3;// in k
13 disp(R1,"The value of R1 in      is : ")
14 disp(Rf,"The value of Rf in k   is : ")
15 disp("(Standard value of Rf is 2.2 k)")
```

Scilab code Exa 3.20 Voltage gain input resistance output resistance and bandwidth

```
1 // Example 3.20
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',9);
7 R1= 3.3;// in k
8 R2= 3.3;// in k
9 R3= 1.2;// in k
10 R4= 1.2;// in k
11 Rf= 3.9;// in k
```

```

12 R5= 3.9; // in k
13 Rp= 2.5; // in k
14 A= 2*10^5; // unit less
15 f0= 5; // in Hz
16 Rin= 2*10^6; // in
17 Rout= 75; // in
18 Ad= -(1+2*R1/Rp)*Rf/R3; // voltage gain
19 disp(Ad,"The voltage gain is : ");
20 Rinf= Rin*(1+A*(R1+Rp)/(2*R1+Rp)); //input resistance
    in
21 Rinf= Rinf*10^-9; // in G
22 disp(Rinf,"The input resistance in G is : ");
23 Routf= Rout/(1+A/Ad); // output resistance in
24 disp(Routf,"The output resistance in is : ");
25 f_f= A*f0/abs(Ad); // bandwidth in Hz
26 f_f= f_f*10^-3; // in kHz
27 disp(f_f,"The bandwidth in kHz is : ");

```

Chapter 4

Linear Applications of Op Amps

Scilab code Exa 4.1 Designing of an adder circuit

```
1 // Example 4.1
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 Vout= '-(V1+10*V2+100*V3)'; //given expression
8 Rf= 100; // in k
9 //  $V_{out} = -R_f \cdot (V_1/R_1 + V_2/R_2 + V_3/R_3) = -(R_f/R_1 \cdot V_1 + R_f/R_2 \cdot V_2 + R_f/R_3 \cdot V_3)$  (i)
10 // Compare equation(i) with given expression
11 R1= Rf/1; //in k
12 R2= Rf/10; // in k
13 R3= Rf/100; // in k
14 disp(Rf, "The value of Rf in k is : ");
15 disp(R1, "The value of R1 in k is : ");
16 disp(R2, "The value of R2 in k is : ");
17 disp(R3, "The value of R3 in k is : ");
```

Scilab code Exa 4.2 Output voltage

```
1 // Example 4.2
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 Rf= 12; // in k
8 R1= 12; // in k
9 R2= 2; // in k
10 R3= 3; // in k
11 V1= 9; // in V
12 V2= -3; // in V
13 V3= -1; // in V
14 Vout= -Rf*(V1/R1+V2/R2+V3/R3); // output voltage in V
15 disp(Vout,"The output voltage in volts is : ");
```

Scilab code Exa 4.3 Summing amplifier

```
1 // Example 4.3
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 Vout= '(-V1+2*V2-3*V3)'; //given expression
8 Rf= 6; // in k
9 // Vout= -(Rf/R1*V1+Rf/R2*V2+Rf/R3*V3) (i)
10 // Compare equation(i) with given expression
11 R1= Rf/1; //in k
12 R2= Rf/2; // in k
```



```

13 R3= Rf/3; // in k
14 disp(Rf,"The value of Rf in k is : ");
15 disp(R1,"The value of R1 in k is : ");
16 disp(R2,"The value of R2 in k is : ");
17 disp(R3,"The value of R3 in k is : ");

```

Scilab code Exa 4.4 Value of R1 R2 and Rf

```

1 // Example 4.4
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 Vout= '(-2*V1+3*V2+4*V3)'; //given expression
8 R3= 10; // in k
9 // Vout= -(Rf/R1*V1+Rf/R2*V2+Rf/R3*V3) (i)
10 // Compare equation(i) with given expression
11 Rf= 4*R3; //in k
12 R2= Rf/3; // in k
13 R1= Rf/2; // in k
14 disp(Rf,"The value of Rf in k is : ");
15 disp(R2,"The value of R2 in k is : ");
16 disp(R1,"The value of R1 in k is : ");

```

Scilab code Exa 4.5 Output voltage

```

1 // Example 4.5
2 clc;
3 clear;
4 close;
5 format('v',6);
6 // Given data

```

```

7 V1= 2; // in V
8 V2= -1; // in V
9 R=100; // in (assumed)
10 Vs1= V1*(R/2)/(R+R/2); // in V
11 Rf= 2*R; // in
12 Vo_1= Vs1*(1+Rf/R); // in V
13 Vs2= V2*(R/2)/(R+R/2); // in V
14 Vo_2= Vs2*(1+Rf/R); // in V
15 Vout= Vo_1+Vo_2; //output voltage in V
16 disp(Vout,"The output voltage in volts is : ");

```

Scilab code Exa 4.7 Capacitor voltage at the end of pulse

