Scilab Textbook Companion for Solid State Devices and Circuits by V. Chaudhary and H. K. Maity[1]

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Book Description

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

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List of Scilab Codes

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Chapter 2

Bipolar Junction Transistors

Scilab code Exa 2.1 Value of alphaDC and emitter current

```
1  // Exa 2.1
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  I_C = 15;// in mA
8  I_CbyI_E= 0.995;
9  I_E= I_C/I_CbyI_E;// in mA
10 I_B= 0.005*I_E;// in mA
11 I_CBO = 3;// in  A
12 I_CBO = I_CBO * 10^-3;// in mA
13 alpha_dc= I_C/I_E;
14 disp(alpha_dc,"The value of Alpha_dc is");
15 // I_C = Alpha_dc*I_E + I_CBO;
16 I_E = (I_C-I_CBO)/alpha_dc;// in mA
17 disp(I_E,"The value of I_E in mA is");
```

Scilab code Exa 2.2 Value of IC and IE

```
1  // Exa 2.2
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  Alpha_dc = 0.99;
8  I_CBO = 10;// in   A
9  I_CBO = I_CBO * 10^-3;// in mA
10 I_E = 10;// in mA
11 // To calculate I_C :
12 I_C = (Alpha_dc*I_E) + I_CBO;// in mA
13 disp(I_C,"The value of I_C in mA is");
14 // To calculate I_B :
15 I_B = I_E-I_C;// in mA
16 I_B = I_B * 10^3;// in   A
17 disp(I_B,"The value of I_B in   A  is");
```

Scilab code Exa 2.3 Base current

```
1  // Exa 2.3
2  clc;
3  clear;
4  close;
5  format('v',4)
6  // Given data
7  Alpha_dc = 0.99;
8  I_C = 6;// in mA
9  I_CBO = 15;// in   A
10 I_CBO = I_CBO * 10^-3;// in mA
11 // I_C = Alpha_dc*I_E + I_CBO;
12 I_E = (I_C - I_CBO)/Alpha_dc;// in mA
13 I_B = I_E - I_C;// in mA
14 I_B = I_B * 10^3;// in   A
15 disp(I_B,"The value of I_B in   A  is");
```

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Scilab code Exa 2.5 Emitter current

```
1  // Exa 2.5
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  Alpha_dc = 0.98;
8  I_CBO = 12;// in   A
9  I_CBO = I_CBO * 10^-6;// in A
10 I_B = 120;// in   A
11 I_B = I_B * 10^-6;// in A
12 // Calculation of Beta_dc
13 Beta_dc = Alpha_dc/(1-Alpha_dc);
14 I_E = (1+Beta_dc)*I_B + (1+Beta_dc)*I_CBO;// in A
15 I_E = I_E * 10^3;// in mA
16 disp(I_E,"The value of I_E in mA is");
```

Scilab code Exa 2.6 Region of operation

```
1  // Exa 2.6
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  V_BEsat = 0.8;// in V
8  V_BEact = 0.7;// in V
9  V_CEsat = 0.2;// in V
10 V_CC = 10;// in V
```

```
11  Beta = 100;
12  V = 5;// in V
13  R_B = 50* 10^3;// in ohm
14  R_E = 2* 10^3;// in ohm
15  R_C = 3* 10^3;// in ohm
16  //Applying KVL to input loop,  V = R_B*I_B + V_BEact
        + I_C*R_E and I_C = Beta*I_B;
17  I_B = (V-V_BEact)/(R_B+R_E*Beta);// in A
18  // Applying KVL to collector circuit, V_CC= I_C*R_C+
        V_CEsat+I_E*R_E and I_E=I_C+I_B
19  I_C = (V_CC-V_CEsat-I_B*R_E)/(R_C+R_E);// in A
20  I_Bmin = I_C/Beta;// in A
21  if I_B < I_Bmin then
22      disp("Since the value of I_B ( "+string(I_B
            *10^6)+ "   A ) is less than the value of
            I_Bmin ( "+string(I_Bmin*10^6)+"   A ), ")
23      disp("So the transistor is in the active region.
            ")
24  end
```

Scilab code Exa 2.7 Value of IB IC and Vce

```
1  // Exa 2.7
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  Beta = 100;
8  V_BEsat = 0.8;// in V
9  V_BEact = 0.7;// in V
10 V_CC = 10;// in V
11 V = 5;// in V
12 R_B = 50* 10^3;// in ohm
13 R_E = 2* 10^3;// in ohm
```

```
14  R_C = 3* 10^3;// in ohm
15  // As the transistor is in active region, so V = R1*
        I_B + V_BEact + (1+Beta)*I_B*R2;
16  I_B = (V-V_BEact)/(R_B+(1+Beta)*R_E);// in A
17  I_B = round(I_B * 10^6);// in  A
18  disp(I_B,"The value of I_B in  A  is");
19  I_C = Beta*I_B*10^-6;// in A
20  I_C = I_C * 10^3;// in mA
21  disp(I_C,"The value of I_C in mA is");
22  // Applying KVL to collector circuit, V_CC = (I_C*R3
        ) + V_CEact + (I_C+I_B)*R2;
23  V_CEact = V_CC - (I_B*10^-6*R_E) - (I_C*10^-3*(R_E+
        R_C));// in V
24  disp(V_CEact,"The value of V_CE in V is");
```

Scilab code Exa 2.8 Value of VBB

```
 1  // Exa  2.8
 2  clc;
 3  clear;
 4  close;
 5  format('v',6)
 6  // Given data
 7  V_CEsat = 0.2;// in V
 8  V_BEsat = 0.8;// in V
 9  Beta = 100;
10  R_C = 0.5* 10^3;// in ohm
11  R_E = 1* 10^3;// in ohm
12  R_B = 44* 10^3;// in ohm
13  V1 = 15;// in V
14  V2 = 15;// in V
15  //Applying KVL to collector circuit,  V1+V2 - I_Csat
        *R_C - V_CEsat - I_E*R_E = 0;
16  //but I_Csat = beta*I_Bmin and I_E = (1+Beta)*I_Bmin
        , So
```

```
17  I_Bmin= (V1+V2-V_CEsat)/(Beta*R_C+R_E*(1+Beta));// 
        in A
18  I_Bmin= I_Bmin*10^3;// in mA
19  disp(I_Bmin,"The value of I_Bmin in mA is : ")
20  I_Bmin= I_Bmin*10^-3;// in A
21  I_E = (1+Beta)*I_Bmin;// in A
22  // Applying KVL to base emitter circuits , V_BB−
        I_Bmin∗R_B−V_BEsat−(I_E∗R_E)−V1=0
23  V_BB = (I_Bmin*R_B) + V_BEsat + (I_E*R_E) - V1;// in
         V
24  disp(V_BB,"The value of V_BB which just barely
        saturate the transistor in V is");
```

Scilab code Exa 2.9 RC and RE

```
1  // Exa 2.9
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  bita = 200;
8  V_CEQ = 3;// in V
9  V_CC = 6;// in V
10 V_BB= -6;// in V
11 V_BE= 0.7;// in V
12 Vo = 0;// in V
13 R1= 90*10^3;// in ohm
14 R2= 90*10^3;// in ohm
15 // V_CC − I_CR_C − V_CEQ − I_ER_E−V_BB = 0          (i
        )
16 // Vo = V_CEQ + I_E∗R_E − V_CC or
17 I_ER_E= Vo+V_CC-V_CEQ;// in V
18 // From eq(i)
19 I_CR_C= V_CC - I_ER_E - V_CEQ - V_BB;// in V
```

```
20  // Applying KVL to the input side of circuit
21  //V_CEQ-[(R1 || R2)*I_B]-V_BE-I_ER_E+V_CC=0 or
22  I_B= (V_CEQ-V_BE-I_ER_E+V_CC)/((R1*R2)/(R1+R2));//
        in A
23  I_E= (1+bita)*I_B;//in A
24  R_E= I_ER_E/I_E;// in ohm
25  I_C= bita*I_B;// in A
26  R_C= I_CR_C/I_C;// in ohm
27  disp("Part (a) : ")
28  disp(R_E,"The value of R_E in ohm is : ")
29  disp(R_C,"The value of R_C in ohm is : ")
30  disp("Parb (b) :")
31  bita= 100;
32  I_E= (1+bita)*I_B;//in A
33  I_C= bita*I_B;// in A
34  Vo_new= V_CEQ+I_E*R_E-V_CC;// in V
35  Change_in_Vo= Vo_new-Vo;// in V
36  disp(Change_in_Vo,"The change in Vo in volts is : ")
```

