

Scilab Textbook Companion for
Linear Integrated Circuits
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Scilab numbering policy used in this document and the relation to the above book.

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

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Chapter 1

Differential And Cascode Amplifiers

Scilab code Exa 1.1 Operating current and voltage and voltage gain

```
1 // Exa 1.1
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',7)
7 V_CC= 10; // in volt
8 V_EE= V_CC;
9 V_BE= 0.715; // in volt
10 R_c1= 2.7; // in k ohm
11 R_c1= R_c1*10^3; // in ohm
12 R_c2= R_c1; // in ohm
13 R_E=3.9; // in k ohm
14 R_E= R_E*10^3; // in ohm
15 Beta_ac= 100;
16 Beta_dc= Beta_ac;
17 I_E= (V_EE-V_BE)/(2*R_E); // in amp
18 I_C= I_E; // in amp
19 V_C= V_CC-I_C*R_c1; // in volt
```

```

20 V_E= 0-V_BE;// in volt
21 V_CE= V_C-V_E;// in volt
22 re_desh= 25*10^-3/I_E;
23 A_d= R_c1/re_desh;
24 disp(I_C*10^3,"Operating current in mA");
25 disp(V_CE,"Operating voltage in volt");
26 disp(A_d,"Voltage gain")

```

Scilab code Exa 1.2 Quiescent collector current

```

1 // Exa 1.2
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',7)
7 V_CC= 10;// in volt
8 V_EE= 10;// in volt
9 V_BE=0.7// in volt
10 I_C=0.5;// in mA
11 I_C=I_C*10^-3;// in amp
12 R_C= 10;// in k ohm
13 R_C= R_C*10^3;// in ohm
14 R_E= 9.3;// in k ohm
15 R_E= R_E*10^3;// in ohm
16 I_E= (V_EE-V_BE)/(2*R_E);// in amp
17 I_CQ= I_E;// in amp
18 disp(I_CQ*10^3,"Quiescent collector current in mA");
19 V_CEQ= V_CC+V_BE-I_C*R_C;// in volt
20 disp(V_CEQ,"Quiescent collector emitter voltage in
    volt");

```

Scilab code Exa 1.3 Output Voltage base current and base voltage

```

1 // Exa 1.3
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',9)
7 V_CC= 12; // in volt
8 V_EE= 12; // in volt
9 V_BE= 0.7; // in volt
10 R_C= 10; // in k ohm
11 R_C= R_C*10^3; // in ohm
12 R_E= 10; // in k ohm
13 R_E= R_E*10^3; // in ohm
14 R_B= 20; // in k ohm
15 R_B= R_B*10^3; // in ohm
16 Beta_dc= 75;
17 // Part (i)
18 //Ignoring V_BE
19 I_T= V_EE/R_E//in amp
20 I_E= I_T/2; // in amp
21 I_C=I_E;
22 V_out= V_CC-I_C*R_C// in volt
23 disp(V_out,"Output Voltage in volt (Ignoring V_BE)")
    ;
24 //Considering V_BE
25 I_T= (V_EE-V_BE)/R_E//in amp
26 I_E= I_T/2; // in amp
27 I_C=I_E;
28 V_out= V_CC-I_C*R_C// in volt
29 disp(V_out,"Output Voltage in volt (Condidering V_BE
    )");
30 I_T= (V_EE-V_BE)/(R_E+R_B/(2*Beta_dc)); // in amp
31 I_E= I_T/2; // in amp
32 I_C=I_E;
33 V_out= V_CC-I_C*R_C// in volt
34 disp(V_out,"Output Voltage in volt (With Beta_dc)");
35
36 // Part(ii)

```

```

37 I_C= 0.6; // in mA
38 I_C=I_C*10^-3;
39 I_B= I_C/Beta_dc; // in amp
40 disp(I_B*10^6,"Base current in micro ampere");
41 V_B= -I_B*R_B; // in volt
42 disp(V_B,"Base Voltage in volt")
43
44 // Part (iii)
45 Beta_dc= 60;
46 I_B1= I_C/Beta_dc; // in amp
47 disp(I_B1*10^6,"Base current for transistor Q1 in
    micro ampere");
48 V_B1= -I_B1*R_B; // in volt
49 disp(V_B1,"Base Voltage for transistor Q1 in volt")
50 Beta_dc= 80;
51 I_B2= I_C/Beta_dc; // in amp
52 disp(I_B2*10^6,"Base current for transistor Q2 in
    micro ampere");
53 V_B2= -I_B2*R_B; // in volt
54 disp(V_B2,"Base Voltage for transistor Q2 in volt")

```

Scilab code Exa 1.4 Voltage gain

```

1 // Exa 1.4
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',7)
7 V_CC= 10; // in volt
8 V_EE= 10; // in volt
9 V_BE= 0.7; // in volt
10 R_C= 2.2; // in k ohm
11 R_C= R_C*10^3; // in ohm
12 R_E= 4.7; // in k ohm

```

```

13 R_E= R_E*10^3; // in ohm
14 Ri_1= 50; // in ohm
15 Ri_2= Ri_1; // in ohm
16 Bita_dc= 100;
17 Bita_ac = Bita_dc;
18 // Part (a)
19 I_CQ = (V_EE-V_BE)/(2*R_E+Ri_1/Bit_a_dc); // in amp
20 I_E= I_CQ; // in amp
21 disp(I_CQ*10^3,"Value of I_CQ in mA");
22 V_CEQ= V_CC + V_BE - I_CQ*R_C; // in volt
23 disp(V_CEQ,"Value of V_CEQ in volt");
24
25 // Part(b)
26 re_desh= (26*10^-3)/I_E; // in ohm
27 // A_d= V_out/V_ind = R_C/re_desh
28 A_d = R_C/re_desh;
29 disp(A_d,"Voltage gain ");
30
31 // Part(c)
32 // R_in1= R_in2= 2*Bit_a_ac*re_desh
33 R_in1= 2*Bit_a_ac*re_desh; // in ohm
34 disp(R_in1*10^-3,"Input resistance in k ohm");
35
36 // Part(d)
37 // R_out1= R_out2= R_C
38 R_out1= R_C; // in ohm
39 disp(R_out1*10^-3,"Output resistance in k ohm");

```

Scilab code Exa 1.5 Output voltage

```

1 // Exa 1.5
2 clc;
3 clear;
4 close;
5 // Given data

```

```

6  format('v',7)
7  V_CC= 15; // in volt
8  V_EE= 15; // in volt
9  V_BE= 0.7; // in volt
10 R_C= 1; // in M ohm
11 R_C= R_C*10^6; // in ohm
12 R_E= R_C; // in ohm
13
14 Beta_ac= 100;
15 I_E = (V_EE-V_BE)/(2*R_E); // in amp
16 re_desh= (26*10^-3)/I_E; // in ohm
17 A_d = R_C/re_desh;
18 disp(A_d,"Voltage gain ");
19 Z_in= 2*Beta_ac*re_desh; // in ohm
20 disp(Z_in*10^-6,"Input impedance in M ohm");
21 Z_out= R_C; // in ohm
22 disp(Z_out*10^-6,"Output impedance in M ohm");
23 A_cm= R_C/(2*R_E+re_desh);
24 CMRR= A_d/A_cm;
25 disp(CMRR,"Common-mode rejection ratio");
26 disp("When v_in is zero, the ac output voltage is
      zero. So total output voltage at the quiescent
      value in volt")
27 I_C=I_E;
28 V_out= V_CC-I_C*R_C; // in volt
29 disp(V_out);
30 // when v_in = 1
31 v_in= 1; // in mV
32 v_in= v_in*10^-3; // in volt
33 disp("When v_in = 1 mv, the ac output voltage in
      volt");
34 v_out= A_d*v_in;
35 disp(v_out);
36
37 // Note : Answer of CMRR in the book is wrong due to
      wrong calculation of A_cm

```

Scilab code Exa 1.6 Magnitude of differential gain

```
1 // Exa 1.6
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',7)
7 V_EE= 5; // in volt
8 R_C= 2; // in k ohm
9 R_C= R_C*10^3; // in ohm
10 R_E= 4.3; // in k ohm
11 R_E= R_E*10^3; // in ohm
12 V_BE=0.7; // in volt (Assuming)
13 V_T= 26*10^-3; // in volt
14 I_E = (V_EE-V_BE)/(2*R_E); // in amp
15 re_desh= V_T/I_E; // in ohm
16 A_d = R_C/(2*re_desh);
17 disp(A_d,"Voltage gain ");
```

Scilab code Exa 1.7 Common mode gain

```
1 // Exa 1.7
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',7)
7 V_EE= 5; // in volt
8 R_C= 2; // in k ohm
9 R_C= R_C*10^3; // in ohm
10 R_E= 4.3; // in k ohm
```

```

11 R_E= R_E*10^3; // in ohm
12 V_BE=0.7; // in volt (Assuming)
13 V_T= 26*10^-3; // in volt
14 I_E = (V_EE-V_BE)/(2*R_E); // in amp
15 re_desh= V_T/I_E; // in ohm
16 A_d = R_C/(2*re_desh);
17 A_cm= R_C/(2*R_E+re_desh);
18 disp(A_cm,"Common mode gain");
19 CMRR= A_d/A_cm;
20 disp(CMRR,"Common mode rejection ratio")

```

Scilab code Exa 1.8 Output voltage

```

1 // Exa 1.8
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',7)
7 V_CC= 9; // in volt
8 V_EE= 9; // in volt
9 V_BE= 0.7; // in volt (Assuming value)
10 R_C= 47; // in k ohm
11 R_C= R_C*10^3; // in ohm
12 R_E= 43; // in k ohm
13 R_E= R_E*10^3; // in ohm
14 Ri_1= 20; // in ohm
15 Ri_2= Ri_1; // in ohm
16 v_in1= 2.5; // in mv
17 v_in1=v_in1*10^-3; // in volt
18 Beta_1= 75;
19 Beta_2= Beta_1;
20 I_CQ = (V_EE-V_BE)/(2*R_E+Ri_1/Beta_1); // in amp
21 I_E= I_CQ; // in amp
22 V_CEQ= V_CC + V_BE - I_CQ*R_C; // in volt

```



```

23 re_desh= (26*10^-3)/I_E; // in ohm
24 A_d = R_C/re_desh;
25 v_out= A_d*v_in1; // in volt
26 disp(v_out,"Output voltage in volt")

```

Scilab code Exa 1.9 Dual input unbalanced input

```

1 // Exa 1.9
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',7)
7 V_CC= 10; // in volt
8 V_EE= 10; // in volt
9 V_BE= 0.7; // in volt
10 R_C= 2.2; // in k ohm
11 R_C= R_C*10^3; // in ohm
12 R_E= 4.7; // in k ohm
13 R_E= R_E*10^3; // in ohm
14 Ri_1= 50; // in ohm
15 Ri_2= Ri_1; // in ohm
16 Beta_dc= 100;
17 Beta_ac = Beta_dc;
18 I_CQ = (V_EE-V_BE)/(2*R_E+Ri_1/Beta_dc); // in amp
19 I_E= I_CQ; // in amp
20 V_CEQ= V_CC + V_BE - I_CQ*R_C; // in volt
21 re_desh= (26*10^-3)/I_E; // in ohm
22 A_d = R_C/re_desh;
23 R_in1= 2*Beta_ac*re_desh; // in ohm
24 R_out1= R_C; // in ohm
25 disp(I_CQ*10^3,"Quiescent collector current in mA");
26 disp(V_CEQ,"Quiescent collector-emitter voltage in
    volt");
27 disp(R_in1*10^-3,"Input resistance in k ohm");

```

```

28 disp(R_out1*10^-3,"Output resistance in k ohm");
29 // However, the voltage gain of dual input ,
    unbalaned output differential amplifier is half
    the gain of the dual input , balanced output
    differential amplifier as
30 disp(A_d/2,"Voltage gain")
31
32 // (ii)
33 disp("Because of same component values and same
    biasing arrangement the values of I_CQ,V_CEQ,R_in
    ,R_out and A_d are the same as those for dual
    input balanced output configuration. Thus");
34 disp(I_CQ*10^3,"Quiescent collector current in mA");
35 disp(V_CEQ,"Quiescent collector-emitter voltage in
    volt");
36 disp(R_in1*10^-3,"Input resistance in k ohm");
37 disp(R_out1*10^-3,"Output resistance in k ohm");
38 disp(A_d,"Voltage gain")

```

Scilab code Exa 1.10 Single input unbalanced input

```

1 // Exa 1.10
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',7)
7 V_CC= 9;// in volt
8 V_EE= 9;// in volt
9 V_BE= 0.7;// in volt (Assuming value)
10 R_C= 47;// in k ohm
11 R_C= R_C*10^3;// in ohm
12 R_E= 43;// in k ohm
13 R_E= R_E*10^3;// in ohm
14 Ri_1= 20;// in ohm

```

```

15 Ri_2= Ri_1;// in ohm
16 v_in1= 2.5;// in mv
17 v_in1=v_in1*10^-3;// in volt
18 Bita_1= 75;
19 Bita_2= Bita_1;
20 I_CQ = (V_EE-V_BE)/(2*R_E+Ri_1/Bita_1);// in amp
21 I_E= I_CQ;// in amp
22 V_CEQ= V_CC + V_BE - I_CQ*R_C;// in volt
23 re_desh= (26*10^-3)/I_E;// in ohm
24 // However, voltage gain of single-input, unbalanced
    -output differential amplifier is given by so
25 A_d = R_C/(2*re_desh);
26 v_out= A_d*v_in1;// in volt
27 disp(v_out,"Output voltage in volt")