```

1 // Example 4.7
2 clc;
3 clear;
4 close;
5 format('v',6);
6 // Given data
7 Vin= 10; // in V
8 R= 2.2; // in k
9 R= R*10^3; // in k
10 Ad= 10^5; // differential voltage gain
11 C=1; // in F
12 C= C*10^-6; // in F
13 T= 1; // in ms
14 T= T*10^-3; // in s
15 I= Vin/R; // in mA
16 V= I*T/C; // output voltage at the end of pulse in mV
17 V= V*10^-3; // in V
18 disp(V,"The output voltage at the end of the pulse
    in volts is : ")
19 RC_desh= R*C*Ad; // closed-loop time constant in sec.
20 disp(RC_desh,"The closed-loop time constant in
    seconds : ")

```

Scilab code Exa 4.8 Value of R1 and Rf

```
1 // Example 4.8
2 clc;
3 clear;
4 close;
5 format('v',6);
6 // Given data
7 A_dB= 20; // peak gain in dB
8 A= 10^(A_dB/20); // peak gain
9 omega= 10000; // in rad/second
10 C= 0.01; // in F
11 C= C*10^-6; // in F
12 Rf= 10; // in k
13 // Vout/V1= Rf/R1= A
14 R1= Rf/A; // in k
15 disp(Rf,"The value of Rf in k is : ");
16 disp(R1,"The value of R1 in k is : ");
```

Scilab code Exa 4.9 Output voltage

```
1 // Example 4.9
2 clc;
3 clear;
4 close;
5 format('v',6);
6 // Given data
7 R= 40; // in k
8 R= R*10^3; // in
9 C= 0.2; // in F
10 C= C*10^-6; // in F
```

```

11 Vin= 5; // in V
12 V1= 3; // in V
13 t= 50; // in ms
14 Vout= 3; // in V
15 t=[0:0.1:50];
16 vout= -1/(R*C)*integrate('(Vin-V1)', 't', 0, t)*10^-3+
    Vout; //in V
17 plot(t, vout);
18 title("Sketch of output voltage");
19 xlabel("Time in milliseconds");
20 ylabel("Output voltage in volts")
21 disp("Plot for output voltage shown in figure");

```

Scilab code Exa 4.10 Time duration required for saturation

```

1 // Example 4.10
2 clc;
3 clear;
4 close;
5 format('v', 6);
6 // Given data
7 R= 500; // in k
8 R= R*10^3; // in
9 C= 10; // in F
10 C= C*10^-6; // in F
11 vout= 12; // in V
12 v= -0.5; // in V
13 vout_by_t= -1/(R*C)*integrate('-t', 't', 0, 1); //in V/
    sec
14 // Time required for saturation of output voltage
15 t= vout/vout_by_t; // in sec
16 disp(t, "The time duration required for saturation of
    output voltage in seconds is : ")

```

Scilab code Exa 4.12 Output voltage

```
1 // Example 4.12
2 clc;
3 clear;
4 close;
5 format('v',7);
6 // Given data
7 fa= 1; // in kHz
8 fa= fa*10^3; // in Hz
9 Vp= 1.5; // in V
10 f= 200; // in Hz
11 C= 0.1*10^-6; // in F
12 t= poly(0, 't');
13 R= 1/(2*%pi*fa*C); // in
14 R= 1.5; // in k (standard value)
15 fb= 20*fa; // in Hz
16 R_desh= 1/(2*%pi*fb*C); // in
17 R_desh= 82; // in (standard value), so
18 R_OM= R; // in k
19 // Vin= Vp*sin(omega*t)= Vp*sin(2*%pi*f)*t
20 disp("The input vottage : Vin = "+string(Vp)+ " sin
      (400*%pi*t)")
21 RC= R*10^3*C; // in F
22 V= -RC*Vp*400*%pi;
23 //Vout= -RC*dVin/dt= -RC*Vp*400*%pi*cos(400*%pi*t)
24 disp("The output voltage : Vout = "+string(V)+" cos
      (400*%pi*t)")
25 x=[0:0.1:5*%pi/2];
26 plot(V*cos(x))
27 title("output Waveform");
28 xlabel("----- Time ----->");
29 ylabel("----- output voltage ----->");
30 disp("output Waveform is shown in figure.")
```

Scilab code Exa 4.13 Differentiator to differentiate an input signal

```
1 // Example 4.13
2 clc;
3 clear;
4 close;
5 format('v',6);
6 // Given data
7 Vp= 1; // in V
8 f= 1000; // in Hz
9 R= 1.5*10^3; // in
10 C= 0.1*10^-6; // in F
11 // Vin= Vp*sin(omega*t)= Vp*sin(2*%pi*f)*t
12 disp("The input votage : Vin = sin(2000*%pi*t)")
13 RC= R*C; // in F
14 V= -RC*2000*%pi;
15 //Vout= -RC*dVin/dt= -RC*Vp*2000*%pi*cos(2000*%pi*t)
16 disp("The output voltage : Vout = "+string(V)+" cos
      (2000*%pi*t)")
17 x=[0:0.1:4*%pi];
18 plot(-1.88*cos(x))
19 title("Output Waveform");
20 xlabel("---- Time ---->");
21 ylabel("---- output voltage ---->");
22 disp("Waveform is shown in figure.")
```

Scilab code Exa 4.15 Instrumentation amplifier