Scilab code Exa 2.10 Maximum value of bita

```
1  // Exa 2.10
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  bita = 75;
8  V_CC = 9;// in V
9  V_CEsat = 0.2;// in V
10 V_BEsat = 0.8;// in V
11 R_C = 2;// in k ohm
12 R_C = R_C * 10^3;// in ohm
13 R_E = 1;// in k ohm
14 R_E = R_E * 10^3;// in ohm
```

```scilab
15  R_B = 50;// in k ohm
16  R_B = R_B * 10^3;// in ohm
17  I_Csat= poly(0,'I_Cs')
18  // Part (i) : To check the region of operation
19  // Applying KVL to collector circuit , we get : V_CC
        = (R_C*I_Cs) + V_CEsat + (I_E*R_E)          (i)
20   I_E = I_Csat;// in A (approximate)
21   // From eq(i)
22  I_Csat= (R_C*I_Csat) + V_CEsat + (I_E*R_E)-V_CC;//
        in A
23  I_Csat= roots(I_Csat);// in A
24  I_Bmin= I_Csat/bita;// in A
25  I_Bmin= I_Bmin*10^6;// in   A
26  disp("Part (i)")
27  disp(I_Bmin,"The minimum value of  I_B in   A  is : "
        )
28  I_B= poly(0,'I_B')
29  I_E= (1+bita)*I_B;// in A
30  // Applying KVL to input circuit , we get
31  // V_CC = I_B*R_B+V_BEsat+I_E*R_E or
32  I_B= I_B*R_B+V_BEsat+I_E*R_E-V_CC;// in A
33  I_B= roots(I_B);// in A
34  I_B= round(I_B*10^6);// in   A
35  disp(I_B,"The value of I_B in   A  is : ")
36  if I_B>I_Bmin then
37      disp("As the value of I_B is greater than the
            value of I_B min")
38      disp("Hence the trasistor is definitely in the
            saturation region")
39  end
40  I_E= (1+bita)*I_Bmin;// in   A
41  V_C= V_CEsat+I_E*10^-6*R_E;// in V
42  disp(V_C,"Part (ii) : The value of V_C in volts is :
        ");
43  bita_min= I_Csat/(I_B*10^-6);
44  disp(bita_min,"Part (iii) : The minimum value of
        bita that will change the state of transistor is
        : ")
```

Scilab code Exa 2.11 Minimum value of RC required

```
1  // Exa 2.11
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  V_CEsat = 0.2;// in V
8  V_CC = 10;// in V
9  V_BEsat = 0.8;// in V
10 // Part (i) To obtain minimum value of R_C
11 R_B = 220;// in k ohm
12 R_B = R_B * 10^3;// in ohm
13 Beta = 100;
14 // Applying KVL to collector circuit, we get
15 // V_CC = V_CEsat + I_Esat*R_C  or          (i)
16 I_CsatR_C= V_CC-V_CEsat;// in V
17 // Applying KVL to input loop
18 // V_CC= V_BEsat+I_B*R_B  or               (ii)
19 I_B= (V_CC-V_BEsat)/R_B;// in A
20 // Just at saturation I_B= I_C/Beta or
21 I_C= Beta*I_B;// in A
22 R_Cmin= I_CsatR_C/I_C;// in ohm
23 R_Cmin= R_Cmin*10^-3;// in k ohm
24 disp(R_Cmin,"The minimum value of R_C to produce
        saturation of Si transistor in k  is : ")
25
26 // Part (ii) To obtain maximum value of R_B
27 R_C = 1.2;// in k ohm
28 R_C = R_C * 10^3;// in ohm
29 I_Csat= I_CsatR_C/R_C;// in A
30 // Just at saturation
31 I_B= I_Csat/Beta;// in A
```

16

```
32 // Now on substituting the new value of I_B in eq (
      ii )
33 R_Bmax= (V_CC-V_BEsat)/I_B;// in ohm
34 R_Bmax= R_Bmax*10^-3;// in k ohm
35 disp(R_Bmax,"The largest value of R_B that will
      saturate the transistor in k   is : ")
```

Scilab code Exa 2.12 Value R1 and R3

```
1 // Exa 2.12
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 V_CE = 2.5;// in V
8 Beta = 100;
9 R2 = 10 * 10^3;// in ohm
10 R4 = 300;// in ohm
11 V_CC = 5;// in V
12 I_C = 1 * 10^-3;// in A
13 V_BE= 0.6;// in V
14 // Applying KVL to collector circuit , we get
15 // V_CC = I_C*R3 + V_CE + I_E*R4                  (i)
16  I_B = I_C/Beta;// in A
17  I_E = (I_C + I_B);// in A
18  // On substituting the value of I_B and I_E in eq (
      i ) , we get
19  R3= (V_CC-V_CE-I_E*R4)/I_C;// in ohm
20 V_B= I_E*R4+V_BE;// in V
21 // But also V_B= R2/(R1+R3)*V_CC, so
22 R1= R2*V_CC/V_B-R2;// in ohm
23 R1= R1*10^-3;// in k ohm
24 R3= R3*10^-3;// in k ohm
25 disp(R1,"The value of R1 in k   is : ")
```

```
26 disp(R3,"The value of R3 in  k   is : ")
```

Scilab code Exa 2.13 Value of RE for which transistor just comes out of saturation

```
1 // Exa 2.13
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 V_CEsat = 0.2;// in V
8 R_B = 100 * 10^3;// in ohm
9 R_C = 2 * 10^3;// in ohm
10 bita = 100;
11 R_E = 1 * 10^3;// in ohm
12 V_CC = 10;//in V
13 V_BEsat = 0.8;// in V
14 V_BEactive = 0.7;// in V
15 V_BE= 0.7;// in V
16 V_BEcutin = 0.5;// in V
17 // Applying KVL to output circuit , we get
18 // V_CC = R_C*I_C + V_CEsat + R_E*I_E       (i)
19 I_Bmin= poly(0,'I_Bm');
20 I_C= bita*I_Bmin;// in A
21 I_E= (1+bita)*I_Bmin;// in A
22 // From eq(i)
23 I_Bmin= R_C*I_C + V_CEsat + R_E*I_E-V_CC;// in A
24 I_Bmin= roots(I_Bmin);// in A
25 I_Bmin= I_Bmin*10^6;// in   A
26 // Applying KVL to input circuit , we get
27 // V_CC = R_B*I_B + V_BEsat + R_E*I_E       (ii)
28 I_B= poly(0,'I_B');// in A
29 I_E= (1+bita)*I_B;// in A
30 // From eq(ii)
```

```
31  I_B= R_B*I_B + V_BEsat + R_E*I_E-V_CC;// in A
32  I_B= roots(I_B);// in A
33  I_B= I_B*10^6;// in   A
34  if I_B>I_Bmin then
35      disp("As the value of I_B ("+string(I_B)+"  A )
            is greater than the value of I_Bmin ("+string
            (I_Bmin)+"   A )")
36      disp("Hence the transistor is in saturation
            region")
37  end
38
39  // Part (b) : To obtain the value of R_E
40  V_CE= 0.4;// in V (assumed)
41  // Rewrite eq(ii) as, V_CC = (R_C*I_C) + V_CE + (R_E
        *I_E) or
42  // I_B= (V_CC-V_CE)/(bita*R_C+(1+bita)*R_E)
        (iii)         (as I_C= bita*I_B and I_E= (1+bita)*
        I_B )
43  // Applying KVL to input circuit, V_CC= I_B*R_B+V_BE
        +(1+bita)*I_B*R_E         (iv)
44  // On substituting the I_B from eq (iii) in eq (iv)
45  R_E= [(V_CC-V_BE)*bita*R_C-(V_CC-V_CE)*R_B]/[(1+bita
        )*(V_BE-V_CE)];// in ohm
46  R_E= R_E*10^-3;// in k ohm
47  disp(R_E,"The value of R_E in  k   is : ")
```