```

Scilab code Exa 1.11 Voltage gain input output resistance

```

1 // Exa 1.11
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',7)
7 R_E_desh= 200;// in ohm
8 V_CC= 10;// in volt
9 V_EE= 10;// in volt
10 V_BE= 0.7;// in volt
11 R_C= 2.2;// in k ohm
12 R_C= R_C*10^3;// in ohm
13 R_E= 4.7;// in k ohm
14 R_E= R_E*10^3;// in ohm
15 Ri_1= 50;// in ohm
16 Ri_2= Ri_1;// in ohm
17 Bita_dc= 100;
18 Bita_ac = Bita_dc;

```

```

19 I_CQ = (V_EE-V_BE)/(2*R_E+ R_E_desh+Ri_1/Bit_a_dc); //
    in amp
20 I_E= I_CQ; // in amp
21 disp(I_CQ*10^3,"Value of I_CQ in mA");
22 V_CEQ= V_CC + V_BE - I_CQ*R_C; // in volt
23 disp(V_CEQ,"Value of V_CEQ in volt");
24 re_desh= (26*10^-3)/I_E; // in ohm
25 A_d = R_C/(re_desh+R_E_desh);
26 disp(A_d,"Voltage gain");
27 R_in1= 2*Bit_a_ac*(re_desh+R_E_desh); // in ohm
28 disp(R_in1*10^-3,"Input resistance in k ohm");
29 R_out1= R_C; // in ohm
30 disp(R_out1*10^-3,"Output resistance in k ohm");

```

Scilab code Exa 1.12 Q point Differential voltage gain

```

1 // Exa 1.12
2 clc;
3 clear;
4 close;
5 // Given data
6 V_D1=0.7; // in volt
7 V_D2=V_D1;
8 V_BE= 0.7; // in volt
9 Bit_a= 100;
10 R3=180; // in ohm
11 V_EE= 15; // in volt
12 V_CC=15; // in volt
13 R_C=470; // in ohm
14 V_B3= -V_EE+V_D1+V_D2; // in volt
15 V_E3= V_B3-V_BE; // in volt
16 I_E3= (V_E3-(-V_EE))/R3; // in amp
17
18 // Part (i)
19 I_CQ= I_E3/2; // in amp

```

```

20 I_CQ= I_CQ*10^3; // in mA
21 I_CQ= ceil(I_CQ);
22 I_E=I_CQ;
23 disp(I_CQ,"Quiescent current in mA")
24 V_CEQ= V_CC + V_BE - I_CQ*10^-3*R_C; // in volt
25 disp(V_CEQ,"Value of V_CEQ in volt");
26 re_desh= 26/I_E; // in ohm
27 // Part(ii)
28 A_d = R_C/(re_desh);
29 disp(A_d,"Differential Voltage gain");
30 // part(iii)
31 R_in1= 2*Beta*re_desh; // in ohm
32 disp(R_in1*10^-3,"Input resistance in k ohm");

```

Scilab code Exa 1.13 voltage gain of differential amplifier

```

1 // Exa 1.13
2 clc;
3 clear;
4 close;
5 // Given data
6 Beta_ac= 100;
7 Beta_dc= Beta_ac;
8 V_BE=0.715; // in volt
9 V_D1= V_BE;
10 R3=2.7*10^3; // in ohm
11 R_C=4.7*10^3; // in ohm
12 V_EE=10; // in volt
13 V_CC= 10; // in volt
14 V_Z= 6.2; // in volt
15 I_ZT= 41; // in mA
16 I_ZT=I_ZT*10^-3; // in amp
17 V_B3= -V_EE+V_Z+V_D1; // in volt
18 V_E3= V_B3-V_BE; // in volt
19 I_E3= (V_E3-(-V_EE))/R3; // in amp

```

```

20 // I_CQ1= I_CQ2= I_CQ= I_E3/2
21 I_CQ= I_E3/2; // in amp
22 I_CQ1=I_CQ;
23 I_CQ2=I_CQ1;
24 I_E=I_CQ;
25 V_CEQ= V_CC + V_BE - I_CQ*R_C; // in volt
26
27 // Part (c)
28 // Thus Q_point= (I_CQ,V_CEQ)
29 disp("Operating point values are : "+string(I_CQ
      *10^3)+" mA and "+string(V_CEQ))
30 re_desh= (26*10^-3)/I_E; // in ohm
31
32 // Part(a)
33 A_d= R_C/re_desh;
34 disp(A_d,"Voltage gain");
35
36 // part(b)
37 R_in= 2*Beta_ac*re_desh; // in ohm
38 disp(R_in*10^-3,"Input resistance in k ohm");

```

Scilab code Exa 1.14 Mirrored current

```

1 // Exa 1.14
2 clc;
3 clear;
4 close;
5 // Given data
6 V_CC=12; // in volt
7 V_BE=0.7; // in volt
8 R1= 25; // in k ohm
9 R1=R1*10^3; // in ohm
10 // I=I_REF= (V_CC-V_BE)/R1
11 I= (V_CC-V_BE)/R1; // in amp
12 disp(I*10^3,"Mirrored current in mA")

```

Scilab code Exa 1.15 Reference current and output current

```
1 // Exa 1.15
2 clc;
3 clear;
4 close;
5 // Given data
6 V_CC=10; // in volt
7 V_BE=0.7; // in volt
8 R1= 15; // in k ohm
9 R1=R1*10^3; // in ohm
10 Bita=100;
11 I_REF= (V_CC-V_BE)/R1; // in amp
12 disp(I_REF*10^3,"Reference current in mA")
13 I_out= I_REF*Bita/(Bita+2); // in amp
14 disp(I_out*10^3,"Output current in mA")
```

Scilab code Exa 1.16 Finding current

```
1 // Exa 1.16
2 clc;
3 clear;
4 close;
5 // Given data
6 V_CC=15; // in volt
7 V_BE=0.7; // in volt
8 R_REF= 2.2; // in k ohm
9 R_REF= R_REF*10^3; // in ohm
10 Bita=220;
11 I_REF= (V_CC-V_BE)/R_REF; // in amp
12 I= I_REF*Bita/(Bita+2); // in amp
13 disp(I*10^3,"Current in mA")
```

Scilab code Exa 1.17 Finding current

```
1 // Exa 1.17
2 clc;
3 clear;
4 close;
5 // Given data
6 V_BE=0.7; // in volt
7 V_Z= 1.8; // in volt
8 R_E=1; // in k ohm
9 Beta=180;
10 //V_Z-V_BE-V_B=0
11 V_B= V_Z-V_BE; // in volt
12 I_E= V_B/R_E; // in mA
13 I= Beta/(Beta+1)*I_E; // in mA
14 disp(I,"Current in mA")
```

Scilab code Exa 1.18 Current depicted

```
1 // Exa 1.18
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',7)
7 V_BE=0.7; // in volt
8 V_CC=9; // in volt
9 R1=12; // in k ohm
10 R1=R1*10^3; // in ohm
11 Beta=100;
12 Beta_1= Beta;
```



```

13 Bita_2=Bitas;
14 Bitas_3=Bitas;
15 I_REF= (V_CC-2*V_BE)/R1; // in amp
16 disp(I_REF*10^3,"Reference current in mA");
17 I_out= I_REF/(1+2/(Bitas*(1+Bitas_3))); // in amp
18 disp(I_out*10^3,"Output current in mA");
19 I_C2=I_out; // in amp
20 disp(I_C2*10^3,"Collector current in mA");
21 I_C1= I_C2;
22 I_B3= I_REF-I_C1; // in amp
23 disp(I_B3*10^6,"Base current of transistor in micro
    amphere");
24 I_E3= I_B3*(1+Bitas_3); // in amp
25 disp(I_E3*10^6,"Emitter current of transistor in
    micro amphere");
26 I_B1= I_E3/2; // in amp
27 disp(I_B1*10^6,"Base current in micro amphere");

```

Scilab code Exa 1.19 Collector current

```

1 // Exa 1.19
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',7)
7 V_BE=0.715; // in volt
8 V_CC=9; // in volt
9 Bitas_dc=100;
10 Bitas_ac= Bitas_dc;
11 V_EE= 10; // in volt
12 R=5.6; // in k ohm
13 R= R*10^3; // in ohm
14 I_REF= (V_EE-V_BE)/R; // in amp
15 // From  $2*I_B + I_{C1} - I_{REF} = 0$ 

```

```

16 I_C1= I_REF*Beta_dc/(2+Beta_dc); // in amp
17 // By symmetry
18 I_C2= I_C1;
19 I_C3= I_C2;
20 I=3*I_C1; // current through R_C in amp
21 disp(I*10^3,"Current through R_C in mA");

```

Scilab code Exa 1.20 Differential input resistance

```

1 // Exa 1.20
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',7)
7 V_BE=0.7; // in volt
8 V_CC=5; // in volt
9 V_EE=-5; // in volt
10 Beta=100;
11 R=18.6; // in k ohm
12 R= R*10^3; // in ohm
13 I2= (V_CC-V_BE-V_EE)/R; // in amp
14 I_C3=I2;
15 I_E= I_C3/2; // in amp
16 re_desh= (26*10^-3)/I_E; // in ohm
17 re1_desh=re_desh;
18 re2_desh=re1_desh;
19 R_in1= 2*Beta*re_desh; // in ohm
20 R_in2= R_in1
21 disp(R_in1*10^-3,"Differential input resistance in k
    ohm")

```

Scilab code Exa 1.21 Voltage gain for the cascode amplifier

```

1 // Exa 1.21
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',7)
7 V_BE=0.7; // in volt
8 V_CC=18; // in volt
9 R_E=1.1; // in k ohm
10 R_C=1.8; // in k ohm
11 R_C=R_C*10^3; // in ohm
12 R1=4.7; // in k ohm
13 R2=5.6; // in k ohm
14 R3=6.8; // in k ohm
15 I_E1= (V_CC*R1/(R1+R2+R3)-V_BE)/R_E; // in mA
16 re_desh= 26/I_E1; // in ohm
17 re2_desh=re_desh
18 Av= -R_C/re2_desh;
19 disp(Av,"Voltage gain of the cascode amplifier is :
    ")

```

Chapter 2

Introduction To Operation Amplifiers

Scilab code Exa 2.2 Output voltage

```
1 // Exa 2.2
2 clc;
3 clear;
4 close;
5 // Part (i)
6 // Given data
7 V_in1= 5; // in micro volt
8 V_in1=V_in1*10^-6; // in volt
9 V_in2= -7; // in micro volt
10 V_in2=V_in2*10^-6; // in volt
11 Av=2*10^5;
12 V_out= (V_in1-V_in2)*Av; // in volt
13 disp(V_out, "(i) Output voltage in first case in volt
    ");
14
15 // Part(ii)
16 V_in1= 10; // in mV
17 V_in1=V_in1*10^-3; // in volt
18 V_in2= 20; // in mV
```

```

19 V_in2=V_in2*10^-3; // in volt
20 V= Av*(V_in1*sqrt(2)-V_in2*sqrt(2)); // V = V_out/sin
    (omega*t) in volts
21 V=ceil(V);
22 disp("(ii) Output voltage in second case : "+string(
    V)+"*sin(omega*t) volts")

```

Scilab code Exa 2.4 Input resistance

```

1 // Exa 2.4
2 clc;
3 clear;
4 close;
5 // Given data
6 Rs= 2; // in k ohm
7 Rs=Rs*10^3; // in ohm
8 RL= 5; // in k ohm
9 RL=RL*10^3; // in ohm
10 Rin= 100; // in k ohm
11 Rin=Rin*10^3; // in ohm
12 Rout= 50; // in ohm
13 A=10^5;
14 Vout= 10; // in volt
15 //  $V_1 = V_s \cdot R_{in} / (R_{in} + R_s) = V_s \cdot 100 / 102$  (i)
16 //  $V_2 / (5 \text{ kohm}) + V_2 / (100 \text{ kohm}) + (V_2 - 10^5 \cdot (V_1 - V_2)) / 50$ 
    = 0
17 // or  $20 \cdot V_2 + V_2 + 2 \cdot 10^3 \cdot V_2 = 2 \cdot 10^8 \cdot (V_1 - V_2)$ 
18 // or  $V_2 \cdot (20 + 1 + 2 \cdot 10^3 + 2 \cdot 10^8) = 2 \cdot 10^8 \cdot V_1$ 
19 // or  $V_1 = V_2$  (approx)
20 // For
21 V_out= 10; // in volt
22 V1=10; // in volt
23 V2=V1;
24 Vs= (Rin+Rs)/Rin*V1; // in volts
25 V_out_BY_Vs= V_out/Vs; //in volts

```

```

26 disp(Vs," Value of Vs in volts");
27 disp(V_out_BY_Vs," Value of V_out/Vs ")
28 disp(Rin*10^-3,"Input resistance of circuit in kohm"
    )

```

Scilab code Exa 2.5 Output voltage

```

1 // Exa 2.5
2 clc;
3 clear;
4 close;
5 // Given data
6 R1= 1; // in k
7 R2= 2; // in k
8 R3= 4; // in k
9 R4= 8; // in k
10 R5= 1; // in k
11 R6= 3 ; // in k
12 Vc= -1; // in V
13 // V_A= Vout*R5/(R5+R6) (i)
14 // Applying Kirchoff's law at node B and A
15 // V_B*(1/R3+1/R2) -Vc/R3 = Vout*R5/(R2*(R5+R6))
16 // V_B/R2 +1= 3*Vout*R5/(R2*(R5+R6)) (ii)
17 Vout= (R2+R6)/(3*R6/R3+Vc/R2); // in volts
18 disp(Vout,"The output voltage in volts is 20/7 volts
    or ")