```
1 // Example 4.15
2 clc;
3 clear;
4 close;
```

```

5 format('v',6);
6 // Given data
7 R1= 50;// in k
8 R3=15;// in k
9 R4=R3;// in k
10 // For minimum differential voltage gain ,
11 Ad_min= 5;// and
12 Ad= Ad_min;
13 // From Ad= 1+2*R2/R1
14 R2= (Ad-1)*R1/2;// in k
15 // For maximum differential voltage gain ,
16 Ad_max= 200;// and
17 Ad= Ad_max;
18 // From Ad= 1+2*R2/R1
19 R1_min= round(2*R2/(Ad-1));// in k
20 disp("The value of R1 : "+string(R1_min)+" k - "+
      string(R1)+" k ")
21 disp(R2,"The value of R2 in k is : ")
22 disp(R3,"The value of R3 and R4 in k is : ")

```

Chapter 5

Waveform Generators

Scilab code Exa 5.1 Frequency and duty cycle

```
1 // Example 5.1
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 C= 0.01; // in F
8 C=C*10^-6; // in F
9 R_A= 2; // in k
10 R_A=R_A*10^3; // in
11 R_B= 100; // in k
12 R_B=R_B*10^3; // in
13 T_HIGH= 0.693*(R_A+R_B)*C; //charging period in
    second
14 T_LOW= 0.693*R_B*C; // discharging period in second
15 T= T_HIGH+T_LOW; // overall period of oscillations in
    second
16 f= 1/T; // frequency of oscillations in Hz
17 D= T_HIGH/T*100; // duty cycle in %
18 disp(f,"The frequency of oscillations in Hz is : ")
19 disp(D,"Duty cycle in % is : ")
```

Scilab code Exa 5.2 Positive and negative pulse width and free running frequency

```
1 // Example 5.2
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 C= 1; // in F
8 C=C*10^-6; // in F
9 R_A= 4.7; // in k
10 R_A=R_A*10^3; // in
11 R_B= 1; // in k
12 R_B=R_B*10^3; // in
13 T_on= 0.693*(R_A+R_B)*C; // positive pulse width in
    second
14 T_on= T_on*10^3; // in ms
15 T_off= 0.693*R_B*C; // pulse width in second
16 T_off= T_off*10^3; // in ms
17 f= 1.4/((R_A+2*R_B)*C); // free running frequency in
    Hz
18 D= round((R_A+R_B)/(R_A+2*R_B)*100); // in %
19 disp(T_on,"The positive pulse width in ms")
20 disp(T_off,"The negative pulse width in ms")
21 disp(f,"The frequency of oscillations in Hz is : ")
22 disp(D,"Duty cycle in % is : ")
```

Scilab code Exa 5.3 Required resistor

```
1 // Example 5.3
```

```

2  clc;
3  clear;
4  close;
5  // Given data
6  format('v',6);
7  C= 0.01;// in F
8  C= C*10^-6;// in F
9  f= 1;// in kHz
10 f= f*10^3;// in Hz
11 // For 50% duty cycle , Ton= Toff = T/2 and R_A= R_B
12 // From equation , f= 1.44/((R_A+R_B)*C)= 1.44/(2*R_A
    *C)
13 R_A= 1.44/(2*f*C);// in
14 R_A= R_A*10^-3;// in k
15 R_B= R_A;// in k
16 disp(R_A,"The value of R_A and R_B in k : ")
17 disp("(Standard value 68 k)")

```

Scilab code Exa 5.4 Designing of a 555 timer

```

1  // Example 5.4
2  clc;
3  clear;
4  close;
5  // Given data
6  format('v',5);
7  f= 700;// in Hz
8  C= 0.01;// in F (assumed)
9  C= C*10^-6;// in F
10 // For 50% duty cycle , Ton= Toff = T/2 and R_A= R_B
11 // From equation , f= 1.44/((R_A+R_B)*C)= 1.44/(2*R_A
    *C)
12 R_A= 1.44/(2*f*C);// in
13 R_A= R_A*10^-3;// in k
14 R_B= R_A;// in k

```

```

15 C= C*10^6; // in F
16 disp(R_A,"The value of R_A and R_B in k : ")
17 disp("(Standard value 100 k)")
18 disp(C,"The value of C in F is : ")

```

Scilab code Exa 5.5 Designing of a 555 timer

```

1 // Example 5.5
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',5);
7 f= 800; // in Hz
8 C= 0.01; // in F (assumed)
9 C= C*10^-6; // in F
10 D= 60; // in duty cycle in %
11 // D= (R_A+R_B)/(R_A+2*R_B)*100= 60 or
12 // R_B= 2*R_A
13 R_A= 1.44/(f*5*C); // in (From f=1.44/((R_A+2*R_B
    )*C))
14 R_A= R_A*10^-3; // in k
15 R_B= 2*R_A; // in k
16 C= C*10^6; // in F
17 disp(R_A,"The value of R_A in k is : ");
18 disp(R_B,"The value of R_B in k is : ");
19 disp(C,"The value of C in F is : ")

```

Scilab code Exa 5.6 Resonance frequencies