Scilab code Exa 2.14 Vo1 and Vo2 and new value of RC

```
1  // Exa 2.14           (Printed As Exa 2.13)
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  Beta_dc = 100;
```

```
 8  R_C = 0.5*10^3;// in ohm
 9  V_BB = 0;// in V
10  V_BE= 0.7;// in V
11  R_B = 44 * 10^3;// in k ohm
12  R_E = 1 * 10^3;// in ohm
13  V_EE = -15;// in V
14  V_CC = 15;// in V
15  // Applying KVL to base circuit
16  // V_CC= R_B*I_B+V_BE+(1+Beta_dc)*R_E*I_B or
17  I_B= (V_CC-V_BE)/(R_B+(1+Beta_dc)*R_E);// in A
18  I_C= I_B*Beta_dc;// in A
19  I_E= (1+Beta_dc)*I_B;// in A
20  // Applying KVL to collector circuit
21  // V_CC = R_C*I_C + V_CE + R_E*I_E + V_EE or
22  V_CE= V_CC-V_EE-I_C*R_C-I_E*R_E;// in V
23  Vo2= I_E*R_E-V_CC;// in V
24  // But V_CE= V01-Vo2, so
25  Vo1= V_CE+Vo2;// in V
26  disp(Vo1,"The value of Vo1 in volts is : ")
27  disp(Vo2,"The value of Vo2 in volts is : ")
28  // Part (ii) New Value of R_C to make Vo1= 0 V
29  Vo1= 0;
30  // V_CC= I_C*R_C+Vo1-Vo2+I_E*R_E-V_EE or
31  R_C= (V_CC-V_EE-Vo1+Vo2-I_E*R_E)/(I_C);// in ohm
32  R_C= R_C*10^-3;// in k ohm
33  disp(R_C,"The value of R_C in k  is : ")
34  // Part (iii) New value of R_E to get Vo2= 0;
35  Vo2= 0;// in V
36  // Formula Vo2= I_E*R_E-V_CC, so
37  R_E= (Vo2+V_CC)/I_E;// in ohm
38  R_E= R_E*10^-3;// in kohm
39  format('v',4)
40  disp(R_E,"The value of R_E in k  is :")
41
42  // Note : The calculated value of R_C in the book is
        not correct
```

Scilab code Exa 2.15 IC and IB

```scilab
1  // Exa 2.15
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  bita = 50;
8  V_CC = 25;// in V
9  V_BB = 10;// in V
10 R_C = 15 * 10^3;// in ohm
11 R_B = 40 * 10^3;// in ohm
12 R_E = 5 * 10^3;// in ohm
13 V_BE = 0.7;// in V
14 I_B= poly(0,'I_B');
15 I_E= (1+bita)*I_B;// in A
16 // Applying KVL to Base-Emitter loop,
17 // V_BB = I_B*R_B + V_BE + I_E*R_E
18 I_B=  I_B*R_B + V_BE + I_E*R_E-V_BB;
19 I_B= roots(I_B);// in A
20 I_E= (1+bita)*I_B;// in A
21 I_B= I_B*10^6;// in  A
22 disp("Part (a) : On assuming that the transistor is
        in the active region")
23 disp(I_B,"The value of I_B in   A  is : ")
24 I_C= bita*I_B;// in   A
25 I_C= I_C*10^-3;// in mA
26 disp(I_C,"The value of I_C in mA is");
27 I_E = (1+bita)*I_B;// in   A
28 I_E = I_E * 10^-6;// in A
29 I_C= I_C*10^-3;// in A
30 I_B= I_B*10^-6;// in A
31
```

```scilab
32  // Part (b): To verify that the transistor is not in
        the active region
33  // Applying KVL to collector circuit, we get V_CC=
        I_C*R_C+V_CE+I_E*R_E or
34  V_CE= V_CC-I_C*R_C-I_E*R_E;// in V
35  if V_CE<0 then
36      disp("Part (b)")
37      disp("Since the value of V_CE ("+string(V_CE)+"
            V) is negative,")
38      disp("hence the transistor is not in active
            region")
39  end
40
41  // Part (c)
42  V_BEsat= 0.8;// in V
43  V_CEsat= 0.2;// in V
44  // Applying KVL to base circuit, V_BB= I_B*R_B+
        V_BEsat+I_C*R_E+I_B*R_E, or
45  // I_B*(R_B+R_E)+I_C*R_E= V_BB-V_BEsat
        (i)
46  // Applying KVL to collector circuit, V_CC= I_C*R_C+
        V_CEsat+(I_C+I_B)*R_E, or
47  // I_B*R_E+I_C*(R_C+R_E)= V_CC-V_CEsat              (
        ii)
48  // Solving eq(i) and (ii) by matrix method
49  A= [(R_B+R_E) R_E;R_E (R_C+R_E)];
50  B= [V_BB-V_BEsat V_CC-V_CEsat];
51  R= B*A^-1;
52  I_B= R(1);// in A
53  I_B= I_B*10^6;// in  A
54  I_C= R(2);// in A
55  I_C= I_C*10^3;// in mA
56  disp("Part (c) : On assuming that the transistor is
        in saturation region")
57  disp(I_B,"The value of I_B in  A is : ")
58  disp(I_C,"The value of I_C  in mA is : ")
59  I_Bmin= I_C/bita;// in mA
60  I_Bmin= I_Bmin*10^3;// in  A
```

```scilab
61  if I_B > I_Bmin then
62      disp("Part (d) :")
63      disp("Since the value of I_B ("+string(I_B)+"
            A) is greater than the value of I_Bmin ("+
            string(I_Bmin)+"  A)")
64      disp("Hence the transistor is indeed in
            saturation region")
65  end
66
67  // Pard (e) : R_E to bring the transistor out of
       saturation
68  Vcut= 0.5;//cut in voltage in V
69  I_B= poly(0,'I_B');// in A
70  I_C= bita*I_B;// in A
71  I_E= (1+bita)*I_B;// in A
72  // Applying KVL to input loop, V_BB= I_B*R_B+V_BE+(
       I_C+I_B)*R_E or
73  // I_B= (V_BB-V_BE)/(R_B+(1+bita)*R_E)
                              (iii)
74  // I_C= bita*I_B =  (V_BB-V_BE)/(R_B+(1+bita)*R_E)*
       bita    (iv)
75  // V_B= V_BE+(1+bita)*I_B*R_E= V_BE+ (1+bita)*(V_BB-
       V_BE)/(R_B+(1+bita)*R_E)*R_E        (v)
                        (on substituting eq(iii))
76  // V_C= V_CC-I_C*R_C= V_CC-(V_BB-V_BE)/(R_B+(1+bita)
       *R_E)*bita*R_C                              (
       vi)                  (on substituting eq(iv))
77  // but V_B-V_C<= Vcut and substituting the value
       from eq (v) and (vi), we get
78  R_E= [bita*R_C*(V_BB-V_BE)-R_B*(Vcut+V_CC-V_BE)
       ]/[(1+bita)*(-V_BB+Vcut+V_CC)];// in ohm
79  R_E= R_E*10^-3;// in k ohm
80  disp("Part (e) : The value of R_E >= "+string(R_E)+"
        k ")
```

Scilab code Exa 2.16 Region of transistor and output voltage

```scilab
1  // Exa 2.16
2  clc;
3  clear;
4  close;
5  format('v',7)
6  // Given data
7  bita = 100;
8  V_CEsat = 0.2;// in V
9  V_BEsat = 0.8;// in V
10 R_C = 3;// in k ohm
11 R_C = R_C * 10^3;// in k ohm
12 V_CC = 10;// in V
13 R_B = 7;// in k ohm
14 R_B = R_B * 10^3;// in ohm
15 R_E = 500;// in ohm
16 V_BB = 3;// in V
17 V_BE= 0.7;// in V
18 // Part (a) :
19 // Applying KVL to input loop, V_BB = I_B*R_B+(I_B+
      I_C)*R_E+V_BEsat or I_B*(R_B+R_E)+I_C*R_E= V_BB-
      V_BEsat              (i)
20 // Applying KVL to output loop, V_CC=I_C*R_C+V_CEsat
      +(I_B+I_C)*R_E or I_B*R_E+I_C*(R_C+R_E)= V_CC-
      V_CEsat              (ii)
21 // Solving eq(i) and (ii)by matrix method
22 A= [(R_B+R_E) R_E;R_E (R_C+R_E)] ;
23 B= [V_BB-V_BEsat V_CC-V_CEsat];
24 R= B*A^-1;
25 I_B= R(1);// in A
26 I_C= R(2);// in A
27 I_Bmin= I_C/bita;// in A
28 I_B= I_B*10^3;// in mA
29 I_Bmin=I_Bmin*10^3;// in mA
30 if I_B>I_Bmin then
31     disp("As the value of I_B ("+string(I_B)+" mA)
          is greater than the value of I_Bmin ("+string
```