```

Scilab code Exa 2.6 CMMR in db

```

1 // Exa 2.6
2 clc;
3 clear;
4 close;

```

```

5 // Given data
6 Ad= 100;
7 Acn= 0.01;
8 CMRR= Ad/Acn;
9 CMRR_desh= 20*log10(CMRR); // in dB
10 disp(CMRR_desh,"CMRR in dB")

```

Scilab code Exa 2.7 Common mode gain

```

1 // Exa 2.7
2 clc;
3 clear;
4 close;
5 // Given data
6 Ad= 10^5;
7 CMRR= 10^5;
8 Acn= Ad/CMRR;
9 disp(Acn,"Common mode gain");

```

Scilab code Exa 2.8 Percentage error in the output voltage

```

1 // Exa 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 Vd= V1-V2; // in mV
10 Vcm= (V1+V2)/2; // in mV
11 Ad= 60; // in dB
12 Ad= 10^(Ad/20);

```

```

13 CMRR= 80; // in dB
14 CMRR= 10^(CMRR/20);
15 V_out= Ad*Vd*10^-3*(1+1/CMRR*Vcm/Vd); // in volt
16 errorVoltage= V_out-Ad*Vd*10^-3; // in volt
17 disp(errorVoltage*10^3,"Error Voltage in mV");
18 PercentError= errorVoltage/V_out*100; // in %
19 disp(PercentError,"Percentage error is")

```

Scilab code Exa 2.9 Percentage error due to common mode

```

1 // Exa 2.9
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',7)
7 V1=745; // in micro volt
8 V2=740; // in micro volt
9 Vd= V1-V2; // in micro volt
10 Vcm= (V1+V2)/2; // in micro volt
11 Ad= 5*10^5;
12 CMRR= 80; // in dB
13 CMRR= 10^(CMRR/20);
14 V_out= Ad*Vd*10^-6*(1+1/CMRR*Vcm/Vd); // in volt
15 disp(V_out,"Output voltage in volt")
16 errorVoltage= V_out-Ad*Vd*10^-6; // in volt
17 PercentError= errorVoltage/V_out*100; // in %
18 disp(PercentError,"Percentage error is")

```

Scilab code Exa 2.10 Output voltage

```

1 // Exa 2.10
2 clc;

```



```

3 clear;
4 close;
5 // Given data
6 format('v',9)
7 Vd=25;// in micro volt
8 Vd= Vd*10^-6;// in volt
9 A=200000;
10 V_out= Vd*A;
11 disp(V_out,"Output voltage in volt");

```

Scilab code Exa 2.11 Output voltage

```

1 // Exa 2.11
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',9)
7 dV_out=20;// in volt
8 dt= 4;// in micro seconds
9 SR= dV_out/dt;// in V/micro sec
10 disp(SR,"Slew rate in V/micro sec");

```

Scilab code Exa 2.12 Input bias current

```

1 // Exa 2.12
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',9)
7 IB1= 10;// in mA
8 IB2= 7.5;// in mA

```

```

9 I_in_bias= (IB1+IB2)/2; // in mA
10 disp(I_in_bias,"Input bias current in mA")
11 I_in_offset= IB1-IB2 ; // in mA
12 disp(I_in_offset,"Input offset current in mA")
13
14 // Note: Units in Answer in the book is wrong

```

Scilab code Exa 2.13 Value of limiting frequency

```

1 // Exa 2.13
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',9)
7 SR= 6; // in V/micro S
8 SR=SR*10^6; // in V/s
9 // (i)
10 V_max= 1; // in volt
11 f_max= SR/(2*pi*V_max);
12 disp(f_max*10^-6,"Frequency for V_max=1V in MHz")
13 // (ii)
14 V_max= 10; // in volt
15 f_max= SR/(2*pi*V_max);
16 disp(f_max*10^-3,"Frequency for V_max=10V in kHz")

```

Scilab code Exa 2.14 741 op amp

```

1 // Exa 2.14
2 clc;
3 clear;
4 close;
5 // Given data

```

```
6 format('v',9)
7 V_PP= 3;// in volt
8 delta_t= 4;// in micro sec
9 // delta_V= 90% of V_PP - 10% of V_PP = (90%-10%)*
  V_PP
10 delta_V= 0.8*V_PP;
11 SR= delta_V/delta_t;// in V/micro sec
12 disp(SR,"Required slew rate in V/micro second")
```

Chapter 3

Negative Feedback In Op Amps

Scilab code Exa 3.2 Maximum and minimum voltage gain

```
1 // Exa 3.2
2 clc;
3 clear;
4 close;
5 //given data
6 R1=2; // in k ohm
7 R_f_min=0;
8 R_f_max=100; // in k ohm
9 A_f_max = 1+R_f_max/R1;
10 disp(A_f_max,"Maximum closed loop")
11 A_f_min = 1+R_f_min/R1;
12 disp(A_f_min,"Minimum closed loop")
```

Scilab code Exa 3.3 Voltage gain input resistance

```
1 // Exa 3.3
2 clc;
3 clear;
```

```

4 close;
5 //given data
6 R1=100;// in ohm
7 R_f=100;// in k ohm
8 R_f=R_f*10^3;// in ohm
9 A=2*10^5;
10 R_in= 2;// in M ohm
11 R_in=R_in*10^6;// in ohm
12 R_out= 75;// in ohm
13 f_o= 5;// in Hz
14 B= R1/(R1+R_f);
15 FeedbackFactor= A*B;
16 A_f = 1+R_f/R1;
17 disp(A_f," Voltage gain")
18 R_inf= R_in*(1+A*B);
19 disp(R_inf*10^-6,"Input Resistance in M ohm")
20 R_outf= R_out/(1+A*B);// in ohm
21 disp(R_outf,"Output Resistance in ohm");
22 f_f= f_o*(1+A*B);// in Hz
23 disp(f_f,"Bandwidth in Hz");

```

Scilab code Exa 3.4 Value of Rof and VooT

```

1 // Exa 3.4
2 clc;
3 clear;
4 close;
5 //given data
6 R1=1;// in k ohm
7 R1=R1*10^3;// in ohm
8 R_f=10;// in k ohm
9 R_f=R_f*10^3;// in ohm
10 A=200000;
11 OutputVoltageSwing= 13;// in volt
12 SupplyVoltage=15;// in volt

```

```

13 Ri= 2; // in M ohm
14 Ri=Ri*10^6; // in ohm
15 Ro= 75; // in ohm
16 fo= 5; // in Hz
17 B= R1/(R1+R_f);
18 AB = A*B;
19 R_outf= Ro/(1+A*B); // in ohm
20 disp(R_outf*10^3,"Output Resistance in m ohm");
21 V_ooT= OutputVoltageSwing/(1+A*B); // in volt
22 disp(V_ooT*10^3,"Output offset voltage in mV");

```

Scilab code Exa 3.5 Voltage gain input resistance

```

1 // Exa 3.5
2 clc;
3 clear;
4 close;
5 //given data
6 R_in= 2; // in M ohm
7 R_in=R_in*10^6; // in ohm
8 R_out=75; // in ohm
9 A=2*10^5;
10 f_o=5; // in Hz
11 // For voltage follower
12 B=1; // since R_f=0
13 A_f=1;
14 disp(A_f,"Voltage gain :");
15 R_inf= A*R_in; // in ohm
16 R_inf=R_inf*10^-9; // in G ohm
17 disp(R_inf,"Input resistance in G ohm");
18 R_outf= R_out/A; // in ohm
19 disp(R_outf,"Output resistance in ohm");
20 f_f= A*f_o; // in Hz
21 disp(f_f*10^-6,"Bandwidth in MHz");

```

Scilab code Exa 3.6 Voltage gain input resistance

```
1 // Exa 3.6
2 clc;
3 clear;
4 close;
5 //given data
6 R1=330; // in ohm
7 R_f=3.3; // in k ohm
8 R_f=R_f*10^3; // in ohm
9 R_in= 2; // in M ohm
10 R_in=R_in*10^6; // in ohm
11 R_out=75; // in ohm
12 A=2*10^5;
13 f_o=5; // in Hz
14 B= R1/(R1+R_f);
15 AB= A*B;
16 A_f = -R_f/R1;
17 disp(A_f,"Voltage gain")
18 R_inf= R1;
19 disp(R_inf,"Input Resistance in ohm")
20 R_outf= R_out/(1+A*B); // in ohm
21 disp(R_outf,"Output Resistance in ohm");
22 f_f= f_o*(1+A*B); // in Hz
23 disp(f_f*10^-3,"Bandwidth in kHz");
```

Scilab code Exa 3.7 Voltage gain input resistance

```
1 // Exa 3.7
2 clc;
3 clear;
4 close;
```

```

5 //given data
6 R_in= 2;// in M ohm
7 R_in=R_in*10^6;// in ohm
8 R_out=75;// in ohm
9 A=2*10^5;
10 f_o=5;// in Hz
11 R1=330;// in ohm (assuming)
12 R_f=R1;
13 B= R1/(R1+R_f);
14 A_f = -1;
15 disp(A_f,"Voltage gain")
16 R_inf= R1;
17 disp(R_inf,"Input Resistance in ohm")
18 R_outf= R_out/(A/2);// in ohm
19 disp(R_outf,"Output Resistance in ohm");
20 f_f= f_o*A/2;// in Hz
21 disp(f_f*10^-6,"Bandwidth in MHz");

```

Scilab code Exa 3.8 Values of Af R1f and Rof

```

1 // Exa 3.9
2 clc;
3 clear;
4 close;
5 //given data
6 R1=5;// in k ohm
7 R1=R1*10^3;// in ohm
8 R_f=500;// in k ohm
9 R_f=R_f*10^3;// in ohm
10 V_in= 0.1;// in volt
11 A_f = -R_f/R1;
12 OutPutResOfopamp=0;// in ohm
13 disp(A_f,"Voltage gain")
14 R_in= R1;// in ohm
15 disp(R_in*10^-3,"Input Resistance in k ohm")

```



```

16 R_out=OutPutResOfopamp; // in ohm
17 disp(R_out,"Output Resistance in ohm");
18 V_out= A_f*V_in; // in volt
19 disp(V_out,"Output voltage in volt");
20 I_in= V_in/R1; // in amp
21 disp(I_in*10^3,"Input Current in mA");

```

Scilab code Exa 3.9 Output voltage and input current

```

1 // Exa 3.9
2 clc;
3 clear;
4 close;
5 //given data
6 R1=5; // in k ohm
7 R1=R1*10^3; // in ohm
8 R_f=500; // in k ohm
9 R_f=R_f*10^3; // in ohm
10 V_in= 0.1; // in volt
11 A_f = -R_f/R1;
12 OutPutResOfopamp=0; // in ohm
13 disp(A_f,"Voltage gain")
14 R_in= R1; // in ohm
15 disp(R_in*10^-3,"Input Resistance in k ohm")
16 R_out=OutPutResOfopamp; // in ohm
17 disp(R_out,"Output Resistance in ohm");
18 V_out= A_f*V_in; // in volt
19 disp(V_out,"Output voltage in volt");
20 I_in= V_in/R1; // in amp
21 disp(I_in*10^3,"Input Current in mA");

```

Scilab code Exa 3.10 Input impedance

```

1 // Exa 3.10
2 clc;
3 clear;
4 close;
5 // (i) Given amplifier is an inverting amplifier ,
   where
6 //  $V_{out} = -R_f/R_{in} * V_{in} = 1\text{Mohm}/1\text{Mohm} * V_{in} = -V_{in}$  ,
   So
7 //  $A_v = V_{out}/V_{in}$ 
8 Av=-1;
9 disp(Av,"Input impedance :");
10 // (ii) Because it is a unity gain inverter , So  $I_{in}$ 
    =  $I_{out}$ 
11 //  $A_{in} = I_{out}/I_{in}$ 
12 A_in = 1;
13 disp(A_in,"Voltage gain :");
14 // (iii) Power gain of op-amp circuit
15 A_p=abs(Av*A_in);
16 disp(A_p,"Power gain :");

```

Scilab code Exa 3.11 Inverting Op amp

```

1 // Exa 3.11
2 clc;
3 clear;
4 close;
5 // Given data
6 Av=-30;
7 disp("Voltage gain ,  $V_o/V_i = -R_f/R_1 = -30$ ");
8 disp("Or  $R_f = 30 * R_1$ ");
9 disp("Obviously  $R_f$  will be larger resistance ,
    being 30 times of  $R_1$  and largest resistance value
    is limited to 1 M ohm, So")
10 R_f=1; // in M ohm
11 disp(R_f,"Value of  $R_f$  in M ohm :");

```

```

12 R_f= R_f*10^6; // in ohm
13 R1=R_f/30; // in ohm
14 disp(R1*10^-3," Value of R1 in k ohm :");

```

Scilab code Exa 3.12 Inverting Op amp

```

1 // Exa 3.12
2 clc;
3 clear;
4 close;
5 // Given data
6 Av=-8; // voltage gain
7 I1=15; // in micro A
8 I1=I1*10^-6; // in amp
9 Vi=-1; // in volt
10 R1=abs(Vi)/I1; // in ohm
11 disp("Resistace R1 is : "+string(R1*10^-3)+" in k
      ohm (Use 68 k ohm standard value)")
12 R1=68; // in k ohm (standard value)
13 R_f= -Av*R1; // in ohm
14 disp("Resistance R_f is : "+string(R_f)+" k ohm (Use
      560 k ohm standard value)")