```

1 // Example 5.6
2 clc;
3 clear;

```

```

4  close;
5  // Given data
6  format('v',5);
7  Rs= 5*10^3;//series resistance in
8  Ls= 0.8;// series inductance in H
9  Cs= 0.08*10^-12;//series capacitance in F
10 Cp= 1.0*10^-12;// parallel capacitance in F
11 fs= 1/(2*%pi*sqrt(Ls*Cs));// series resonant
    frequency in Hz
12 fs= fs*10^-3;// in kHz
13 fp= 1/(2*%pi)*sqrt((1+Cs/Cp)/(Ls*Cs));// parallel
    resonant frequency in Hz
14 fp= fp*10^-3;// in kHz
15 disp(fs,"The series resonant frequency in kHz is : "
    )
16 disp(fp,"The parallel resonant frequency in kHz is :
    ")

```

Scilab code Exa 5.7 Power dissipated in the crystal

```

1  // Example 5.7
2  clc;
3  clear;
4  close;
5  // Given data
6  format('v',6);
7  C1= 1000*10^-12;// in F
8  C2= 100*10^-12;// in F
9  f= 1*10^6;// in Hz
10 R1= 1*10^6;// in      (assume)
11 R2= 10*10^3;// in      (assume)
12 Rs= 800;// in
13 VDD= 5;// in V
14 C_T= C1*C2/(C1+C2);//total capacitance in F
15 // At resonance , X_L= X_CT or 2*%pi*f*L= 1/(2*%pi*f*

```

```

    C_T), So
16 L= 1/((2*pi*f)^2*C_T); // in H
17 L= L*10^3; // in mH
18 disp(L,"The value of inductance in mH is : ")
19 i_p= VDD/(R1+R2+Rs); //current through crystal in A
20 // Power dissipated in the crystal ,
21 P_D= (0.707*i_p)^2*Rs; // in W
22 P_D= P_D*10^9; //in nW
23 disp(P_D,"The power dissipated in the crystal in nW
    is : ")

```

Scilab code Exa 5.8 Signal frequency and amplitude of triangular and square wave

```

1 // Example 5.8
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 R= 12*10^3; // in
8 R1= 120*10^3; // in
9 Rf= 1*10^6; // in
10 C= 0.1*10^-6; // in F
11 Vsupply= 12; // in V
12 Vsat= 10; //in V
13 //Part (i) : Signal frequency ,
14 f= Rf/(4*R1*R*C); // in Hz
15 f= f*10^-3; // in kHz
16 disp("Part (i) : The signal frequency : "+string(f)+
    " kHz")
17 // Part (ii) : Amplitude of triangular wave,
18 Vpp= 2*R1/Rf*Vsat; // Vp-p
19 disp("Part (ii) : Amplitude of the triangular wave
    is : "+string(Vpp)+" Vp-p")

```

```

20 // Amplitude of square wave,
21 Vpp= Vsat-(-Vsat); //Vp-p
22 disp("Amplitude of the square wave is : "+string(Vpp
    )+" Vp-p")

```

Scilab code Exa 5.10 A Wien bridge oscillator

```

1 // Example 5.10
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 I_Bmax= 500; // in nA
8 I_Bmax= I_Bmax*10^-9; // in A
9 VCC= 10; // in V
10 f= 10*10^3; // in Hz
11 I1= 500*10^-6; // current through R1 in A (assume)
12 Vout= (VCC-1); //output voltage in V
13 // Rf+R1= Vout/I1 and Rf= 2*R1, so
14 R1= Vout/(3*I1); // in
15 R1= R1*10^-3; // in k
16 disp("The value of R1 is : "+string(R1)+" k (
    standard value 5.6 k )");
17 R1= 5.6; // in k (standard value)
18 Rf= 2*R1; // in k
19 disp("The value of Rf is : "+string(Rf)+" k (
    standard value 12 k )");
20 R= R1; // in k
21 R= R*10^3; // in
22 C= 1/(2*%pi*f*R); // in F
23 C= C*10^12; // in pF
24 disp("The value of C is : "+string(C)+" pF");

```

Scilab code Exa 5.11 Frequency of oscillation

```
1 // Example 5.11
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 R= 1*10^3; // in
8 C= 4.7*10^-6; // in F
9 omega= 1/(R*C); // radians/second
10 f= omega/(2*%pi); // in Hz
11 disp(f,"The frequency of oscillation in Hz is : ")
```

Chapter 6

Digitally Controlled Frequency Synthesizers

Scilab code Exa 6.1 Free running frequency