24

```scilab
            (I_Bmin)+" mA)")
32      disp("Hence the transistor is in saturation
            region")
33  end
34
35  // Pard (e) : R_E to bring the transistor out of
        saturation
36  Vcut =0.5;//cut in voltage in V
37  I_B= poly(0,'I_B');// in A
38  I_C= bita*I_B;// in A
39  I_E= (1+bita)*I_B;// in A
40  // Applying KVL to input loop, V_BB= I_B*R_B+V_BE+(
        I_C+I_B)*R_E or
41  // I_B= (V_BB-V_BE)/(R_B+(1+bita)*R_E)
                                        (iii)
42  // I_C= bita*I_B =   (V_BB-V_BE)/(R_B+(1+bita)*R_E)*
        bita     (iv)
43  // V_C= -V_CC+I_C*R_C= -V_CC+(V_BB-V_BE)/(R_B+(1+
        bita)*R_E)*bita*R_C
                                            (v)
                    (on substituting eq(iv))
44  // V_B= V_BE-(1+bita)*I_B*R_E= V_BE- (1+bita)*(V_BB-
        V_BE)/(R_B+(1+bita)*R_E)*R_E       (vi)
                        (on substituting eq(iii))
45  // but V_C-V_B<= Vcut and substituting the value
        from eq (v) and (vi), we get
46  R_E= [(V_BB-V_BE)*bita*R_C-(Vcut+V_CC+V_BE)*R_B
        ]/[(1+bita)*(Vcut+V_CC-V_BB+2*V_BE)];// in ohm
47  disp(R_E,"The value of R_E in ohm is : ")
```

Scilab code Exa 2.17 Collector voltage and minimum value of hFE

```scilab
1  // Exa 2.17
2  clc;
3  clear;
```

```
 4  close;
 5  format('v',6)
 6  // Given data
 7  V_CC = 9;// in V
 8  R_C = 2;// in k ohm
 9  R_C =R_C * 10^3;// in ohm
10  R_B = 50;// in k ohm
11  R_B = R_B * 10^3;//in ohm
12  Beta = 70;
13  R_E = 1;// in k ohm
14  R_E = R_E * 10^3;// in ohm
15  V_BEsat = 0.8;// in V
16  V_CEsat = 0.2;// in V
17  // Applying KVL to input loop, V_CC= I_B*R_B+V_BEsat
        +I_E*R_E or
18  I_B= (V_CC-V_BEsat)/(R_B+(1+Beta)*R_E);// in A
19  // Applying KVL to output loop, V_CC= I_C*R_C+
        V_CEsat+I_E*R_E or
20  I_C= (V_CC-V_CEsat-I_B*R_E)/(R_C+R_E);// in A
21  I_Bmin= I_C/Beta;// in A
22  I_B= I_B*10^6;// in   A
23  I_Bmin= I_Bmin*10^6;// in   A
24  if I_B>I_Bmin then
25      disp("Part (i) :")
26      disp("As the value of I_B ("+string(I_B)+" mA)
           is greater than the value of I_Bmin ("+string
           (I_Bmin)+" mA)")
27      disp("Hence the transistor is in saturation
           region")
28  end
29  disp("Part (ii) : ")
30  V_C= V_CC-I_C*R_C;// in V
31  disp(V_C,"The collector voltage in volts is : ")
32  h_FE= I_C/(I_B*10^-6);
33  disp(h_FE,"The minimum value of h_FE that will
        change the state of the transistor is : ")
```

Scilab code Exa 2.18 Output voltage and minimum value of R1

```
1  // Exa 2.18
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  V_CC= 12;// in V
8  bita_min= 30;
9  R1= 15;// in k ohm
10 R2= 100;// in k ohm
11 R_C= 2.2;// in kohm
12 V_BB= -12;// in V
13 V_BE= 0.7;// in V
14 // Part (i)
15 Vi= 12;// in V
16 V_BEsat= 0.8;// in V
17 V_CEsat= 0.2;// in V
18 // Applying KVL to B-E circuit, Vi= I1*R1+V_BEsat or
19 I1= (Vi-V_BEsat)/R1;// in mA
20 // Applying KVL to -12 V supply,
21 I2= (V_BEsat-V_BB)/R2;// in mA
22 // Applying KVL to input loop,
23 I_B= I1-I2;// in mA
24 // Applying KVL to output loop, V_CC= I_C*R_C+
       V_CEsat or
25 I_C= (V_CC-V_CEsat)/R_C;// in mA
26 I_Bmin= I_C/bita_min;// in mA
27 if I_B>I_Bmin then
28     disp("Part (a) :")
29     disp("As the value of I_B ("+string(I_B)+" mA)
           is greater than the value of I_Bmin ("+string
           (I_Bmin)+" mA)")
```

```
30      disp("Hence the transistor is in saturation
           region")
31 end
32 Vo= V_CC-I_C*R_C;// in V
33 disp(Vo,"The output voltage in volts is : ")
34
35 // Part (b)
36 I2= (V_CC+V_BE)/R2;// in mA
37 // and I1= (V_CC-V_BE)/R1;// in mA         (i)
38 I_B= I_Bmin;// in mA
39 I1= I2+I_Bmin;// in mA
40 // Now from eq(i)
41 R1= (V_CC-V_BE)/I1;// in k ohm
42 disp("Part (b)")
43 disp(R1,"The value of R1 in k ohm is : ")
44
45 // Part (c)
46 I_C= 0;// in mA
47 Vo= V_CC-I_C*R_C;// in V
48 disp("Part (c) : Transistor is in cutoff")
49 disp(Vo,"The value of Vo in volts is : ")
50
51 // Note: There is some difference between coding
       output and answer of the book. This is why
       because in the book the calculate value of I_C is
        5.36 mA/ 30 = 0.178 mA while accurate value is
       0.179 mA
```

Chapter 3

Transistor Biasing And Thermal Stabilization

Scilab code Exa 3.1 DC load line

```scilab
1  // Exa 3.1
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  V_CC = 15;// in V
8  R_C = 4;// in k ohm
9  R_C =R_C * 10^3;// in ohm
10 I_C = 0;// in A
11 V_CE = V_CC - (I_C*R_C);// in V
12 V_CE = 0;// in V
13 // V_CE = V_CC - I_C*R_C;
14 I_C = V_CC/R_C;// in A
15 I_C = I_C * 10^3;// in mA
16 plot([V_CC 0],[0 I_C])
17 xlabel("V_CE in volts")
18 ylabel("I_C in mA")
19 title("DC load line")
```

```
20 disp("DC load line shown in figure")
```

Scilab code Exa 3.2 Q point

```
1  // Exa 3.2
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  R_C = 5;// in k ohm
8  V_CC = 10;// in V
9  I_C = 1;// in mA
10 V_CE = V_CC - (I_C*R_C);// in V
11 disp("Part (i) When Collector load = 5 kohm");
12 disp("Operating point is : "+string(V_CE)+" V, "+
       string(I_C)+" mA")
13 disp("The quiescent point 5V and 1mA");
14 R_C = 6;// in k ohm
15 V_CE = V_CC - (I_C*R_C);// in V
16 disp("Part (ii) When Collector load = 6 kohm");
17 disp("Operating point is : "+string(V_CE)+" V, "+
       string(I_C)+" mA")
```

Scilab code Exa 3.3 Q point values

```
1  // Exa 3.3
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  Beta = 100;
```

```
 8  V_CC = 10; // in V
 9  V_BE = 0.7; // in V
10  R_B = 150; // in k ohm
11  // V_CC - I_B*R_B - V_BE = 0;
12  I_B = (V_CC-V_BE)/R_B; // in mA
13  // I_C = Beta*I_B + (1+Beta)*I_CO;
14  I_C = Beta * I_B; // in A
15  // V_CC - I_C*R_C - V_CE = 0;
16  R_C = 1; // in k ohm
17  V_CE = V_CC - (I_C*R_C); // in V
18  disp("The operating point is : "+string(V_CE)+" V, "
        +string(I_C)+" mA")
```