```

Scilab code Exa 3.15 Gain of amplifier circuit

```

1 // Exa 3.15
2 clc;
3 clear;
4 close;
5 // Given data
6 R_f=20; // in k ohm
7 R1=10; // in k ohm
8

```

```

9 // Part (i) When switch S is off
10 A_off_non_inv= 1+R_f/R1;
11 A_off_inv= -R_f/R1;
12 A_off = A_off_non_inv + A_off_inv;
13 disp(A_off,"Gain of amplifier circuit when switch S
      is off");
14
15 // Part (ii) When switch S is on
16 A_on= -R_f/R1;
17 disp(A_on,"Gain of amplifier circuit when switch S
      is on");

```

Scilab code Exa 3.16 VI Characteristic of the impedance

```

1 // Exa 3.16
2 clear;
3 clc;
4 close;
5 //Part (a) is a derivation not a numerical problem
6 //Part (b) is a plot, and can be plotted with any
      assumed value of R
7 R=5;//in ohm(assumed)
8 V=0:12;//in volt
9 I=-V/R//in Ampere
10 disp("V-I characteristics is shown in figure.")
11 plot(V,I);
12 title("V-I characteristics");
13 xlabel("V(volt)");
14 ylabel("I(Ampere)");

```

Scilab code Exa 3.18 Output voltage

```

1 // Exa 3.18

```

```

2  clc;
3  clear;
4  close;
5  // Given data
6  R_f=10; // in k ohm
7  R1=1; // in k ohm
8  V_d= 5; // in mV
9  v_cm= 2; // in mV
10 A_d= -R_f/R1;
11 Vout= A_d*V_d; // in mV
12 disp(abs(Vout),"Output voltage in mV : ")
13 CMRR_dB= 90; // in dB
14 CMRR= 10^(CMRR_dB/20);
15 A_cm= abs(A_d)/CMRR
16 Mag= A_cm*v_cm; // magnitude of the induced 60 Hz
    noise at the output in mV
17 disp(Mag*10^3," magnitude of the induced 60 Hz noise
    at the output in micro volt :")

```

Scilab code Exa 3.19 Voltage gain

```

1  // Exa 3.19
2  clc;
3  clear;
4  close;
5  // Given data
6  R1=540; // in ohm
7  R3=R1;
8  R_f=5.4; // in k ohm
9  R_f=R_f*10^3; // in ohm
10 R2=R_f; // in ohm
11 v_in1= -2.5; // in volt
12 v_in2= -3.5; // in volt
13 R_in=2; // in M ohm
14 R_in= R_in*10^6; // in ohm

```

```

15 A=2*10^5;
16 A_d= (1+R_f/R1);
17 disp(A_d,"Voltage gain : ");
18 v_out=A_d*(v_in1-v_in2);// in volt
19 disp(v_out,"Output voltage in volt");
20 R_inf1= R_in*(1+A*R1/(R1+R_f));
21 R_inf2= R_in*(1+A*R2/(R2+R3));
22 disp("Internal resistance : "+string(R_inf1)+" ohm
      and "+string(R_inf2)+" ohm ");

```

Scilab code Exa 3.20 Gain of the circuit

```

1 // Exa 3.20
2 clc;
3 clear;
4 close;
5 // Given data
6 v_in= 100;// in mili volt
7 v_in=v_in*10^-3;// in volt
8 v_out= 4.25;// in volt
9 // Taking
10 R1=100;// in ohm
11 // Formula v_out = (1+2*R_f/R1)*v_in
12 R_f= R1/2*(v_out/v_in-1);// in ohm
13 R_f=R_f*10^-3;// in k ohm
14 disp(R_f,"Gain of the circuit in k ohm");
15 disp("Use 2.2 k ohm standard value");

```

Scilab code Exa 3.21 Voltage gain input resistance

```

1 // Exa 3.21
2 clc;
3 clear;

```

```

4 close;
5 // Given data
6 R1=3.3; // in k ohm
7 R1=R1*10^3; // in ohm
8 R2=R1;
9 R_p= 2.5; // in k ohm
10 R_p =R_p*10^3; // in ohm
11 R3=1.2; // in k ohm
12 R3=R3*10^3; // in ohm
13 R4=R3;
14 R_f= 3.9; // in k ohm
15 R_f =R_f*10^3; // in ohm
16 R5=R_f;
17 R_in= 2; // in M ohm
18 R_in= R_in*10^6; // in ohm
19 R_out= 75; // in ohm
20 A=2*10^5;
21 f_o= 5; // in Hz
22 A_d= -1*(1+2*R1/R_p)*R_f/R3;
23 disp(A_d,"Voltage gain ");
24 A_d=abs(A_d);
25 R_inf= R_in*(1+(R1+R_p)/(2*R1+R_p)*A); // in ohm
26 disp(R_inf*10^-9,"Input resistance in G ohm")
27 R_outf= R_out/(1+A/A_d); // in ohm
28 disp(R_outf,"Output voltage in ohm")
29 f_f= A*f_o/A_d; // in Hz
30 disp(f_f*10^-3,"Bandwidth in kHz");

```

Chapter 4

Frequency Response Of An Op Amp

Scilab code Exa 4.1 Inverting amplifier

```
1 // Exa 4.1
2 clc;
3 clear;
4 close;
5 // Given data
6 Vin= 0.5; // in V
7 Av= 10;
8 I_B_max= 1.5; // in micro amp
9 I_B_max=I_B_max*10^-6; // in A
10 // Let
11 I1=100*I_B_max; // in A
12 R1= Vin/I1; // in ohm
13 Rf= Av*R1; // in ohm
14 // R2= R1 || Rf = R1 (approx.)
15 R2= R1; // in ohm
16 disp(I1*10^6, "Value of I1 in micro amp");
17 disp(R1*10^-3, "Value of R1 in kohm");
18 disp(R2*10^-3, "Value of R2 in kohm");
19 disp(Rf*10^-3, "Value of Rf in kohm");
```

Scilab code Exa 4.2 Inverting amplifier

```
1 // Exa 4.2
2 clc;
3 clear;
4 close;
5 // Given data
6 Vin= 50;// in mV
7 Vin = Vin*10^-3;// in V
8 I_B_max= 200;// in nA
9 I_B_max=I_B_max*10^-9;// in A
10 I1=100*I_B_max;// in A(assumed)
11 Av=100;
12 R1= Vin/I1;// in
13 disp(R1*10^-3,"The value of R1 in k is : ")
14 disp("Standard value of R1 in k is ")
15 disp("2.2")
16 R1= 2.2;// kohm (standard value)
17 Rf= Av*R1;// in kohm
18 disp(Rf,"The value of Rf in k is : ")
19 // R2 = R1 || Rf = R1 (approx)
20 R2= R1;// in kohm
21 disp(R2,"The value of R2 in k is : ")
22 Av= 20*log10(Av);// in dB
23 C1= 100;// in pF
24 R1= 1.5;// in k
25 C2= 3;// in pF
26 disp(Av,"Voltage gain in dB is : ");
27 disp(C1,"Value of C1 in pF is : ");
28 disp(C2,"Value of C2 in pF is : ");
29 disp(R1,"Value of R1 in k is : ")
```

Scilab code Exa 4.3 Cut off frequency

```
1 // Exa 4.3
2 clc;
3 clear;
4 close;
5 // Given data
6 A_VD= 200; // in V/mV
7 A_VD=A_VD*10^3; // in V/V
8 B1=1; // in MHz
9 B1=B1*10^6; // in Hz
10 f1=B1;
11 f0= f1/A_VD; // in Hz
12 disp(f0,"Cut-off frequency in Hz")
```

Scilab code Exa 4.4 Full power bandwidth

```
1 // Exa 4.4
2 clc;
3 clear;
4 close;
5 // Given data
6 Vin= 15; // in volt
7 SR= 0.8; // in V/micro sec
8 SR=SR*10^6; // in V/sec
9 omega= SR/Vin;
10 f= omega/(2*%pi); // in Hz
11 disp(f*10^-3,"Full power bandwidth in kHz")
12 disp(f*10^-3,"It means that a 741 op-amp with a
    sinusoidal output of 15 V amplitude will begin to
    show slew limiting distortion if the frequency
    exceeds (in KHz)")
```

Scilab code Exa 4.5 Maximum closed loop voltage gain

```
1 // Exa 4.5
2 clc;
3 clear;
4 close;
5 // Given data
6 SR= 2;// in V/micro sec
7 del_v_in= 0.5;// in volt
8 del_t=10;//in micro sec
9 del_v_inBYdel_t= del_v_in/del_t;// in V/micro sec
10 // v_out= A_CL*v_in
11 A_CL= SR/del_v_inBYdel_t;
12 disp(A_CL,"Closed-loop gain ")
13 disp(A_CL,"Any closed loop voltage gain of magnitude
    exceeding 40 would drive the output at a rate
    greater than the SR allows , so the maximum closed
    loop gain is")
```

Scilab code Exa 4.6 741 op amp

```
1 // Exa 4.6
2 clc;
3 clear;
4 close;
5 // Given data
6 V_PP= 3;// in volt
7 del_t= 4;// in micro sec
8 // del_V= 90% of V_PP - 10% of V_PP = 0.8*V_PP
9 del_V= 0.8*V_PP;
10 SR_required= del_V/del_t;// in V/micro sec
11 disp("The required op-amp must have an SR equal or
    more than "+string(SR_required)+" V/micro sec");
12
13 // (i)
```

```

14 disp("The 741 op-amp has an SR of 0.5 V/micro sec .
    It is too slow and cannot be used");
15
16 // (ii)
17 SR= 50; // in V/micro sec
18 SR= SR*10^6; // in V/sec
19 del_t= del_V/SR; // in sec
20 del_t= del_t*10^9; // in ns
21 disp(del_t,"The 318 op-amp has an SR of 50 V/micro
    sec. It is fast enough and can be used. The rese
    time using a 318 op-amp will be (in ns)")

```

Scilab code Exa 4.7 A 741 or 318 be used

```

1 // Exa 4.7
2 clc;
3 clear;
4 close;
5 // Given data
6 Vout= 6 ; // times Vrms
7 Vin= 20*10^-3; // times Vrms
8 f_max= 15; // in kHz
9 f_max=f_max*10^3; // in Hz
10 A_CL= Vout/Vin; // at 15 kHz
11 V_out_peak= 6*1.414;
12 // Formula f_max= SRmax/(2*%pi*V_out_peak)
13 SRmax= f_max*2*%pi*V_out_peak*10^-6; // in V/ s
14 disp("(i) The 741 has an SR of 0.5 V/ s . It is too
    slow and would distort the sine wave output")
15 disp("(ii) The 318 has an SR of 50 V/ s . It is fast
    enough to develop 6 Vrms sine wave output at 15
    kHz")
16 flpercent= f_max; // in Hz
17 // flpercent= fH/7= GBW/A_CL/7= GBW/(7*A_CL)
18 GBW= 7*A_CL*flpercent; // in Hz

```

```
19 GBW= GBW*10^-6; // in MHz
20 disp(GBW,"Gain bandwidth in MHz ")
21 disp("The GBW for 318 op-amp is only 15 MHz. So even
      though the 318 op-amp satisfies the SR
      requirement");
22 disp(" but it does not have a large enough gain
      bandwidth to provide a gain of 300 ( 1% ) at 15
      kHz")
23 GBW10= 7*10*f_max; // Gain of 10 in Hz
24 GBW30= 7*30*f_max; // Gain of 30 in Hz
25 disp(GBW10*10^-6,"Gain of 10 in MHz");
26 disp(GBW30*10^-6,"Gain of 30 in MHz");
27 disp("The 318 op-amp has a large enough gain
      bandwidth to operate both amplifiers.")
```

Chapter 5

General Applications Of Op Amp

Scilab code Exa 5.1 All component used in a circuit

```
1 // Exa 5.1
2 clc;
3 clear;
4 close;
5 // Given data
6 fo= 15;// in kHz
7 fo= fo*10^3;// in Hz
8 C=0.01;// in micro F
9 C=C*10^-6;// in F
10 L= 1/(4*%pi^2*fo^2*C);// in H
11 L=ceil(L*10^3);// in mH
12 // Let L be of 12 mH and internal resistance 30 ohm
13 R=30;// internal resistance in ohm
14 XL= 2*%pi*L*10^-3*fo;
15 Q= XL/R;
16 R_P= Q^2*R;// in ohm
17 // If
18 R1=100;// in ohm
19 // Formula L= R_f*R_P/(R1*(R_f+R_P));
```

```

20 R_f= R1*L*R_P/(R_P-R1*L); // in ohm
21 R_f=R_f*10^3; // in kohm
22 R_f= 1.2; // in k ohm (Standard value)
23 disp("The values of component chosen are:-");
24 disp(L," Value of L in mH")
25 disp(C*10^6," Value of C in micro F")
26 disp(R_f," Value of L in k ohm")
27 disp(R1," Value of L in ohm")

```

Scilab code Exa 5.2 Output voltage

```

1 // Exa 5.2
2 clc;
3 clear;
4 close;
5 // Given data
6 Rf= 12; // in k ohm
7 Rs1= 12; // in k ohm
8 Rs2= 2; // in k ohm
9 Rs3= 3; // in k ohm
10 Vi1= 9; // in volt
11 Vi2= -3; // in volt
12 Vi3= -1; // in volt
13 Vout= -Rf*[Vi1/Rs1+Vi2/Rs2+Vi3/Rs3]; // in volt
14 disp(Vout,"Output voltage in volt");