```
1 // Example 6.1
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 R1= 15*10^3; // in
8 C1= 0.01*10^-6; // in F
9 C2= 10*10^-6; // in F
10 R2= 3.6*10^3; // in
11 Vpos= 12; // in V
12 Vneg= -12; // in V
13 f_out= 1.2/(4*R1*C1); // free running frequency in Hz
14 f_out= f_out*10^-3; // in kHz
15 disp("The free running frequency is : "+string(f_out
    )+" kHz");
16 f_L= 8*f_out/(Vpos-(Vneg)); //Lock-range in kHz
17 disp("Lock-range of the circuit is : "+string(f_L
    )+" kHz");
```



```

18 f_L= f_L*10^3; // in Hz
19 f_C= sqrt(f_L/(2*%pi*R2*C2)); // Hz
20 disp("Capture-range of the circuit is : "+string(
    f_C)+" Hz");

```

Scilab code Exa 6.2 Frequency of reference oscillator

```

1 // Example 6.2
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',12);
7 f_out_max= 200; // in kHz
8 f_lowest= 1; // in Hz
9 // Frequency of reference oscillator ,
10 f_ref_os= 2.2*f_out_max; // in kHz
11 disp("The frequency of reference oscillator is : "+
    string(f_ref_os)+" kHz")
12 // Formula used : f_lowest= f_ref_os/2^n
13 n= round(log(f_ref_os*10^3/f_lowest)/log(2)); //
    number of bits required
14 disp("The number of bits required is : "+string(n))

```

Chapter 7

Active Filters

Scilab code Exa 7.1 Low pass filter

```
1 // Example 7.1
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 f_H= 2*10^3; //cut-off frequency in Hz
8 C= 0.01*10^-6; // in F
9 passband_gain= 2.5;
10 R= 1/(2*%pi*f_H*C); // in
11 R= 8.2; // in k (standard value)
12 // 1+Rf/R1= passband_gain or Rf should be equal to
    1.5*R1 since Rf||R1= R
13 R1= passband_gain/1.5*R; // in k
14 disp("The value of R1 is : "+string(R1)+" k ");
15 disp("(Standard value 15 k )");
16 Rf= floor(1.5*R1); // in k
17 disp("The value of Rf is : "+string(Rf)+" k ");
```

Scilab code Exa 7.2 Second order low pass filter

```
1 // Example 7.2
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 f_H= 2*10^3; //cut-off frequency in Hz
8 C= 0.033*10^-6; // in F
9 R= 1/(2*pi*f_H*C); // in
10 //  $2R = R_f R_1 / (R_f + R_1) = 0.586 R_1^2 / (1.586 R_1)$  since
    Rf= 0.586*R1
11 R1= 2*R*1.586/0.586; // in
12 R1= round(R1*10^-3); // in k
13 disp("The value of R1 is : "+string(R1)+" k ");
14 disp("(The value of R1 may be taken of 15 k )");
15 R1= 15; // in k
16 Rf= R1*0.586; // in k
17 //Rf= floor(1.5*R1); // in k
18 disp("The value of Rf is : "+string(Rf)+" k ");
19 disp("(The value of Rf may be taken as a pot of 10
    k )");
```

Scilab code Exa 7.3 Second order low pass filter

```
1 // Example 7.3
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',7);
7 f_H= 1*10^3; //cut-off frequency in Hz
8 C= 0.0047*10^-6; // in F
9 R= 1/(2*pi*f_H*C); // in
```

```

10 R= (R*10^-3); // in k
11 R1= 30; // in k (assume)
12 Rf= 0.586*R1; // in k
13 C= C*10^6; // in F
14 disp("The value of R''= R= "+string(R)+" k (
    standard value 33 k )");
15 disp("The value of C''= C= "+string(C)+" F ");
16 disp("The value of R1= "+string(R1)+" k ");
17 disp("The value of Rf= "+string(Rf)+" k (standard
    value 20 k pot) ");

```

Scilab code Exa 7.4 Flattest band second order active filter

```

1 // Example 7.4
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',5);
7 fc= 1*10^3; // in Hz
8 alpha= 1.414;
9 C= 0.1*10^-6; // in F (assume)
10 C_desh= C*alpha^2/4; // in F
11 C_desh= C_desh*10^6; // in F
12 disp("The value of C'' is : "+string(C_desh)+" F ")
    ;
13 C_desh= C_desh*10^-6; // in F
14 R_desh= 1/(2*%pi*fc*sqrt(C*C_desh)); // in
15 R_desh= R_desh*10^-3; // in k
16 disp("The value of R'' is : "+string(R_desh)+" k (
    standard value 2.2 k )")

```

Scilab code Exa 7.5 Flattest passband second order active filter