Scilab code Exa 3.4 IBQ ICQ VCEQ VB VC and VBC

```
 1  // Exa 3.4
 2  clc;
 3  clear;
 4  close;
 5  format('v',6)
 6  // Given data
 7  V_CC = 12; // in V
 8  R_C = 2.2; // in k ohm
 9  R_C = R_C * 10^3; // in ohm
10  R_B = 240; //in k ohm
11  R_B = R_B * 10^3; // in ohm
12  V_BE = 0.7; // in V
13  // V_CC - I_B*R_B - V_BE = 0;
14  I_BQ = (V_CC-V_BE)/R_B; // in A
15  I_BQ = I_BQ * 10^6; // in  A
16  disp(I_BQ,"The value of I_BQ in  A is");
17  Beta = 50;
18  // I_CQ = Beta*I_BQ + (1+BEta)*I_CO;
19  I_CQ = Beta*I_BQ*10^-6; // in A
20  I_CQ = I_CQ * 10^3; // in mA
```

```
21  disp(I_CQ,"The value of I_CQ in mA is");
22  // V_CC - I_CQ*R_C - V_CEQ = 0;
23  V_CEQ = V_CC - I_CQ*10^-3*R_C;// in V
24  disp(V_CEQ,"The value of V_CEQ in V is");
25  V_B = V_BE;// in V
26  disp(V_B,"The value of V_B in V is");
27  V_C = V_CEQ;// in V
28  disp(V_C,"The value of V_C in V is");
29  // V_CE = V_CB + V_BE;
30  V_CB = V_CEQ - V_BE;// in V
31  V_BC = -V_CB;// in V
32  disp(V_BC,"The value of V_BC in V is");
```

Scilab code Exa 3.5 Percent change the Q point value over temparature range

```
1   // Exa 3.5
2   clc;
3   clear;
4   close;
5   format('v',6)
6   // Given data
7   V_CC = 12;// in V
8   R_B = 100;// in k ohm
9   R_C = 500*10^-3;// in k ohm
10  Beta_dc = 100;
11  V_BE= 0.7;// in V
12  // V_CC - I_BQ*R_B - V_BE = 0;
13  I_BQ = (V_CC - V_BE)/R_B;// in mA
14  I_CQ = Beta_dc*I_BQ;// in mA
15  // V_CC - I_CQ*R_C - V_CEQ = 0;
16  V_CEQ = V_CC - (I_CQ*R_C);// in V
17  disp("The Q point at 30    is : "+string(V_CEQ)+" V,
        "+string(I_CQ)+" mA")
18  Beta_dc = 120;
```

```
19  I_CQ1 = Beta_dc*I_BQ;// in mA
20  V_CEQ1 = V_CC - (I_CQ1*R_C);// in V
21  disp("The Q point at 80   is : "+string(V_CEQ1)+" V,
         "+string(I_CQ1)+" mA")
22  PerI_CQ = ((I_CQ1-I_CQ)/I_CQ)*100;// in %
23  disp("The percentage change in I_CQ is : "+string(
         PerI_CQ )+" % (increase)");
24  PerV_CEQ = ((V_CEQ1-V_CEQ)/V_CEQ)*100;// in %
25  disp("The percentage change in V_CEQ is : "+string(
         abs(PerV_CEQ))+" % (decrease)");
```

Scilab code Exa 3.6 Stability factor

```
 1  // Exa 3.36
 2  clc;
 3  clear;
 4  close;
 5  format('v',5)
 6  // Given data
 7  R_B = 100;// in k ohm
 8  R_B = R_B * 10^3;// in ohm
 9  R_C = 1;// in k ohm
10  R_C = R_C * 10^3;// in ohm
11  V_BE = 0.3;// in V
12  // S = 1 + Beta and Beta = I_C/I_B;
13  V_CC = 12;// in V
14  V_CE = 6;// in V
15  I_C = (V_CC-V_CE)/R_C;// in A
16  I_C = I_C * 10^3;// in mA
17  I_B = (V_CC-V_BE)/R_B;// in A
18  I_B = I_B * 10^6;// in   A
19  Beta = (I_C*10^-3)/(I_B*10^-6);
20  S = 1 + Beta;
21  disp(S,"The stability factor is");
```

Scilab code Exa 3.7 Collector current VCE and stability factor

```
1  // Exa 3.7
2  clc ;
3  clear ;
4  close ;
5  format ( 'v' ,6)
6  // Given data
7  V_CC = 25;// in V
8  R_B = 180;// in k ohm
9  R_C = 820*10^-3;// in k ohm
10 R_E = 200*10^-3;// in k ohm
11 bita = 80;
12 V_BE = 0.7;// in V
13 // Applying KVL to B-E loop, V_CC-I_B*R_B-V_BE-I_E*
      R_E=0 or
14 I_C= (V_CC-V_BE)/((R_B+R_E)/bita-R_E);// in A   (on
      putting I_B= I_C/bita and I_E= I_B+I_E)
15 disp(I_C,"The collector current in mA is");
16 V_CE = V_CC - (I_C*R_C);// in V
17 disp(V_CE,"The collector to emmiter voltage in V is"
      );
18 S = (1 + bita)/( 1 + ( (bita*R_E)/(R_B+R_E) ) );
19 disp(S,"Current stability factor is");
20 Sdas = -bita/( R_B + R_E*(1+bita) );
21 disp(Sdas,"The voltage stability factor is");
```

Scilab code Exa 3.8 Q point value

```
1  // Exsa 3.8
2  clc ;
3  clear ;
```

34

```
 4  close;
 5  format('v',6)
 6  // Given data
 7  V_CC = 20;// in V
 8  V_BE= 0.7;// in V
 9  R_C = 4.7;//in k ohm
10  bita = 100;
11  R_B = 680;// in k ohm
12  I_C= poly(0,'I_C');// in mA
13  I_B= I_C/bita;// in  mA
14  // Applying KVL to C–B circuit , V_CC − (I_C+I_B)*R_C
        − I_B*R_B − V_BE = 0;
15  I_C= V_CC - (I_C+I_B)*R_C - I_B*R_B - V_BE;
16  I_C= roots(I_C);// in mA
17  I_B= I_C/bita;// in  mA
18  V_CEQ = V_CC - (I_C+I_B)*R_C;// in V
19  disp("Q point : "+string(V_CEQ)+" volts , "+string(
        I_C)+" mA")
```

Scilab code Exa 3.9 Collector to base bias circuit

```
 1  // Exa  3.9
 2  clc;
 3  clear;
 4  close;
 5  format('v',6)
 6  // Given data
 7  V_CEQ = 5;// in V
 8  I_CQ = 5;// in mA
 9  V_CC = 12;// in V
10  bita = 120;
11  I_C = I_CQ;// in mA
12  V_BE = 0.7;// in V
13  I_B= I_C/bita;// in mA
14  // V_CC − (I_C+I_B)*R_C − V_CE = 0  or
```

```
15  R_C= (V_CC-V_CEQ)/(I_C+I_B);// in k ohm
16  // Applying KVL to base circuit, V_CC − (I_C+I_B)∗
        R_C − I_B∗R_B − V_BE = 0 or
17  R_B= (V_CEQ-V_BE)/I_B;// in k ohm
18  disp(R_C,"The value of R_C in k ohm is");
19  disp(R_B,"The value of R_B in k ohm is");
```

Scilab code Exa 3.10 Stability factor

```
 1  // Exa 3.10
 2  clc;
 3  clear;
 4  close;
 5  format('v',5);
 6  // Given data
 7  V_CC = 10;// in V
 8  R_C = 1;// in k ohm
 9  R_B = 100;//in k ohm
10  V_CE = 5;// in V
11  V_BE = 0.7;// in V
12  V_CB= V_CE-V_BE;// in V
13  I_B= V_CB/R_B;// in mA
14  // V_CC = (I_C+I_B)∗R_C + V_CE = I_C∗R_C + I_B∗R_C +
        V_CE;
15  I_C =  (V_CC-V_CE-(I_B*R_C))/R_C;// in mA
16  bita= I_C/I_B;
17  S = (1 + bita)/( 1 + bita*( R_C/(R_B+R_C) ) );
18  disp(S,"The value of stability factor is");
19  S_fixed_bias= 1+bita;// stability factor for fixed
        bias circuit
20  disp(S_fixed_bias,"For the fixed bias circuit, the
        value of stability factor would have been")
21  disp("Thus collector to base circuit has a low value
         of S and hence provides better Q point stability
        ")
```

Scilab code Exa 3.11 Q point value

```
1  // Exa 3.11
2  clc;
3  clear;
4  close;
5  format('v',5)
6  //Given data
7  Beta = 100;
8  V_CC = 10;// V
9  R1 = 9.1;// in k ohm
10 R_C = 1;// in k ohm
11 R_E = 560*10^-3;// in  k ohm
12 R2 = 4.7;// in k ohm
13 V_BE = 0.7;// in V
14 V_Th = (V_CC/(R1+R2))*R2;// in V
15 R_B = (R1*R2)/(R1+R2);// in k ohm
16 // V_Th - I_B*R_B - V_BE - I_E*R_E = 0 or
17 I_B = (V_Th-V_BE)/(R_B+((1+Beta)*R_E));// in mA
18 // I_C = Beta*I_B + (1+Beta)*I_CO;
19 I_C = Beta*I_B;// in mA (neglecting I_CO as it is
       very small)
20 // V_CC - (I_C*R_C) - V_CE - I_E*R_E = 0;
21 V_CE = V_CC - (I_C*R_C) - (I_C*R_E);// in V
22 disp("Q Point : "+string(V_CE)+" volts , "+string(I_C
       )+" mA")
```