```

Scilab code Exa 5.3 Realize a circuit

```

1 // Exa 5.3
2 clc;
3 clear;
4 close;
5 // Given expression Vout= -2*V1+3*V2+4*V3

```

```

6 // For an operational amplifier
7 // Vout= -Rf*[V1/R1+V2/R2+V3/R3]
8 // Compare the above expression with the given
   expression for the output
9 r_1=2;// value of Rf/R1
10 r_2=3;// value of Rf/R2
11 r_3=4;// value of Rf/R3
12 // Resistance R3 will be minimum value of 10 k ohm
13 R3=10;// in k ohm
14 Rf= r_3*R3;// in k ohm
15 R2= Rf/r_2;// in k ohm
16 R1= Rf/r_1;// in k ohm
17 disp(Rf," Value of Rf in k ohm");
18 disp(R2," Value of R2 in k ohm");
19 disp(R1," Value of R1 in k ohm");

```

Scilab code Exa 5.4 Output voltage

```

1 // Exa 5.4
2 clc;
3 clear;
4 close;
5 // Given data
6 V1= 2;// in volt
7 V2= -1;// in volt
8 // Let R1= (R||R)/(R+(R||R))= (R/2)/(R+R/2) = 1/3
9 R1=1/3;
10 Vs1= V1*R1;// in volt
11 // Let R2= (1+Rf/R)= (1+2*R/R)= 3
12 R2= 3;
13 Vo_desh= Vs1*R2;// in volt
14 Vs2= V2*R1;// in volt
15 Vo_doubleDesh= Vs2*R2;// in volt
16 V_out= Vo_desh+Vo_doubleDesh;// in volt
17 disp(V_out," Output voltage in volt")

```

Scilab code Exa 5.5 Differential Amplifier

```
1 // Exa 5.5
2 clc;
3 clear;
4 close;
5 // Given expression  $V_{out} = 10 \cdot (V_2 - V_1)$ 
6 // For a differential amplifier circuit
7 //  $V_{out} = R_f/R \cdot (V_2 - V_1)$ 
8 // Compare the above expression with the given
   expression for the output, we have
9 RfbyR= 10;
10 R=10; // minimum value of resistance to be used in
   kohm
11 Rf= RfbyR * R; // in k ohm
12 disp(Rf, "Value of Rf in k ohm");
```

Scilab code Exa 5.6 Output voltage

```
1 // Exa 5.6
2 clc;
3 clear;
4 close;
5 // Given data
6 R= 10; // in k ohm
7 Rp= 1; // in k ohm
8 // Let  $R_1 = (1 + 2 \cdot R/R_p)$ 
9  $R_1 = (1 + 2 \cdot R/R_p)$ ;
10 // output voltage,  $V_5 = R_1 \cdot (V_2 - V_1)$ 
11 disp("Output voltage in volt is : "+string(R1)+"*(V2
   -V1)");
```

Scilab code Exa 5.7 Instrumentation variable differential gain

```
1 // Exa 5.7
2 clc;
3 clear;
4 close;
5 // Given data
6 R1= 50;// in kohm
7 // Let us choose
8 R3= 15;// in k ohm
9 R4= R3;
10 // Ad= 1+2*R2/R1 (i)
11 // Ad= ((1+2*R2/R1)*(V2-V1))/(V2-V1)= 1+2*R2/R1
12 // For minimum differential voltage gain
13 Ad_min=5;
14 Ad= Ad_min;
15 R1_max= R1;// since Ad will be minimum only when R1
    // will be maximum
16 // Putting values of Ad and R1 in eq(i)
17 R2= (Ad-1)*R1/2;// in k ohm
18 // For maximum differential voltage gain
19 Ad_max=200;
20 Ad= Ad_min;
21 // Putting values of Ad and R2 in eq(i)
22 R1= 2*R2/(Ad-1);// in k ohm
23 R1=floor(R1);
24 // For maximum value of Ad, R1 will have minimum
    // value , therefore
25 R1_min= 1;// in kohm
26 disp("Value of R1_min is : "+string(R1_min)+" k ohm"
    );
27 disp("Value of R1 is : "+string(R1)+"-50 k ohm")
    ;
28 disp("Value of R2 is : "+string(R2)+" k ohm");
```

```
29 disp(" Value of R3 is      : "+string(R3)+" k ohm");
30 disp(" Value of R4 is      : "+string(R4)+" k ohm");
```

Scilab code Exa 5.9 Output voltage

```
1 // Exa 5.9
2 clc;
3 clear;
4 close;
5 // Given data
6 R=50; // in k ohm
7 R=R*10^3; // in ohm
8 C=2; // in micro F
9 C=C*10^-6; // in F
10 f=2; // in kHz
11 f=f*10^3; // in Hz
12 Vrms= 10; // in mV
13 RC= R*C;
14 // v_out= -1/(RC)*integrate('sqrt(2)*10*sind(4000*
    %pi*t)', 't', 0, t)= 0.0113*(cosd(4000*t)-1) in mV
15 disp(" Output voltage in mV is : 0.0113*(cosd(4000*t)
    -1)")
```

Scilab code Exa 5.10 Capacitor voltage

```
1 // Exa 5.10
2 clc;
3 clear;
4 close;
5 // Given data
6 Vin= 10; // in volt
7 R=2.2; // in k ohm
8 R=R*10^3; //in ohm
```

```

 9 Ad=10^5; // voltage gain
10 T= 1; // in ms
11 T=T*10^-3; // in second
12 C=1; // in micro F
13 C=C*10^-6; // in F
14 I= Vin/R; // in volt
15 V= I*T/C; // in V
16 disp(V,"The output voltage at the end of the pulse
    in volt");
17 RC_desh= R*C*Ad;
18 disp(RC_desh,"The closed-loop time constant in
    second is");

```

Scilab code Exa 5.11 R1 and Rf

```

1 // Exa 5.11
2 clc;
3 clear;
4 close;
5 // Given data
6 C=0.01; // in micro F
7 C=C*10^-6; // in F
8 omega= 10000; // in rad/second
9 //  $V_{out}/V_1 = (R_f/R_1)/(1+s*C*R_f)$ 
10 // substituting  $s = j*\omega$  we have
11 //  $V_{out}/V_1 = (R_f/R_1)/\sqrt{(\omega*C*R_f)^2+1}$ 
12 // At  $\omega=0$ 
13 //  $V_{out}/V_1 = R_f/R_1$ 
14 // Formula  $\omega = 1/(C*R_f)$ 
15 Rf= 1/(C*omega); // in ohm
16 Rf= Rf*10^-3; // in k ohm
17 //  $20*\log_{10}(R_f/R_1) = 20$ 
18 R1= Rf/10; // in k ohm
19 disp(Rf,"Value of Rf in k ohm");
20 disp(R1,"Value of R1 in k ohm");

```

Scilab code Exa 5.12 Output voltage

```
1 // Exa 5.12
2 clear;
3 clc;
4 close;
5 //Given Data :
6 R=40*1000; //in ohm(assumed)
7 C=0.2*10^-6; //IN FARAD
8 Vout=3; //in Volt
9 V1=Vout; //in Volt
10 V2=Vout; //in Volt
11 t1=0.0001:50; //in msec
12 t1=t1*10^-3; //in sec
13 vout=-1/R/C*integrate('2','t',0,t1)+Vout;
14 t1=0.0001:50; //in msec
15 plot(t1,vout);
16 title("Output Voltage");
17 xlabel("Time in MilliSecond");
18 ylabel("Output Voltage in Volts");
19 disp("Assuming Ideal op-amp, sketch for Vout is
      shown in figure.");
```

Scilab code Exa 5.13 Output voltage

```
1 // Exa 5.13
2 clc;
3 clear;
4 close;
5 // Given data
6 R=50; // in k ohm
```

```

7 R=R*10^3; // in ohm
8 C=2; // in micro F
9 C=C*10^-6; // in F
10 f=2; // in kHz
11 f=f*10^3; // in Hz
12 Vmax= 10; // in micro volt
13 CR= C*R;
14 v_in= 'Vmax*sind(2*%pi*f*t)';
15 v_in= '10*sind(4000*%pi*t)'; // in micro volt
16 // v_out= -CR*diff(v_in) = -0.1*10*diff(sind(4000*
    %pi*t)) // in micro volt
17 disp("Output Voltage")
18 disp(" 12.56 cos(4000*pi*t)")

```

Scilab code Exa 5.14 Differentiator to defferentiate an input signal

```

1 // Exa 5.14
2 clc;
3 clear;
4 close;
5 // Given data
6 fa= 1; // in kHz
7 fa=fa*10^3; // in Hz
8 Vp=1.5; // in volt
9 f= 200; // in Hz
10 C=0.1; // in micro F
11 C=C*10^-6; // in F
12 R= 1/(2*%pi*fa*C); // in ohm
13 R=R*10^-3; // in k ohm
14 R=floor(R*10)/10; // in k ohm
15 fb= 20*fa; // in Hz
16 R_desh= 1/(2*%pi*fb*C); // in ohm
17 // Let
18 R_desh= 82; // in ohm
19 R_OM= R; // in k ohm

```

```

20 disp(R_OM," Value of R_OM in k ohm")
21 CR= C*R;
22 // Vin= Vp*sin(omega*t)= 1.5*sin(400*t)
23 // v_out= -CR*diff(v_in) = -0.2827 Cos(400*%pi*t)//
    in micro volt
24 disp(" Output Voltage")
25 disp(" -0.2827 Cos(400*%pi*t)");
26 t=-1/800:0.00001:1/200; //
27 v_out=-0.2827*cos(400*%pi*t)// in micro volt
28 plot(t,v_out);
29 title(" Output Voltage Waveform");
30 xlabel("Time in ms");
31 ylabel("Vout in Volts");
32 disp(" Output Voltage waveform is shown in figure.")

```

Scilab code Exa 5.15 Differentiator to defferentiate an input signal

```

1 // Exa 5.15
2 clc;
3 clear;
4 close;
5 // Given data
6 fa= 1;// in kHz
7 fa=fa*10^3;// in Hz
8 Vp=1.5;// in volt
9 C=0.1;// in micro F
10 C=C*10^-6;// in F
11 // Part (a)
12 R= 1/(2*%pi*fa*C);// in ohm
13 R=R*10^-3;// in k ohm
14 R=floor(R*10)/10;// in k ohm
15 fb= 20*fa;// in Hz
16 R_desh= 1/(2*%pi*fb*C);// in ohm
17 // Let
18 R_desh= 82;// in ohm

```

```
19 R_OM= R; // in k ohm
20 disp(R_OM,"Value of R_OM in k ohm")
21
22 // Part(b)
23 // given data
24 Vp=1.5; // in volt
25 f= 200; // in Hz
26 // v_in= Vp*sin(omega*t) = sin(2*%pi*f*t) = sin
    (2000*omega*t)
27 // v_out= -CR*diff(v_in) = -0.942 Cos(2000*%pi*t) //
    in micro volt
28 disp("Output Voltage")
29 disp("-0.942 Cos(2000*%pi*t)")
```

Chapter 6

Active Filters

Scilab code Exa 6.1 Low pass filter

```
1 // Exa 6.1
2 clc;
3 clear;
4 close;
5 // Given Data
6 f_H= 2;// in kHz
7 f_H= f_H*10^3;// in Hz
8 C=0.01;// in micro F
9 C=C*10^-6;// in F
10 R= 1/(2*%pi*f_H*C);// in ohm
11 R=R*10^-3;// in kohm
12 // R may be taken a pot of 10 k ohm
13 R=10;// in k ohm
14 // Since the passband gain is 2.5, so
15 //  $1+R_f/R_1= 2.5$  or  $R_f= 1.5*R_1$ 
16 // Since  $R_f||R_1$ 
17 R1= R*2.5/1.5;// in k ohm
18 Rf= R1*1.5;// in k ohm
19 disp("Value of R1 is : "+string(R1)+" k ohm")
20 disp("Value of Rf is : "+string(Rf)+" k ohm")
```

Scilab code Exa 6.2 Second order low pass filter

```
1 // Exa 6.2
2 clc;
3 clear;
4 close;
5 // Given Data
6 f_H= 2; // in kHz
7 f_H= f_H*10^3; // in Hz
8 C=0.033; // in micor F
9 C=C*10^-6; // in F
10 C_desh= C;
11 R= 1/(2*%pi*f_H*C); // in ohm
12 R=R*10^-3; // in kohm
13 R=2.7; // k ohm (Standard value)
14 R_desh= R;
15 // So  $2*R = R_f*R_1/(R_f+R_1) = 0.586*R_1^2/(1.586*R_1)$ 
16 R1= 2*R*1.586/(0.586); // in k ohm
17 R1= 15; // k ohm (Standard value)
18 Rf= 0.586*R1; // in k ohm
19 Rf= 10; // k ohm (Standard value)
20 disp("Rf may be taken as a pot of : "+string(Rf)+" k
      ohm")
```

Scilab code Exa 6.3 Second order low pass filter

```
1 // Exa 6.3
2 clc;
3 clear;
4 close;
5 // Given Data
6 f_H= 1; // in kHz
```

```

7 f_H= f_H*10^3; // in Hz
8 C=0.0047; // in micro F
9 C=C*10^-6; // in F
10 C_desh= C;
11 R= 1/(2*%pi*f_H*C); // in ohm
12 R=R*10^-3; // in kohm
13 R=floor(R);
14 R_desh= R;
15 R1=R ; // in k ohm
16 Rf= 0.586*R1; // in k ohm
17 Rf= ceil(Rf); // in k ohm
18 disp(R," Value of R in k ohm");
19 disp(C*10^6," Value of R in micro F");
20 disp(R1," Value of R1 in k ohm");
21 disp(Rf," Value of Rf in k ohm");