```

1 // Example 7.5
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',5);
7 alpha= 1.414; // passband
8 C= 0.01*10^-6; // in F (assume)
9 fc= 1*10^3; // in Hz
10 dc_gain= 6;
11 R= 1/(2*pi*C*fc); // in
12 R= R*10^-3; // in k
13 disp("The value of R is : "+string(R)+" k (
    standard value 15 k )");
14 R= 15; // in k
15 Af= 3-alpha; // and Af= 1+Rf/R1 or
16 // Rf= (Af-1)*R1 (i)
17 // 2*R= Rf || R1, hence from (i)
18 R1= 2*R*Af/(Af-1); // in k
19 disp("The value of R1 is : "+string(R1)+" k (
    standard value 82 k )");
20 R1= 82; // in k
21 Rf= (Af-1)*R1; // in k
22 disp("The value of Rf is : "+string(Rf)+" k (
    standard value 47 k )");
23 Aamp= dc_gain/Af;
24 disp("The value of Aamp is : "+string(Aamp));

```

Scilab code Exa 7.7 Cut off frequency

```

1 // Example 7.7
2 clc;
3 clear;
4 close;
5 // Given data

```

```

6 format('v',6);
7 R= 2.1*10^3; // in k
8 C= 0.05*10^-6; // in F
9 R1= 20*10^3; // in
10 Rf= 60*10^3; // in
11 // Low cut-off frequency,
12 f_L= 1/(2*%pi*R*C); // in Hz
13 f_L= f_L*10^-3; // in kHz
14 disp(f_L,"The cut-off frequency in kHz is : ")

```

Scilab code Exa 7.8 Centre frequency and gain

```

1 // Example 7.8
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 R1= 2*10^3; // in
8 R2= 2/3*10^3; // in
9 R3= 200*10^3; // in
10 C= 0.1*10^-6; // in F
11 Af= R3/(2*R1); // gain
12 disp(Af,"The value of Af is : ")
13 // R1= Q/(2*%pi*f_C*C*Af) (i)
14 // R2= Q/(2*%pi*f_C*C*(2*Q^2-Af)) (ii)
15 // R3= Q/(%pi*f_C*C) (iii)
16 Q= sqrt((R3/(2*R2)+Af)/2); // from (ii) and (iii)
17 disp(Q,"The value of Q is : ");
18 f_C= Q/(R3*%pi*C); // in Hz (from (iii))
19 disp(f_C,"The value of f_C in Hz is : ");
20 omega_0= 2*%pi*f_C; // in radians/second
21 disp(omega_0,"The value of omega_0 in radians/
seconds is : ")

```

Scilab code Exa 7.10 Bandpass active filter

```
1 // Example 7.10
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 f_L= 2*10^3;// in Hz
8 f_H= 2.5*10^3;// in Hz
9 Af= -5;
10 f_C= sqrt(f_L*f_H);// centre frequency in Hz
11 del_f= f_H-f_L;//bandwidth in Hz
12 Q= f_C/del_f;// selectivity
13 // Assume C1= C2= C= 0.01 F
14 C= 0.01*10^-6;// in F
15 R3= 1/(%pi*del_f*C);// in
16 R3= R3*10^-3;// in k
17 disp("The value of R3 is : "+string(R3)+" k (
    standard value 64 k )");
18 R3= 64;// in k
19 R3= R3*10^3;// in
20 R1= -R3/(2*Af);//in
21 R2= R1/(4*%pi^2*f_C^2*R1*R3*C^2-.1)
22 R1= R1*10^-3;// in k
23 C=C*10^6;// in F
24 disp("The value of R1 is : "+string(R1)+" k ");
25 disp("The value of R2 is : "+string(R2)+" k (
    standard value 800 )");
26 disp("The value of C is : "+string(C)+" F ");
```

Scilab code Exa 7.11 Narrow bandpass filter

```

1 // Example 7.11
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 f_C= 1*10^3;//centre frequency in Hz
8 f_C_desh= 2*10^3;//new centre frequency in Hz
9 Q= 5;// selectivity
10 Af= -8;
11 C= 0.01*10^-6;// in F (assume)
12 R3= Q/(%pi*f_C*C);//in
13 R3= R3*10^-3;// in k
14 disp("The value of R3 is : "+string(R3)+" k (160
    k (approx))");
15 R1= round(-R3/(2*Af));// in k
16 disp("The value of R1 is : "+string(R1)+" k ");
17 R2= R1*10^3/(4*%pi^2*f_C^2*R1*10^3*R3*10^3*C^2-1);//
    in
18 R2= R2*10^-3;// in k
19 disp("The value of R2 is : "+string(R2)+" k (2 k
    (approx))");
20 R2= 2;// in k (approx)
21 R2_desh= R2*(f_C/f_C_desh)^2;// in k
22 R2_desh= R2_desh*10^3;// in
23 disp("The value of R2'' is : "+string(R2_desh)+" ")
    )

```

Scilab code Exa 7.12 Cut off frequencies

```

1 // Example 7.12
2 clc;
3 clear;
4 close;
5 // Given data

```



```

6 format('v',6);
7 R= 10*10^3;// in
8 C1= 0.1*10^-6;// in F
9 C2= 0.0025*10^-6;// in F
10 f_H= 1/(2*pi*R*C2);//higher cut-off frequency in Hz
11 f_H= f_H*10^-3;// in kHz
12 f_L= 1/(2*pi*R*C1);//lower cut-off frequency in Hz
13 BW= f_H-f_L*10^-3;// bandwidth in kHz
14 disp(f_H,"The higher cut-off frequency in kHz is : "
)
15 disp(f_L,"The lower cut-off frequency in Hz is : ")
16 disp(BW,"The bandwidth in kHz is : ")

```

Scilab code Exa 7.13 Designing of a bandpass filter