Scilab code Exa 3.12 Quiescent current and collector emitter voltage

```
1  // Exa 3.12
2  clc;
```

```
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 V_CC = 20;// in V
8 bita = 50;
9 R_C = 2;// in k ohm
10 R_E = 0.1;// in k ohm
11 R1 = 100;// in k ohm
12 R2 = 5;// in k ohm
13 R_Th = (R1*R2)/(R1+R2);// in k ohm
14 R_B = R_Th;// in k ohm
15 V_BE = 0.7;// in V
16 V_Th = (V_CC*R2)/(R1+R2);// in V
17 // Applying KVL to the base circuit, V_Th - I_B*R_B
       - V_BE - I_E*R_E = 0 or
18 I_B = (V_Th-V_BE)/(R_B + (R_E*(1+bita)));// in mA
           (on putting I_E= (1+bita)*I_B)
19 I_C = bita*I_B;// in mA
20 I_E = (1+bita)*I_B;// in mA
21 V_CE = V_CC - (I_C*R_C) - (I_E*R_E);// in V
22 disp("Q Point : "+string(V_CE)+" volts, "+string(I_C
      )+" mA")
```

Scilab code Exa 3.13 Q point value

```
1 // Exa 3.13
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
7 bita= 44;
8 V_BE = 0.2;// in V
9 V_CC = -4.5;// in V
```

```
10  R1 = 2.7;// in k ohm
11  R_C = 1.5;// in k ohm
12  R2 = 27;// in k ohm
13  R_E = 0.27;// in k ohm
14  R_Th = (R1*R2)/(R1+R2);// in k ohm
15  R_B = R_Th;// in k ohm
16  V_Th = (V_CC*R_B)/R2;// in V
17  I_B= poly(0,'I_B');// in mA
18  I_C= bita*I_B;// in mA
19  I_E= -(I_C+I_B);// in mA
20  // Applying KVL to base circuit, -V_Th - I_B*R_B -
        V_BE + (I_E*R_E) = 0       (i)
21  I_B= (V_Th - I_B*R_B + V_BE + (I_E*R_E));// in mA
22  I_B= roots(I_B);// in mA
23  I_C= bita*I_B;// in mA
24  I_E= -(I_C+I_B);// in mA
25  // Applying KVL to collector circuit, -V_CC - I_C*
        R_C - V_CE + I_E*R_E = 0 or
26  V_CE = V_CC - (I_C*R_C) + (I_E*R_E);// in V
27  disp("Part (a) : ")
28  disp("Q Point : "+string(V_CE)+" volts, "+string(I_C
        )+" mA")
29  // Calculation of R'Th or R'B (Thevenin's Resistance
        )
30  r_bb = 0.69;// in k ohm
31  R_deshB = ((R1*R2)/(R1+R2)) + r_bb;// in k ohm
32  // Calculation of Thevenin's voltage
33  I_B= (V_Th+V_BE)/(R_deshB+(1+bita)*R_E);// in mA
34  I_C= bita*I_B;// in mA
35  // Applying KVL to collector circuit, -V_CC - (I_C*
        R_C) - V_CE + I_E*R_E = 0 or
36  V_CE = V_CC - (I_C*R_C) + (I_E*R_E);// in V
37  disp("Part (b) : ")
38  disp("Q Point : "+string(V_CE)+" volts, "+string(I_C
        )+" mA")
```

Scilab code Exa 3.14 DC bias voltage and current

```
1  // Exa 3.14
2  clc;
3  clear;
4  close;
5  format('v',5)
6  // Given data
7  bita = 140;
8  V_BE = 0.7;// in V
9  V_CC = 22;// in V
10 R1 = 39;// in k ohm
11 R_C = 10;// in k ohm
12 R2 = 3.9;// in k ohm
13 R_E = 1.5;// in k ohm
14 // Calculation of Thevenin's Resistance
15 R_Th = (R1*R2)/(R1+R2);// in k ohm
16 // Calculation of Thevenin's Voltage
17 V_Th = (V_CC*R2)/(R1+R2);// in V
18 I_B= poly(0,'I_B');// in mA
19 I_E= (1+bita)*I_B;// in mA
20 // Applying KVL to input side , V_Th - I_B*R_Th -
       V_BE - I_E*R_E=0 or
21 I_B= V_Th - I_B*R_Th - V_BE - I_E*R_E;
22 I_B= roots(I_B);// in mA
23 I_C = bita*I_B;// in mA
24 I_E= (1+bita)*I_B;// in mA
25 // Applying KVL to C-E circuit , V_CC - I_C*R_C -
       V_CE - I_E*R_E = 0 or
26 V_CE = V_CC - (I_C*R_C) - ((1+bita)*I_B*R_E);// in V
27 I_B= I_B*10^3;// in   A
28 disp(I_B,"The value of I_B in   A  is");
29 disp(I_C,"The value of I_C in mA is");
30 disp(V_CE,"The value of V_CE in V is");
```

Scilab code Exa 3.15 RE and stability factor

```
1  // Exa 3.15
2  clc;
3  clear;
4  close;
5  format('v',5)
6  // Given data
7  V_CC =12;// in V
8  R_C = 4.3;// in k ohm
9  V_CE = 4;// in V
10 V_BE = 0.7;// in V
11 V_EE = 6;// in V
12 bita = 50;
13 // Applying KVL in base circuit, -V_BE - I_ER_E +
     V_EE = 0 or
14 I_ER_E = V_EE - V_BE;// in V
15 // Applying KVL in C-E circuit, V_CC-I_C*R_C-V_CE-
     I_ER_E+V_EE=0 or
16 I_C = (V_CC - V_CE - I_ER_E + V_EE)/R_C;// in mA
17 I_B = I_C/bita;// in mA
18 I_E = I_C+I_B;// in mA
19 R_E= I_ER_E/I_E;// in k ohm
20 disp(R_E,"The value of R_E in k ohm is : ")
21 del_IC= bita*(1+bita)*R_E;
22 del_ICO= bita*(1+bita)*R_E;
23 S= del_IC/del_ICO;
24 disp(S,"The value of stability factor, S is : ")
25 S_desh= bita/((1+bita)*R_E);
26 disp(S_desh,"The value of stability factor, S'' is :
     ")
```

Scilab code Exa 3.17 Junction temperature

```
1  // Exa 3.17              (Miss printed as example 3.14)
2  clc;
3  clear;
4  close;
5  format('v',5)
6  // Given data
7  Tj = 150;//Junction temperature in degree C
8  P_Cmax = 125;// in mW
9  T = 25;// free-air temperature in degree C
10 T1 = 0;// in degree C
11 curve = (Tj-T)/(P_Cmax - T1);// in degreeC/mW
12 T_A = 25;// Ambient temperature in degree C
13 P_D = 75;// Collector junction dissipation in mW
14 theta = 1;// in degree C/mW
15 // Tj-T_A = theta*P_D;
16 Tj = T_A + (theta*P_D);// in degree C
17 disp(Tj,"The junction temperature in  C is");
```

Scilab code Exa 3.18 Thermal resistance and junction temperature

```
1  // Exa 3.18              (Miss printed as example
      3.15)
2  clc;
3  clear;
4  close;
5  format('v',5)
6  // Given data
7  P_Cmax = 125;// in mW
8  P_D = P_Cmax;// in mW
9  T_A = 25;// in degree C
10 Tj = 150;// in degree C
11 // Tj-T_A = theta*P_D;
12 theta = (Tj-T_A)/P_D;// in degree C/mW
```

```
13  disp(theta,"The thermal resistance for a transistor
        in   C /mW is");
14  // For theta= 1   C /mW
15  P_D = 75;// in mW
16  // Tj-T_A = theta*P_D;
17  Tj = (theta*P_D) + T_A;// in degree C
18  disp(Tj,"The junction temperature in   C is");
```