```

Scilab code Exa 6.4 Required value of R1 R2 and C

```

1 // Exa 6.4
2 clc;
3 clear;
4 close;
5 // Given Data
6 f= 1; // in kHz
7 f= f*10^3; // in Hz
8 // Vout/Vin= 10
9 R1= 100; // in k ohm
10 R1=R1*10^3; // in ohm
11 R2= 1000; // in k ohm
12 R2=R2*10^3; // in ohm
13 omega= 2*%pi*f;
14 // Vout/Vin at a 3 dB frequency of 1 kHz = 1/sqrt(2)
    = omega*R2*C/sqrt(1+omega^2*R1^2*C2)
15 C= sqrt(1/(omega^2*(2*R2^2-R1^2))); // in F
16 disp(R1*10^-3," Value of R1 in k ohm");

```

```
17 disp(R2*10^-6," Value of R2 in k ohm");
18 disp(C," Value of C in k ohm");
```

Scilab code Exa 6.5 Cut off frequency

```
1 // Exa 6.5
2 clc;
3 clear;
4 close;
5 // Given Data
6 R= 2.1;// in k ohm
7 R=R*10^3;// in ohm
8 R1= 20;// in k ohm
9 R1=R1*10^3;// in ohm
10 Rf= 60;// in k ohm
11 Rf=Rf*10^3;// in ohm
12 C=0.05;// in micro F
13 C=C*10^-6;// in F
14 fL= 1/(2*pi*R*C);// in Hz
15 disp(fL*10^-3,"Low cut-off frequency in kHz")
```

Scilab code Exa 6.6 Cut off frequency and a bandwidth

```
1 // Exa 6.6
2 clc;
3 clear;
4 close;
5 // Given Data
6 R= 10;// in k ohm
7 R=R*10^3;// in ohm
8 R_desh= R;// in ohm
9 C=0.1;// in micro F
10 C=C*10^-6;// in F
```

```

11 C_desh=0.0025; // in micro F
12 C_desh=C_desh*10^-6; // in F
13 fH= 1/(2*pi*R_desh*C_desh); // in Hz
14 disp(fH*10^-3,"Higher cut-off frequency in kHz")
15 fL= 1/(2*pi*R*C); // in Hz
16 disp(fL,"Lower cut-off frequency in Hz")
17 BW= fH-fL;
18 disp(BW*10^-3,"Bandwidth in kHz")

```

Scilab code Exa 6.7 Narrow bandpass filter

```

1 // Exa 6.7
2 clc;
3 clear;
4 close;
5 // Given Data
6 fc= 1; // in kHz
7 fc=fc*10^3; // in Hz
8 Q=5;
9 Af=8;
10 // Let C=C1=C2=0.01 // in micro F
11 C1= 0.01; // in micro F
12 C1=C1*10^-6; // in F
13 C2=C1; // in F
14 C=C2; // in F
15 R1= Q/(2*pi*fc*C*Af); // in ohm
16 R1=R1*10^-3; // in kohm
17 R1=ceil(R1);
18 R2= Q/(2*pi*fc*C*(2*Q^2-Af)); // in ohm
19 R2=R2*10^-3; // in kohm
20 R2=ceil(R2);
21 R3= Q/(%pi*fc*C); // in ohm
22 R3=R3*10^-3; // in kohm
23 R3=ceil(R3);
24 // The value of R2_desh required to change the

```

```

    centre frequency from 1 kHz to 2 kHz is
25 f_desh_c= 2000; // in Hz
26 R2_desh= R2*(fc/f_desh_c)^2; // in kohm
27 disp(R1," Value of R1 in kohm");
28 disp(R2," Value of R2 in kohm");
29 disp(R3," Value of R3 in kohm");
30 disp(R2_desh," Value of R2_desh in kohm");

```

Scilab code Exa 6.8 Centre frequency gain and Q of a filter

```

1 // Exa 6.8
2 clc;
3 clear;
4 close;
5 // Given Data
6 C= 0.1; // in micro F
7 C=C*10^-6; // in F
8 R1= 2; // in kohm
9 R1=R1*10^3; // in ohm
10 R2= 2/3; // in kohm
11 R2=R2*10^3; // in ohm
12 R3= 200; // in kohm
13 R3=R3*10^3; // in ohm
14 // R1= Q/(2*%pi*fc*C*Af) (i)
15 // R2= Q/(2*%pi*fc*C*(2*Q^2-Af)) (ii)
16 // R3= Q/(%pi*fc*C) (iii)
17 // From (i) and (iii)
18 Af= R3/(2*R1);
19 // From (ii) and (iii)
20 Q= sqrt(1/2*(R3/(2*R2)+Af));
21 // From (iii)
22 fc= Q/(R3*%pi*C); // in Hz
23 omega_o= 2*%pi*fc; // in radians/second
24 disp(Af," Gain");
25 disp(Q," Value of Q");

```

```
26 disp(omega_o,"Centre frequency in radians/second")
```

Scilab code Exa 6.9 Bandpass filter

```
1 // Exa 6.9
2 clc;
3 clear;
4 close;
5 // Given Data
6 fL= 200; // in Hz
7 fH= 1; // in kHz
8 fH=fH*10^3; // in Hz
9 //Let the capacitor C_desh be of 0.01 micro F
10 C_desh= 0.01*10^-6; // in F
11 R_desh= 1/(2*%pi*fH*C_desh); // in ohm
12 R_desh=R_desh*10^-3; // in kohm
13 R_desh= 18; // in kohm
14 // Let
15 C=0.05*10^-6; // in F
16 R= 1/(2*%pi*fL*C); // in ohm
17 R=R*10^-3; // in kohm
18 R= 18; // in k ohm
19 Rf= 10; // in kohm
20 disp(Rf,"Value of Rf, Rf_desh, R1 and R1_desh in
    kohm");
21 disp(R,"Value of R and R_desh in kohm");
22 disp(C_desh*10^6,"Value of C_desh in micro F")
23 disp(C*10^6,"Value of C in micro F")
```

Scilab code Exa 6.11 Value of Q for the filter

```
1 // Exa 6.11
2 clc;
```

```

3 clear;
4 close;
5 // Given Data
6 fL= 200; // in Hz
7 fH= 1; // in kHz
8 fH=fH*10^3; // in Hz
9 fc= sqrt(fL*fH); // in Hz
10 Q= fc/(fH-fL);
11 disp(Q,"The value of Q for filter")

```

Scilab code Exa 6.12 Wide band filter

```

1 // Exa 6.12
2 clc;
3 clear;
4 close;
5 // Given Data
6 format('v',5)
7 fH= 200; // in Hz
8 fL= 2; // in kHz
9 fL=fL*10^3; // in Hz
10 C= 0.05; // in micro F
11 C=C*10^-6; // in F
12 R_desh= 1/(2*%pi*fH*C); // in ohm
13 R_desh=R_desh*10^-3; // in kohm
14 R= 1/(2*%pi*fL*C); // in ohm
15 R=R*10^-3; // in kohm
16 disp(R_desh,"Value of R_desh in kohm");
17 disp("Or 18 kohm (Standard value)")
18 disp(R,"Value of R in kohm");
19 disp("Or 1.8 kohm (Standard value)")

```

Scilab code Exa 6.13 Active notch filter


```

1 // Exa 6.13
2 clc;
3 clear;
4 close;
5 // Given Data
6 format('v',7)
7 fN= 50; // in Hz
8 C= 0.068; // in micro F
9 C=C*10^-6; // in F
10 R= 1/(2*%pi*fN*C); // in ohm
11 R=R*10^-3; // in kohm
12 R=ceil(R)
13 disp(R,"Value of R in kohm");
14 disp("For R/2, two "+string(R)+" kohm resistors
      connected in parallel may be used and for 2C
      component, two parallel connected 0.068 micro F
      capacitors may be used")

```

Scilab code Exa 6.14 Active notch filter

```

1 // Exa 6.14
2 clc;
3 clear;
4 close;
5 // Given Data
6 format('v',7)
7 fN= 60; // in Hz
8 // Let
9 C= 0.06; // in micro F
10 C=C*10^-6; // in F
11 R= 1/(2*%pi*fN*C); // in ohm
12 R=R*10^-3; // in kohm
13 disp(R,"Value of R in kohm");
14 disp("Or 47 kohm (Standard value)")
15 disp("For R/2, two 47 kohm resistors connected in

```

parallel may be used and for 2C component, two parallel connected 0.06 micro F capacitors may be used”)

Scilab code Exa 6.15 Phase shift

```
1 // Exa 6.15
2 clc;
3 clear;
4 close;
5 // Given Data
6 format('v',7)
7 f= 2; // in kHz
8 f=f*10^3; // in Hz
9 C= 0.01; // in micro F
10 C=C*10^-6; // in F
11 R= 15; // in kohm
12 R=R*10^3; // in ohm
13 fie= -2*atand(2*%pi*f*R*C);
14 fie= ceil(fie);
15 disp(fie,"Phase shift in ");
16 disp("i.e. "+string(abs(fie))+ " (lagging)")
```

Chapter 7

Oscillators Sinusoidal As Well As Non Sinusoidal

Scilab code Exa 7.1 Phase shift oscillator

```
1 // Exa 7.1
2 clc;
3 clear;
4 close;
5 //given data
6 f=200;// in Hz
7 // Let us take
8 C=0.1;// in micro F
9 C=C*10^-6;// in F
10 R=1/(2*%pi*f*C*sqrt(6));// in ohm
11 R=R*10^-3;// in k ohm
12 // R1>=10*R, Let
13 R1=10*R;// in kohm
14 R_f= 29*R1;// in k ohm
15 R_f=R_f*10^-3; // in M ohm
16 R_f=ceil(R_f);
17 disp(R_f,"Resistor of phase-shift oscillator in Mohm
    ")
```

Scilab code Exa 7.2 Phase shift oscillator

```
1 // Exa 7.2
2 clc;
3 clear;
4 close;
5 //given data
6 f=1; // in kHz
7 f=f*10^3; // in Hz
8 V_CC= 10; // in volt
9 I_B_max= 500; // in nA (for 741 IC op-amp)
10 I_B_max= I_B_max*10^-9; // in A
11 I1= 100*I_B_max; // in A
12 V_out= (V_CC-1); // in volt
13 V_in= V_out/29;
14 R1= V_in/I1; // in ohm
15 R1=R1*10^-3; //in k ohm
16 // 5.6 k ohm resistor may be used for R1, being
    standard value resistor
17 R1=5.6; // in k ohm (standard value)
18 A=29;
19 R_f= A*R1;
20 // 180 k ohm resistor may be used to provide A > 29
21 R_f=180; // in k ohm (standard value)
22 R_comp= R_f;
23 R=R1; // in k ohm
24 R=R*10^3; // in ohm
25 C=1/(2*pi*f*R*sqrt(6)); // in F
26 C=C*10^6; // in micro F
27 disp(R_comp, "Value of R_comp and R_f in kohm");
28 disp(R*10^-3, "Value of R and R1 in kohm");
29 disp(C, "Used capacitor in micro F")
```

Scilab code Exa 7.3 Wien bridge oscillator

```
1 // Exa 7.3
2 clc;
3 clear;
4 close;
5 //given data
6 f=10; // in kHz
7 f=f*10^3; // in Hz
8 I_Bmax= 500; // in nA
9 I_Bmax= I_Bmax*10^-9; // in amphere
10 // Let current through resistor R1 be equal to 100
    times I_Bmax, so
11 I_1= 100*I_Bmax; // in amp
12 Vcc= 10; // in volt
13 Vout= Vcc-1; // in volt
14 Addition_RfR1= Vout/(500*10^-6); // value of Rf+R1 in
    ohm
15 Addition_RfR1=Addition_RfR1*10^-3; // in kohm
16 // Rf= 2*R1, So
17 R1= Addition_RfR1/3; // (used 5.6 kohm Standard value
    resistor)
18 R1= 5.6; // in kohm
19 Rf= 2*R1; // in kohm// (used 12 kohm standard value
    resistor)
20 Rf=ceil(Rf);
21 R=R1; // in kohm
22 C= 1/(2*%pi*f*R); // in F (Used 2700pF standard value
    )
23 C=2700; // in pF
24 disp(R1," Value of R1 in kohm")
25 disp(Rf," Value of Rf in kohm")
26 disp(R," Value of R in kohm")
27 disp(C," Value of C in pF")
```

Scilab code Exa 7.4 Frequency of oscillator

```
1 // Exa 7.4
2 clc;
3 clear;
4 close;
5 //given data
6 R= 1;// in kohm
7 R=R*10^3;// in ohm
8 C= 4.7;// in micro F
9 C=C*10^-6;// in F
10 omega=1/(R*C);// in radians/second
11 f=omega/(2*%pi);// in Hz
12 disp(f,"Frequency of the oscillation of the circuit
      in Hz")
```

Scilab code Exa 7.6 Transfer function

```
1 // Exa 7.6
2 clc;
3 clear;
4 close;
5 //given data
6 R= 10;// in kohm
7 R=R*10^3;// in ohm
8 C= 100;// in pF
9 C=C*10^-12;// in F
10 f=1/(2*%pi*R*C);// in Hz
11 disp(f*10^-3,"Frequency of the oscillation of the
      circuit in kHz")
```