```

1 // Example 7.13
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',5);
7 f_L= 200;// in Hz
8 f_H= 1*10^3;// in Hz
9 alpha=4;// passband gain
10 C_desh= 0.01*10^-6;// in F (assume)
11 R_desh= 1/(2*pi*f_H*C_desh);// in
12 R_desh= R_desh*10^-3;// in k
13 disp("The value of R' is : "+string(R_desh)+" k (
    Approx. 20 k )")
14 R_desh= 20;// in k (standard value)
15 // First Order High-Pass Filter
16 C= 0.05*10^-6;// in F (assume)
17 R= 1/(2*pi*f_L*C);// in
18 R= R*10^-3;// in k
19 R1= 10;// in k

```

```

20 Rf= R1;// in k
21 C_desh= C_desh*10^6;// in F
22 C= C*10^6;// in F
23 disp("The value of R is : "+string(R)+" k (Approx.
    20 k )")
24 R= 20;// in k (standard value)
25 disp("The value of R1 and Rf is : "+string(R1)+" k
    ")
26 disp("The value of C'' is : "+string(C_desh)+" F")
27 disp("The value of C is : "+string(C)+" F")

```

Scilab code Exa 7.14 A wide band stop filter

```

1 // Example 7.14
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',5);
7 f_H= 200;// in Hz
8 f_L= 2*10^3;// in Hz
9 C= 0.05*10^-6;// in F
10 // For low-pass filter ,
11 R_desh= 1/(2*pi*f_H*C);// in
12 R_desh= R_desh*10^-3;// in k
13 disp("The value of R'' is : "+string(R_desh)+" k (
    Approx. 20 k )")
14 // For high-pass filter ,
15 R= 1/(2*pi*f_L*C);// in
16 R= R*10^-3;// in k
17 disp("The value of R is : "+string(R)+" k ( Approx
    . 2 k )")

```

Scilab code Exa 7.15 A 50 Hz active notch filter

```
1 // Example 7.15
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',5);
7 C= 0.068*10^-6; // in F
8 f_N= 50; // in Hz
9 R= 1/(2*pi*f_N*C); // in
10 R= R*10^-3; // in k
11 disp("The value of R is : "+string(R)+" k ( Approx
    . 50 k )")
```

Scilab code Exa 7.16 Phase shift

```
1 // Example 7.16
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',5);
7 R= 15*10^3; // in
8 C= 0.01*10^-6; // in F
9 f= 2*10^3; // in Hz
10 PhaseShift= -2*atand(2*pi*f*R*C); // in
11 disp("The phase shift is : "+string(PhaseShift)+"
    i.e. "+string(abs(PhaseShift))+" (lagging)")
```

Scilab code Exa 7.18 Bandpass centre frequency

```
1 // Example 7.18
```

```

2  clc;
3  clear;
4  close;
5  // Given data
6  format('v',6);
7  R_A= 2.2*10^3; // in
8  R_B= 1.2*10^3; // in
9  Rf= 4.7*10^3; // in
10 C= 0.01*10^-6; // in F
11 k_lp= 1.238;
12 k_hp= 1/k_lp;
13 // Part (i)
14 alpha= 3*R_B/(R_A+R_B);
15 disp(alpha,"Part (i) : The value of alpha is : ");
16 disp("Given filter is 1db peak Chebyshev");
17
18 // Part (ii)
19 f_0= 1/(2*pi*Rf*C); // critical frequency in Hz
20 f_0= f_0*10^-3; // in kHz
21 f_low_pass= f_0*k_lp; // in kHz
22 disp(f_low_pass,"Part (ii) : The low-pass frequency
    in kHz is : ")
23 f_high_pass= f_0*k_hp; // in kHz
24 disp(f_high_pass,"The high-pass frequency in kHz is
    : ")
25
26 // Part (iii)
27 fc= f_0; // bandpass centre frequency in kHz
28 disp(fc,"Part (iii) : The bandpass centre frequency
    in kHz is : ")
29
30 // Part (iv)
31 // Formula used : delta_f= fc/Q= fc/(1/alpha)
32 delta_f= fc/(1/alpha); // in kHz
33 disp(delta_f,"Part (iv) : The bandpass width in kHz
    is : ")
34
35 // Part (v)

```

```
36 A0= 1/alpha;// bandpass gain at centre frequency
37 disp(A0,"Part (v) : The bandpass gain at centre
    frequency is : ")
```

Chapter 8

Non Linear circuits

Scilab code Exa 8.2 Peak value and average value of voltage