Scilab code Exa 3.20 Biasing component for fixed bias

```
 1  // Exa 3.20                    (Miss printed as example
        3.17)
 2  clc;
 3  clear;
 4  close;
 5  format('v',7)
 6  // Given data
 7  V_E = 1;// in V
 8  V_BE = 0.7;// in V
 9  R_C = 1;// in k ohm
10  Beta = 180;
11  V_CC = 12;// in V
12  V_CEQ = 6;// in V
13  // Applying KVL into collector circuit, V _CC - I_C*
        R_C - V_CEQ = 0 or
14  I_C = (V_CC-V_CEQ)/R_C;// in mA
15  I_B = I_C/Beta;// in mA
16  // Applying KVL into base circuit, V_CC - I_B*R_B -
        V_BE = 0 or
17  R_B = (V_CC-V_BE)/I_B;// in k ohm
18  disp(R_B,"The value of R_B in k ohm is");
19  //Applying KVL to collector circuit, V_CC - I_C*R_C
        - V_CE - V_E = 0 or
20  I_C = (V_CC-V_CEQ-V_E)/R_C;// in mA
21  I_B = I_C/Beta;// in mA
```

```
22  I_E = I_C+I_B;// in mA
23  R_E = V_E/(I_E);// in k ohm
24  R_E= round(R_E*10^3);// in ohm
25  disp(R_E,"The value of R_E in ohm is");
26  I_R2 = 10*I_B;// in mA
27  V_BE= 0.6;// in V
28  //R2 =V_B/I_R2 = (V_E+V_BE)/I_R2;
29  R2 = (V_E+V_BE)/I_R2;// in k ohm
30  R2= R2*10^3;// in ohm
31  disp(R2,"The value of R2 in ohm is");
32  I_R1 = I_R2 + I_B;// in mA
33  //R1 = V_R1/I_R1 = (V_CC-V_B)/I_R1;
34  V_B = V_E+V_BE;// in V
35  R1 = (V_CC-V_B)/I_R1;// in k ohm
36  disp(R1,"The value of R1 in k ohm is");
```

Scilab code Exa 3.21 Value of ICQ

```
1  // Exa 3.21                    (Miss printed as example
       3.18)
2  clc;
3  clear;
4  close;
5  format('v',5)
6  // Given data
7  V_BB= 6;// in V
8  I_CBO =0.5;// in  A
9  V_BE = 0.7;// in V
10 R_B= 50;// in k ohm
11 R_E= 1;// in k ohm
12 bita = 75;
13 // V_BB - I_B*R_B - V_BE - I_E*R_E = 0 or
14 I_B=(V_BB-V_BE)/(R_B+(1+bita)*R_E);// in mA      (on
       putting I_E= (1+bita)*I_B)              (i)
15 I_B= round(I_B*10^3);// in  A
```

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```
16  I_C= bita*I_B; // in   A
17  I_C= I_C*10^-3; // in mA
18  I_CQ= I_C; // in mA
19  disp(I_CQ,"The value of I_CQ at room temperature in
        mA is : ")
20  // Part (ii)
21  C= 2; // temperature coefficient in mV/ C
22  C= 2*10^-3; // in V/ C
23  T2= 20; // in   C
24  T1= 0; // in   C
25  I_CBO2= I_CBO*2^((T2-T1)/10); // in   A
26  V_BE2= V_BE-C*T2; // in V
27  // Now from eq(i), for the new value of I_B
28  I_B=(V_BB-V_BE2)/(R_B+(1+bita)*R_E); // in mA
29  I_B= I_B*10^3; // in   A
30  I_C= bita*I_B+(1+bita)*I_CBO2; // in   A
31  I_C= I_C*10^-3; // in mA
32  I_CQ= I_C; // in mA
33  disp(I_CQ,"The value of I_CQ when temperature
        increases by 20  C  in mA is : ")
```

Scilab code Exa 3.22 Value of R1 R2 and RE

```
 1  // Exa 3.22                      (Miss printed as example
        3.19)
 2  clc;
 3  clear;
 4  close;
 5  format('v',6)
 6  // Given data
 7  S = 10;
 8  bita = 50;
 9  h_fe = bita;
10  V_CC= 20; // in V
11  V_CE = 10; // in V
```

```
12  R_C = 2;// in k ohm
13  I_C = 4;// in mA
14  I_B =I_C/bita;// in mA
15  // Applying KVL to collector loop, V_CC -I_C*R_C -
        V_CE - I_E*R_E = 0 or
16  R_E = (V_CC -I_C*R_C - V_CE)/(I_C+I_B);// in k ohm
                    (on putting I_E= I_C+I_B)
17  R_E= round(R_E*10^3);// in ohm
18  disp(R_E,"The value of R_E in ohm is");
19  // Formula S = (1+bita)*( (1 + (R_B/R_E))/( (1+bita)
        + (R_B/R_E) ) ) or
20  R_B= (1+bita)*(1-S)*R_E/(S-1-bita);// in ohm
21  // But R_B= R1 || R2= R1*R2/(R1+R2) => R2/(R1+R2)=
        R_B/R1           (i)
22  // Calculation of R1 and R2 :
23  V_BE= 0.2;// in V
24  // Applying KVL to input loop,
25  V_R2= V_BE+(I_C+I_B)*10^-3*R_E;// in V
26  // But V_R2= R2*V_CC/(R1+R2) =>  R2/(R1+R2)= V_R2/
        V_CC            (ii)
27  // On comparing eq (i) and (ii)
28  R1= R_B*V_CC/V_R2;// in ohm
29  R2= R1*V_R2/(V_CC-V_R2);// in ohm
30  R1= R1*10^-3;// in k ohm
31  R2= R2*10^-3;// in k ohm
32  disp(R1,"The value of R1 in k ohm is : ")
33  disp(R2,"The value of R2 in k ohm is : ")
34  // Effect of Reducing S or 3 :
35  S=3;
36  // Formula S = (1+bita)*( (1 + (R_B/R_E))/( (1+bita)
        + (R_B/R_E) ) ) or
37  R_B= (1+bita)*(1-S)*R_E/(S-1-bita);// in ohm
38  R_B= R_B*10^-3;// in k ohm
39  disp(R_B,"When S<=3, the value of R_B in k ohm is :
        ")
40  disp("Thus S is reduced below 3 at the cost of
        reduction of it''s input impedance")
```

Chapter 4

The Transistor At Low Frequency

Scilab code Exa 4.1 Overall current gain

```scilab
1  // Exa 4.1
2  clc ;
3  clear ;
4  close ;
5  format ( 'v' ,6)
6  // Given data
7  R1 = 100*10^3; // in ohm
8  R2 = 10*10^3; // in ohm
9  h_fe = 50;
10 h_oe = 1/40; // in ohm
11 R_L = 5*10^3; // in ohm
12 R_S= 5*10^3; // in ohm
13 h_ie = 1.1*10^3; // in ohm
14 h_re = 2.5*10^-4;
15 R_B = (R1*R2/(R1+R2)); // in ohm
16 A_I = (-h_fe)/(1 + h_oe*R_L);
17 disp(A_I,"The internal current gain is");
18 //Internal input impedance, Zi = Vbe/Ib or
19 Zi = (h_ie + h_re*A_I*R_L); // in ohm
```

```
20  Zi= Zi*10^-3;// in k ohm
21  disp(Zi,"The internal input impedance in k ohm is");
22  Zi= Zi*10^3;// in ohm
23  //Internal voltage gain , Av = Vce/Vbe or
24  Av = (A_I*R_L)/Zi;
25  disp(Av,"The internal voltage gain is");
26  Ri = floor(R_B*Zi/(R_B+Zi));// in ohm
27  Ri= Ri*10^-3;// in k ohm
28  disp(Ri,"The overall input impedance in k ohm is");
29  Ri= Ri*10^3;// in ohm
30  // V_S= I_i*R_S+v_be or
31  VS_by_vbe= Ri/(Ri+R_S);
32  Avs= Av*VS_by_vbe;
33  disp(Avs,"The overall voltage gain is : ")
34  // R_B*(I_i-I_b)= Zi*I_b or
35  I_bBYI_i= R_B/(R_B+Zi);
36  A_IS= A_I*I_bBYI_i;
37  disp(A_IS,"The overall current gain is : ")
38  Rdesh_S= R_B*R_S/(R_B+R_S);// in ohm
39  Rdesh_S= 3220
40  I_bByVce= -h_re/(h_ie+Rdesh_S);
41  Yo= h_oe-h_fe*h_re/(h_ie+Rdesh_S)*10^3;
42  Zo= 1/Yo;
43  disp(Zo,"The Output impedance in ohm is : ")
```

Scilab code Exa 4.2 Overall current gain