Scilab code Exa 7.7 Quadrature oscillator

```
1 // Exa 7.7
2 clc;
3 clear;
4 close;
5 //given data
6 fo= 318;// in Hz
7 C= 0.015;// in microF
8 C=C*10^-6;// in F
9 R=0.159/(fo*C);// in ohm
10 R=R*10^-3;// in kohm
11 R=floor(R);
12 disp(C*10^6,"Value of C1, C2 and C3 in micro F");
13 disp(R,"Value of R1, R2 and R3 in kohm")
```

Scilab code Exa 7.8 Quadrature oscillator

```
1 // Exa 7.8
2 clc;
3 clear;
4 close;
5 //given data
6 fo= 1.5;// in kHz
7 fo=fo*10^3;// in Hz
8
9 C= 0.01;// in microF
10 C=C*10^-6;// in F
11 R=0.159/(fo*C);// in ohm
12 R=R*10^-3;// in kohm
13 R=floor(R);
14 disp(C*10^6,"Value of C1, C2 and C3 in micro F");
```

```
15 disp(R," Value of R1, R2 and R3 in kohm")
```

Scilab code Exa 7.9 Signal frequency

```
1 // Exa 7.9
2 clc;
3 clear;
4 close;
5 //given data
6 C= 0.1;// in microF
7 C=C*10^-6;// in F
8 R=12;// in kohm
9 R=R*10^3;// in ohm
10 R1=120;// in kohm
11 R1=R1*10^3;// in ohm
12 Rf=1;// in Mohm
13 Rf=Rf*10^6;// in ohm
14 V_sat= 10;// in volt
15 // Part(i)
16 f=Rf/(4*R1*R*C);//in Hz
17 disp(f*10^-3," Signal Frequency in kHz")
18
19 // Part(ii)
20 Vp_p= 2*R1*V_sat/Rf;// in Vp-p
21 disp(Vp_p," Amplitude of the triangular wave in Vp-p"
    )
22
23 // Part(iii)
24 Vp_p= (V_sat)-(-V_sat);
25 disp(Vp_p," Amplitude of the square wave in Vp-p")
```

Scilab code Exa 7.11 Peak to peak amplitude of triangular wave


```

1 // Exa 7.11
2 clc;
3 clear;
4 close;
5 //given data
6 C1= 0.01;// in microF
7 C1=C1*10^-6;// in F
8 R1=120;// in kohm
9 R1=R1*10^3;// in ohm
10 R2=1.2;// in kohm
11 R2=R2*10^3;// in ohm
12 R3=6.8;// in kohm
13 R3=R3*10^3;// in ohm
14 V_sat= 15;// in volt
15 // Part(a)
16 Vp_p= 2*(R2/R3)*V_sat;//in volt
17 disp(Vp_p,"Peak to peak amplitude of triangular wave
      in volt")
18
19 // Part(b)
20 fo= R3/(4*R1*C1*R2);//in Hz
21 disp(fo*10^-3,"Frequency of triangular wave in kHz")
      ;

```

Scilab code Exa 7.12 R3 for a 100 micro second output pulse

```

1 // Exa 7.12
2 clc;
3 clear;
4 close;
5 //given data
6 T= 100;// in micro sec
7 T=T*10^-6;//in se
8 V_sat= 12;// in volt
9 V1= 0.7;// in volt

```

```
10 V= 0.7; // in volt
11 V_D1= V;
12 V_D2=V_D1;
13 C1= 0.1; // in microF
14 C1=C1*10^-6; // in F
15 Beta1= 0.1;
16 // Formula T= R3*C1*log((1+V1/V_sat)/(1-Beta1))
17 R3= T/(C1*log((1+V1/V_sat)/(1-Beta1))); // in ohm
18 disp(R3*10^-3, "Value of R3 in kohm")
```

Chapter 8

Comparators And Converters

Scilab code Exa 8.2 Input voltage range

```
1 // Exa 8.2
2 clc;
3 clear;
4 close;
5 //given data
6 A= 92;// in dB
7 A= 10^(92/20);
8 V_CC= 15;// in volt
9 Vout= 30;// in volt
10 InputOffsetVoltage= 0;// in V
11 InputVoltage= Vout/A;// in V
12 disp(InputVoltage*10^3,"Input Voltage in mV")
```

Scilab code Exa 8.3 Two voltage at which comparator will switch

```
1 // Exa 8.3
2 clc;
3 clear;
```

```

4 close;
5 //given data
6 R1= 2;// in kohm
7 Rf= 390;// in kohm
8 V_sat= 12;// in V
9 Bita= R1/(R1+Rf);
10 UTP= Bita*V_sat;// in volt
11 LTP= -Bita*V_sat;// in volt
12 disp(UTP*10^3," Value of UTP in mv")
13 disp(LTP*10^3," Value of LTP in mv")

```

Scilab code Exa 8.5 DC voltage

```

1 // Exa 8.5
2 clc;
3 clear;
4 close;
5 //given data
6 t=0;
7 Vc=0;
8 Vo=5;//in volt
9 // V1= 2*R/(2*R+3*R)= 2/5*Vo
10 // Vco= 1/5*VR +4/5*Vo = 1/5*(VR+4*Vo)
11 // Req= R||4*R= 4/5*R
12 // Vct= Vco*(1-%e^(-t/(Req*C)))= 1/5*(VR+4*Vo)*(1-%e
    ^(-t/(4*R*C/5)))= 1/5*(VR+4*Vo)*(1-%e^(-1.25*t/(R
    *C)))
13 // T= 2*Rf*C*log(1+2*R3/R2)= 2*R*C*log(7/3)= 1.7*R*C
14 // t= T/2= .85*R*C, Hence
15 Vct=2;//in volt
16 // Vct= 1/5*(VR+4*Vo)*(1-%e^1.0625)
17 VR= Vct*5/(1-%e^-1.0625)-4*Vo;
18 disp(VR," Value of VR in volt")

```

Scilab code Exa 8.6 Output of the scchmitt trigger

```
1 // Exa 8.6
2 clc;
3 clear;
4 close;
5 //given data
6 omega= 200*%pi;// in radians/seconds
7 f=omega/(2*%pi);// in Hz
8 T=1/f;// in sec
9 T=T*10^3;//in ms
10 Vin= 7;//in volt
11 t1= 1/omega*asin(6/Vin);// in sec
12 t1=t1*10^3;// in ms
13 // The output of the schmitt trigger is at -10 volt
14 t1= T/2+t1;// in ms
15 // The output of the schmitt trigger is at +10 volt
16 t2= 10-t1;// in ms
17 disp(t1,"The output of the schmitt trigger is at -10
    volt in ms")
18 disp(t2,"The output of the schmitt trigger is at +10
    volt in ms")
```

Scilab code Exa 8.7 Output voltage

```
1 // Exa 8.7
2 clc;
3 clear;
4 close;
5 //given data
6 R1= 150;// in ohm
7 R2= 68;// in kohm
```

```

8 R2=R2*10^3; // in ohm
9 Vin= 500; // in mv
10 V_sat= 14; //in volt
11 V_pos= R1/(R1+R2)*V_sat; // in volt
12 V_UT= V_pos; //in volt
13 // In the same way when output is -14 volts and
    starts increasing in negative direction
14 V_sat=-14; //in volt
15 V_pos= R1*V_sat/(R1+R2); // in volt
16 V_LT= abs(V_pos); //in volt
17 disp(V_UT, "Value of V_UT in volts")
18 disp(V_LT, "Value of V_LT in volts")

```

Scilab code Exa 8.8 Schmitt trigger

```

1 // Exa 8.8
2 clc;
3 clear;
4 close;
5 //given data
6 V_UT= 5; // in V
7 V_LT= -5; // in V
8 V_sat= 10; // in V (Assume)
9 // V_UT= (R1/(R1+R2))*V_sat = 5
10 // V_LT= (-R1/(R1+R2))*V_sat = -5
11 // 10*R1/(R+R2)= 5
12 V_hy= V_UT-V_LT; // in volt
13 disp(V_hy, "Hysteresis voltage in volt")

```

Scilab code Exa 8.9 Resolution full scale output voltage and weight

```

1 // Exa 8.9
2 clc;

```

```

3 clear;
4 close;
5 //given data
6 V_REF= 10;// in V
7 MSB2= V_REF/2;// in volt
8 disp(MSB2,"The second MSB weight in volt")
9 MSB3= V_REF/4;// in volt
10 disp(MSB3,"The third MSB weight in volt")
11 MSB4= V_REF/8;// in volt
12 disp(MSB4,"The forth MSB (or LSB) weight in volt")
13 DAC= MSB4;
14 disp(DAC,"The resolution of the DAC in volt")
15 FullScaleOutput= V_REF+MSB2+MSB3+MSB4;//in volt
16 disp(FullScaleOutput,"Full scale output in volt");
17 disp("If Rf is reduced to one-fourth, each input will
      be 4 times smaller than the values above. Thus
      the full scale output will be reduced")
18 disp(" in the same ratio and becomes "+string(
      FullScaleOutput/4)+" volt")

```

Scilab code Exa 8.10 Analog output

```

1 // Exa 8.10
2 clc;
3 clear;
4 close;
5 //given data
6 V_REF= -5;// in V
7 V_B= 0;// in volt
8 V_A= -5;// in volt
9 V_C=V_A;
10 V_D=V_C;
11 Vout= -1*(V_A+V_B/2+V_C/4+V_D/8);// in volt
12 disp(Vout,"Output voltage in volt")

```

Scilab code Exa 8.11 Output voltage

```
1 // Exa 8.11
2 clc;
3 clear;
4 close;
5 //given data
6 Dn=16; // in volt
7 MSB1= Dn/2; // in volt
8 disp(MSB1,"The first MSB output in volt")
9 MSB2= Dn/4; // in volt
10 disp(MSB2,"The second MSB output in volt")
11 MSB3= Dn/8; // in volt
12 disp(MSB3,"The third MSB output in volt")
13 MSB4= Dn/16; // in volt
14 disp(MSB4,"The forth MSB output in volt")
15 MSB5= Dn/32; // in volt
16 disp(MSB5,"The fifth MSB output in volt")
17 MSB6= Dn/64; // in volt
18 disp(MSB6,"The sixth MSB (LSB) output in volt")
19 resolution= MSB6; // in volt
20 disp(resolution,"The resolution in volt")
21 fullScaleOutput= MSB1+MSB2+MSB3+MSB4+MSB5+MSB6;
22 disp(fullScaleOutput,"Full scale output occurs for
    digital input of 111111 in volt");
23 // For digital input 101011
24 D0=16;
25 D1=16;
26 D2=0;
27 D3=16;
28 D4=0;
29 D5=16;
30
31 Vout= (D0*2^0 + D1*2^1 + D2*2^2 + D3*2^3 + D4*2^4 +
```



```

    D5*2^5)/2^6; // in volt
32 disp(Vout,"The voltage output for a digital input of
    101011 in volt")

```

Scilab code Exa 8.12 Output voltage

```

1 // Exa 8.12
2 clc;
3 clear;
4 close;
5 //given data
6 // For the word 100100
7 N=6; // Number of bits
8 a5= 1; // Value of bits
9 a4= 0; // Value of bits
10 a3= 0; // Value of bits
11 a2= 1; // Value of bits
12 a1= 0; // Value of bits
13 a0= 0; // Value of bits
14 Vo= 3.6; // in volt
15 // Formula  $V_o = (2^{(N-1)}*a_5 + 2^{(N-2)}*a_4 + 2^{(N-3)}*a_3$ 
    +  $2^{(N-4)}*a_2 + 2^{(N-5)}*a_1 + 2^{(N-6)}*a_0 ) * K$ 
16 K= Vo/( $2^{(N-1)}*a_5 + 2^{(N-2)}*a_4 + 2^{(N-3)}*a_3 + 2^{(N-4)}$ 
    +  $2^{(N-5)}*a_1 + 2^{(N-6)}*a_0$  );
17 // For the word 110011
18 N=6; // Number of bits
19 a5= 1; // Value of bits
20 a4= 1; // Value of bits
21 a3= 0; // Value of bits
22 a2= 0; // Value of bits
23 a1= 1; // Value of bits
24 a0= 1; // Value of bits
25 Vo= ( $2^{(N-1)}*a_5 + 2^{(N-2)}*a_4 + 2^{(N-3)}*a_3 + 2^{(N-4)}$ 
    +  $2^{(N-5)}*a_1 + 2^{(N-6)}*a_0$  ) * K; // in volt
26 disp(Vo,"The value of Vo for the word 110011 in volt

```

```

    ")
27
28 // Part(ii)
29 // For the word 1010
30 N=4; // Number of bits
31 a3= 1; // Value of bits
32 a2= 0; // Value of bits
33 a1= 1; // Value of bits
34 a0= 0; // Value of bits
35 VR= 6; // in volt
36 Vo= VR/2^N*( 2^(N-1)*a3 + 2^(N-2)*a2 + 2^(N-3)*a1 +
    2^(N-4)*a0 );
37 disp(Vo,"Value of output voltage in volt")

```

Scilab code Exa 8.13 Unknown voltage

```

1 // Exa 8.13
2 clc;
3 clear;
4 close;
5 //given data
6 R=100; // in kohm
7 R=R*10^3; // in ohm
8 C= 1; // in micro F
9 C=C*10^-6; // in F
10 V_REF= 5; // in volt
11 t=0.2; // time taken to read an unknown voltage in
    second
12 T=R*C; // in second
13 Vx= T/t*V_REF; // in volt
14 disp(Vx,"Unknown voltage in volt")