```
1 // Example 8.2
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',5);
7 R1= 5;// in k
8 R2= 10;// in k
9 V_peak= R1*R2/(R1+R2);// in V
10 Vav= V_peak/%pi;// in V
11 disp("Peak value of V1 is : "+string(V_peak)+" V")
12 disp("Average value of Vo is : "+string(Vav)+" V")
```

Scilab code Exa 8.7 DC voltage with proper sign

```
1 // Example 8.7
2 clc;
3 clear;
```

```

4 close;
5 // Given data
6 format('v',6);
7 t= 0;
8 Vc= 0; // in volts
9 Vo= 5; // in volts
10 R= 10; // in 2 (assume)
11 RC= 1; // (assume)
12 R3= 2*R; // in
13 R2= 3*R; // in
14 // From equation : T= 2*Rf*C*log[1+2*R3/R2]
15 T= 2*RC*log(1+2*R3/R2);
16 Vc_t= 2; // in volts
17 t= T/2;
18 // Voltage across capacitor ,
19 // Vc_t= Vco*[1-%e^(-t/ReqC)]= 1/5*(VR+4*Vo)*[1-%e
    ^(-t/4*RC/5)]
20 VR= Vc_t*5/[1-%e^(-t/(4*RC/5))]-4*Vo;
21 disp("The value of VR is : "+string(VR)+" volts")

```

Scilab code Exa 8.9 Output voltage

```

1 // Example 8.9
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',7);
7 // Part (c)
8 R1= 150; // in
9 R2= 68*10^3; // in
10 Vin= 50*10^-3; // in V
11 Vsat= 14; // in V
12 Vpositive= Vsat*(R1/(R1+R2)); // in V
13 V_UT= Vpositive; // in V

```

```
14 V_LT= Vpositive;// in V
15 disp(V_UT,"The value of V_UT in volts is : ")
16 disp(V_LT,"The value of V_LT in volts is : ")
```

Scilab code Exa 8.10 Schmitt trigger

```
1 // Example 8.10
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',9);
7 V_UT= 5;// in V
8 V_LT= -5;// in V
9 // Hysteresis voltage ,
10 Vhy= V_UT-V_LT;// in V
11 disp(Vhy,"The hysteresis voltage in volts is : ")
```

Chapter 10

Voltage Regulators

Scilab code Exa 10.1 Minimum input voltage

```
1 // Example 10.1
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 Idc= 300; // in mA
8 C= 200; // in F
9 Vmax= 24; // in V
10 Vrms= 2.4*Idc/C; // in V
11 Vr_peak= sqrt(3)*Vrms; // in V
12 Vdc= Vmax-Vr_peak; // in V
13 disp(Vdc,"The minimum input voltage in volts is : ")
```

Scilab code Exa 10.2 Input voltage

```
1 // Example 10.2
2 clc;
```

```

3 clear;
4 close;
5 // Given data
6 format('v',6);
7 VR= 12; // in V
8 IL= 0.5; // in A
9 RL= 25; // in
10 // Resistanc required ,
11 R= VR/IL; // in
12 VL= IL*RL; // in V
13 Vout= VR+VL; //output voltage in V
14 Vin= Vout+2; // input voltage in V
15 disp(Vin,"The input voltage in volts is : ")

```

Scilab code Exa 10.3 Regulated output voltage

```

1 // Example 10.3
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 R1= 240; // in
8 R2= 1.2*10^3; // in
9 // Regulated output voltage in the circuit ,
10 Vout= 1.25*(1+R2/R1); // in V
11 disp(Vout,"The regulated output voltage in volts is
: ");

```

Scilab code Exa 10.4 Minimum and maximum output voltage

```

1 // Example 10.4
2 clc;

```

```

3 clear;
4 close;
5 // Given data
6 format('v',6);
7 V_REG= 15; // in V
8 I_Q= 10*10^-3; // in A
9 R1= 40; // in
10 // When potentiometer R2=0 (minimum)
11 R2= 0; // in
12 Vout= (1+R2/R1)*V_REG+I_Q*R2;
13 disp(Vout,"The minimum output voltage in volts is :
      ");
14 // When potentiometer R2=200 (maximum)
15 R2= 200; // in
16 Vout= (1+R2/R1)*V_REG+I_Q*R2;
17 disp(Vout,"The minimum output voltage in volts is :
      ");

```

Scilab code Exa 10.5 Regulated output voltage

```

1 // Example 10.5
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 V_REF= 1.25; // in V
8 R1= 2.5*10^3; // in
9 R2= 1*10^3; // in
10 I= V_REF/R2; // in A
11 // The output voltage,
12 Vout= I*(R1+R2); // in V
13 disp(Vout,"The regulated output voltage in volts is
      : ")

```

Scilab code Exa 10.6 Duty cycle of the pulses

```
1 // Example 10.6
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',6);
7 V_REF= 1.25; // in V
8 R1= 3*10^3; // in
9 R2= 1*10^3; // in
10 Vin= 20; // in V
11 Vout= V_REF*(R1+R2)/R2; // output voltage in volts
12 // Duty cycle ,
13 D= Vout/Vin*100; // in %
14 disp("The duty cycle is "+string(D)+" %")
```