```

Scilab code Exa 8.14 Conversion time

```

1 // Exa 8.14
2 clc;
3 clear;
4 close;
5 //given data
6 f=75; // in MHz
7 f=f*10^6; // in Hz
8 // For an 8-bit converter reference voltage
9 V_REF= 100; // in volt
10 // For setting D7=1
11 Vo_7= V_REF*2^7/2^8; //in volt
12 // For setting D6=1
13 Vo_6= V_REF*2^6/2^8; //in volt
14 // For setting D7=1 and D6=1
15 Vo_76= Vo_7+Vo_6; //in volt
16 // For setting D5=1 D6=1 and D7=1
17 Vo_5= V_REF*2^5/2^8+Vo_7+Vo_6; //in volt
18 disp(Vo_7,"For setting D7=1 output voltage in volt
    is :")
19 disp(Vo_6,"For setting D6=1 output voltage in volt
    is :")
20 disp(Vo_76,"For setting D7=1 and D6=1 output voltage
    in volt is :")
21 disp(Vo_5,"For setting D5=1, D6=1 and D7=1 output
    voltage in volt is :")
22 disp("All other digits will be set to zero or 1.
    Output will be accordingly indicated as a result
    of successive approximation. The converted 8-bit
    digital form will be 1110010")
23 T=1/f; // in sec
24 disp(T*10^9,"Conversion time in ns")

```

Scilab code Exa 8.15 Time of conversion

```

1 // Exa 8.15

```

```

2  clc;
3  clear;
4  close;
5  //given data
6  f=1; // in MHz
7  f=f*10^6; // in Hz
8  T=1/f; // conversion time in sec
9  N=8; // number of bits
10 tc= N*T; // in sec
11 disp(tc*10^6, "Time of Conversion in micro sec : ");

```

Scilab code Exa 8.16 Maximum time upto which the reference voltage can be integrat

```

1  // Exa 8.16
2  clc;
3  clear;
4  close;
5  //given data
6  Vin= 2; //in volt
7  Vout= 10; //in volt
8  R=100; // in kohm
9  R=R*10^3; //in ohm
10 C=0.1; // in micro F
11 C=C*10^-6; //in F
12 // Formula  $V_{out} = -1/(R*C) * \int Vin dt$ 
    =  $-Vin*t/(R*C)$ 
13 t= Vout*R*C/Vin; // in sec
14 disp(t, "The maximum time upto which the reference
    voltage can be integrated in second")
15 disp(t*10^3, "Or in mili seconds ")

```

Scilab code Exa 8.17 Maximum permissible leakage current

```

1 // Exa 8.17
2 clc;
3 clear;
4 close;
5 //given data
6 C=0.1; // in nF
7 C=C*10^-9; //in F
8 V=5; //in V
9 t=1; // in micro S
10 t=t*10^-6; // in sec
11 // v= V*(1-%e^(-t/(R*C)))
12 // Since hold value does not drop by more than 0.5%
    or by 0.005 V, hold value is 0.995 V, Thus
13 // 0.995*V= V*(1-%e^(-t/(R*C)))
14 // or %e^(-t/(R*C))= 1-0.995 = 0.005
15 R= t/(C*log(1/0.005)); // in ohm
16 I= V/R*(1-%e^(-t/(R*C))); // Maximum current through
    R in ampere
17 disp(I*10^3, "Maximum permissible leakage current
    through the hold capacitor in mA")

```

Chapter 9

The 555 IC Timer

Scilab code Exa 9.1 Frequency and duty cycle

```
1 // Exa 9.1
2 clc;
3 clear;
4 close;
5 //given data
6 C=.01;// in micro F
7 C=C*10^-6;// in F
8 R_A= 2;// in kohm
9 R_A=R_A*10^3;// in ohm
10 R_B= 100;// in kohm
11 R_B=R_B*10^3;// in ohm
12 T_High= 0.693*(R_A+R_B)*C;// in seconds
13 T_Low= 0.693*R_B*C;// in seconds
14 T=T_High+T_Low;// in seconds
15 f=1/T;// in Hz
16 disp(f,"Frequency of oscillations in Hz");
17 DutyCycle= T_High/T*100;// in percent
18 disp(DutyCycle,"Duty cycle in percentage");
```

Scilab code Exa 9.2 Positive and negative Pulse width

```
1 // Exa 9.2
2 clc;
3 clear;
4 close;
5 //given data
6 C=1; // in micro F
7 C=C*10^-6; // in F
8 C1=0.01; // in micro F
9 C1=C1*10^-6; // in F
10 R_A=4.7; // in kohm
11 R_B=1; // in kohm
12 R_A=R_A*10^3; // in ohm
13 R_B=R_B*10^3; // in ohm
14 T_on= 0.693*(R_A+R_B)*C; // in seconds
15 T_on=T_on*10^3; // in ms
16 disp(T_on,"Positive pulse width in mili seconds")
17 T_off= 0.693*R_B*C; // in seconds
18 T_off=T_off*10^3; // in ms
19 disp(T_off,"Negative pulse width in mili seconds")
20 f=1.4/((R_A+2*R_B)*C); // in Hz
21 disp(f,"Free running Frequency in Hz");
22 DutyCycle= (R_A+R_B)/(R_A+2*R_B)*100 // in percent
23 disp(DutyCycle,"Duty cycle in percentage");
```

Scilab code Exa 9.3 Value of resistor required

```
1 // Exa 9.3
2 clc;
3 clear;
4 close;
5 //given data
6 C=0.01; // in micro F
7 C=C*10^-6; // in F
```

```

8 f=1; // in kHz
9 f=f*10^3; // in Hz
10 // R_A= R_B
11 // T_on = T_off = T/2
12 // Frequency is given by equation  $f = 1.44 / ((R_A + R_B) * C)$ 
13 R_A= 1.44/(2*f*C); // in ohm
14 R_A=R_A*10^-3; // in k ohm
15 R_B= R_A;
16
17 disp("Resistors required : "+string(R_A)+" k ohm
(68 ohm standart value)");

```

Scilab code Exa 9.4 555 timer as an multivibrator

```

1 // Exa 9.4
2 clc;
3 clear;
4 close;
5 //given data
6 f=700; // in Hz
7 // R_A= R_B
8 // T_on = T_off = T/2
9 // Frequency is given by equation  $f = 1.44 / ((R_A + R_B) * C)$ 
10 C=0.01; // in micro F (assumed value)
11 C=C*10^-6; // in F
12 R_A= 1.44/(2*f*C); // in ohm
13 R_A=R_A*10^-3; // in k ohm
14 R_A=ceil(R_A);
15 R_B= R_A;
16 disp("Resistors required : "+string(R_A)+" k ohm
(100 ohm standart value)");

```

Scilab code Exa 9.5 555 timer as an multivibrator

```
1 // Exa 9.5
2 clc;
3 clear;
4 close;
5 //given data
6 f=800;// in Hz
7 D=60;// in percent
8 // Formula  $D = (R_A + R_B) / (R_A + 2 * R_B) * 100 = 60$ 
9 //  $R_A + R_B = 0.6 * R_A + 1.2 * R_B$ 
10 //  $R_B = 2 * R_A$ 
11 C=0.01;// in micro F (assumed value)
12 C=C*10^-6;// in F
13 // Frequency is given by equation  $f = 1.44 / ((R_A + R_B) * C)$ 
14 R_A= 1.44 / (5 * C * f); // in ohm
15 R_A=R_A*10^-3; // in kohm
16 R_B=2*R_A; // in kohm
17 disp("Resistors required : "+string(R_A)+" k ohm
      and "+string(R_B)+" k ohm");
```

Scilab code Exa 9.6 Frequency of free running ramp generator

```
1 // Exa 9.6
2 clc;
3 clear;
4 close;
5 //given data
6 C=.05;// in micro F
7 C=C*10^-6;// in F
8 R= 12; // in kohm
```

```

9 R=R*10^3; // in ohm
10 V_CC= 5; // in volt
11 V_BE= 0.7; // in volt
12 V_D1= V_BE; // in volt
13 I_C= (V_CC-V_BE)/R; // in A
14 f_o= (3*I_C)/(V_CC*C); // in Hz
15 f_o=f_o*10^-3; // in kHz
16 disp(f_o,"Frequency of free running ramp generator
      circuit in kHz");

```

Scilab code Exa 9.7 Output pulse width

```

1 // Exa 9.7
2 clc;
3 clear;
4 close;
5 //given data
6 C=.1; // in micro F
7 C=C*10^-6; // in F
8 R_A= 20; // in kohm
9 R_A=R_A*10^3; // in ohm
10 PulseWidth= 1.1*R_A*C; // in seconds
11 disp(PulseWidth*10^3,"The output pulse width in mili
      seconds");

```

Scilab code Exa 9.9 Value of RA

```

1 // Exa 9.9
2 clc;
3 clear;
4 close;
5 //given data
6 C=.02; // in micro F

```

```

7 C=C*10^-6; // in F
8 f=2; // frequency of the output trigger in kHz
9 f=f*10^3; // in Hz
10 T=1/f; // in seconds
11 // In a divide-by-5 circuit , n=5, so the pulse
    width, t_p= [0.2 + (n-1)]*T = [0.2 + (5-1)]*T =
    4.2*T
12 t_p=4.2*T; // in soconds
13 // Formula t_p = 1.1*R_A*C
14 R_A= t_p/(1.1*C); // in ohm
15 R_A=R_A*10^-3; // in kohm
16 disp(R_A, "The value of R_A in k ohm");

```

Chapter 10

Phase Locked Loop

Scilab code Exa 10.1 Free running frequency

```
1 // Exa 10.1
2 clc;
3 clear;
4 close;
5 //given data
6 V_pos= 12;// in volt
7 V_Neg= -12;// in volt
8 V=V_pos-V_Neg;
9 R1=15;// in k ohm
10 R1=R1*10^3;// in ohm
11 C1=0.01;// in micro F
12 C1=C1*10^-6;// in F
13 C2=10;// in micro F
14 C2=C2*10^-6;// in F
15 // (i)
16 f_out= 1.2/(4*R1*C1);// in Hz
17 disp(f_out*10^-3,"Free running frequency in kHz");
18 // (ii)
19 f_L= (8*f_out)/V;// in Hz
20 disp(f_L*10^-3,"Lock range in k Hz");
21 f_C= sqrt(f_L/(2*%pi*3.6*10^3*C2));// in Hz
```

22 `disp(f_C, "Capture range in Hz")`

Chapter 11

Voltage Regulators

Scilab code Exa 11.1 Minimum input voltage

```
1 // Exa 11.1
2 clc;
3 clear;
4 close;
5 //given data
6 I_dc=300; // in mA
7 C=200; // in micro F
8 V_max= 24; // in volt
9 V_r_rms= 2.4*I_dc/C; // in volt
10 V_r_peak= sqrt(3)*V_r_rms; // in volt
11 V_dc= V_max-V_r_peak; // in volt
12 V_in_low= V_max-V_r_peak; // in volt
13 disp(V_in_low,"Minimum input voltage in volt")
```

Scilab code Exa 11.2 Current source

```
1 // Exa 11.2
2 clc;
```

```

3 clear;
4 close;
5 //given data
6 I_L= 0.5;// in amp
7 R_L=25;// in ohm
8 V_R=12;// in volt (since using 7812 voltage
   regulator)
9 V_L= I_L*R_L;
10 R=V_R/I_L;// in ohm
11 disp(R,"Resistance required in ohm");
12 V_out= V_R+V_L;// in volt
13 disp(V_out,"Output voltage in volt");
14 V_in= V_out+2;// in volt
15 disp(V_in,"Input voltage in volt");

```

Scilab code Exa 11.3 Regulated output voltage

```

1 // Exa 11.3
2 clc;
3 clear;
4 close;
5 //given data
6 R1= 240;// in ohm
7 R2= 1.2;// in kohm
8 R2=R2*10^3;// in ohm
9 V_out= 1.25*(1+R2/R1);// in volt
10 disp(V_out,"Regulated output voltage in volt")

```

Scilab code Exa 11.4 Minimum and maximum output voltage

```

1 // Exa 11.4
2 clc;
3 clear;

```

```

4 close;
5 //given data
6 R1= 40;// in ohm
7 I_Q= 10;// in mA
8 I_Q=I_Q*10^-3;// in amp
9 V_REF= 15;// in volt
10 // When R2 is set at minimum i.e.
11 R2= 0;// in ohm
12 V_out= (1+R2/R1)*V_REF + I_Q*R2;// in volt
13 disp(V_out,"Minimum output voltage in volt")
14 // When R2 is set at maximum i.e.
15 R2= 200;// in ohm
16 V_out= (1+R2/R1)*V_REF + I_Q*R2;// in volt
17 disp(V_out,"Minimum output voltage in volt")

```

Scilab code Exa 11.5 Regulated output voltage

```

1 // Exa 11.5
2 clc;
3 clear;
4 close;
5 //given data
6 R1= 2.5;// in kohm
7 R1= R1*10^3;// in ohm
8 R2= 1;// in kohm
9 R2= R2*10^3;// in ohm
10 V_REF= 1.25;// in volt
11 I= V_REF/R2;// in amp
12 // This current also flows through R1. So the output
    voltage
13 V_out= I*(R1+R2);// in volt
14 disp(V_out,"Output voltage in volt")

```

Scilab code Exa 11.6 Duty cycle of the pulses

```
1 // Exa 11.6
2 clc;
3 clear;
4 close;
5 //given data
6 R1= 3;// in kohm
7 R1= R1*10^3;// in ohm
8 R2= 1;// in kohm
9 R2= R2*10^3;// in ohm
10 V_REF= 1.25;// in volt
11 V_in=20;// in volt
12 V_out= V_REF*(R1+R2)/R2;// in volt
13 D=V_out/V_in*100;// in percent
14 disp(D,"Duty cycle in percent")
```