```
1  // Exa 4.2
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  V_CC = 15;// in V
8  R_L = 10;// in k ohm
```

```scilab
 9  Rf = 200;// in k ohm
10  R_S = 5;// in k ohm
11  Rf2 = Rf;// in k ohm
12  h_fe = 50;
13  V_S= 10*10^-3;// in V
14  h_oe = 1/40;// in k ohm
15  R_L = (R_L*Rf2)/(R_L+Rf2);// in k ohm
16  Ai = -h_fe/(1+h_oe*R_L);
17  disp(Ai,"The internal current gain is");
18  //Zi = Vbe/Ib = h_ie +Ai*h_re*R_L;
19  h_ie = 1.1;// in k ohm
20  h_re = 2.5*10^-4;
21  Zi = h_ie +Ai*h_re*R_L;// in k ohm
22  disp(Zi,"The internal input impedance in k ohm is");
23  //A_V = Vce/Vbe = (Ai*R_L)/Zi;
24  A_V = (Ai*R_L)/Zi;
25  disp(A_V,"The internal voltage gain is");
26  Rf1= Rf/(1-A_V)
27  // Rf1 = Rf/(1-A_V);// in k ohm
28  //Ri = Vi/Ii = Vbe/Ii = (Rf1*Zi)/(Rf1+Zi);
29  Ri = (Rf1*Zi)/(Rf1+Zi);// in k ohm
30  disp(Ri,"The overall input impedance in k ohm is");
31  //A_VS = Vo/V_S or
32  A_VS = A_V*(Ri/(R_S+Ri));
33  disp(A_VS,"The overall voltage gain is");
34  //A_IS = I_L/Ii or
35  A_IS = (Rf2/(Rf2+R_L))*Ai*(Rf1/(Rf1+Zi));
36  disp(A_IS,"The overall current gain is");
37  Rdesh_S= Rf1*R_S/(Rf1+R_S);// in k ohm
38  Yo= h_oe-h_re*h_fe/(h_ie+Rdesh_S);// in mho
39  Zo= 1/Yo;// in ohm
40  disp(Zo,"The output impedance in ohm is : ")
41  Zdesh_o= Rf2*Zo/(Rf2+Zo);// in ohm
42  disp(Zdesh_o,"The overall output impedance in ohm is
        : ");
43  Vo= V_S*abs(A_VS);// in V
44  Vo= Vo*10^3;// in mV
45  disp(Vo,"The magnitude of output voltage in mV is :
```

```
                ")
```

Scilab code Exa 4.3 Output impedance

```
 1  // Exa 4.3
 2  clc;
 3  clear;
 4  close;
 5  format('v',6)
 6  // Given data
 7  h_ic = 2;// in k ohm
 8  h_fc = -51;
 9  h_oc = 25*10^-6;// in ohm
10  h_rc= 1;
11  V_CC = 20;// in V
12  R1 = 10;// in k ohm
13  R2 = 10;// in k ohm
14  R_S = 1;// in k ohm
15  R_E = 5;// in k ohm
16  R_B= 5;// in k ohm
17  R_L= 5;// in k ohm
18  // (i) Current Gain
19  Ai = (-h_fc)/(1+h_oc*R_E*10^3);
20  disp(Ai,"The current gain is");
21  // (ii) Input impedance
22  Zi = h_ic*10^3 + h_rc*Ai*R_E*10^3;// in ohm
23  Zi = Zi * 10^-3;// in k ohm
24  disp(Zi,"The input impedance in k ohm is");
25  // (iii) Voltage Gain
26  A_V = (Ai*R_L*10^3)/(Zi*10^3);
27  A_V = 1;// (approx)
28  disp(A_V,"The voltage gain is");
29  // (iv) Overall Input Impedance
30  Z_IS = (R_B*Zi)/(R_B+Zi);// in k ohm
31  disp(Z_IS,"The overall input impedance in k ohm is")
```

```
     ;
32 // (v) Overall voltage gain
33 A_VS = (A_V*Zi)/(Zi+R_S);
34 disp(A_VS,"The overall voltage gain is");
35 // (vi) Overall current gain
36 A_IS =Ai*(R_B/(R_B+Zi));
37 disp(A_IS,"The overall current gain is");
38 // (vii) Output impedance
39 RdasS = (R_S*R_B)/(R_S+R_B);// in k ohm
40 Yo = h_oc - ( (h_fc*h_rc)/(h_ic*10^3+RdasS*10^3) );
      // in mho
41 Zo = 1/Yo;// in ohm
42 disp(Zo,"The output impedance in ohm is");
```

Scilab code Exa 4.4 Overall current gain

```
 1 // Exa 4.4
 2 clc;
 3 clear;
 4 close;
 5 format('v',6)
 6 // Given data
 7 h_ie = 1.1;// in k ohm
 8 h_re = 2.5*10^-4;
 9 h_fe = 50;
10 h_oe = 25*10^-6;// in A
11 V_CC = 15;// in V
12 R1 = 20;// in k ohm
13 R_C = 2;// in k ohm
14 R2 = 10;// in k ohm
15 R_S = 1;// in k ohm
16 R_E = 1;// in k ohm
17 // (i) Current Gain
18 Ai = -h_fe/(1 + h_oe*R_C*10^3);
19 disp(Ai,"The current gain is");
```

```
20  // (ii) Input impedance
21  Zi = (h_ie*10^3) + (h_re*Ai*R_C*10^3);//in ohm
22  Zi = Zi * 10^-3;// in k ohm
23  disp(Zi,"The input impedance in k ohm is");
24  // (iii) Voltage gain
25  A_V = (Ai*R_C)/Zi;
26  disp(A_V,"The voltage gain is");
27  // (iv) Overall input impedance
28  R_B = (R1*R2)/(R1+R2);// in k ohm
29  Z_IS = (Zi*R_B)/(Zi+R_B);// in k ohm
30  disp(Z_IS,"The overall input impedance in k ohm is")
       ;
31  // (v) Overall voltage gain
32  A_VS = A_V * (Z_IS/(Z_IS+R_S));
33  disp(A_VS,"The overall voltage gain is");
34  // (vi) Overall current gain
35  A_IS =Ai*(R_B/(R_B+Zi));
36  disp(A_IS,"The overall current gain is");
```

Scilab code Exa 4.5 Power gain

```
1  // Exa 4.5
2  clc;
3  clear;
4  close;
5  format('v',7)
6  // Given data
7  h_ie = 1.1;// in k ohm
8  h_oe = 25;// in A/V
9  h_oe = h_oe * 10^-6;// in A/V
10  h_fe = 50;
11  h_re = 2.5*10^-4;
12  R_L = 1.6;// in ohm
13  R_S = 1;// in k ohm
14  V_CC = 15;// in V
```

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```
15  // (i) Current Gain
16  Ai = -h_fe/(1 + (h_oe*R_L));
17  disp(Ai,"The current gain is");
18  // (ii) Input impedance
19  Zi = (h_ie*10^3) + (h_re*Ai*R_L);// in ohm
20  Zi= Zi*10^-3;// in k ohm
21  disp(Zi,"The input impedance in k ohm is");
22  Zi= Zi*10^3;// in ohm
23  // (iii) Voltage gain
24  A_V = Ai*R_L/Zi;
25  disp(A_V,"The voltage gain is");
26  // (iv) Power gain
27  A_P = Ai*A_V;
28  disp(A_P,"The power gain is");
```

Scilab code Exa 4.6 ICQ VCEQ Ai Zi Av ZIS AVS AIS

```
1  // Exa 4.6
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  h_fe = 150;
8  Beta_dc = h_fe;
9  h_ie = 1*10^3;// in ohm
10 h_re = 0;
11 h_oe = 0;
12 V_CC = 18;// in V
13 V_BE= 0.7;// in V
14 R1 = 100*10^3;// in ohm
15 R2 = 50*10^3;// in ohm
16 R_C = 1*10^3;// in ohm
17 R_E = 0.5*10^3;// in ohm
18 V_Th = (V_CC/(R1+R2))*R2;// in V
```

```
19  R_Th =(R1*R2)/(R1+R2);// in ohm
20  // V_Th − I_B*R_Th − V_BE − (1+Beta)*−I_B*R_E = 0;
21  I_B = (V_Th-V_BE)/( R_Th + (1+Beta_dc)*R_E);// in A
22  //I_C = I_CQ = Beta*I_B;
23  I_C = Beta_dc*I_B;// in A
24  I_CQ = I_C;// in A
25  I_CQ= I_CQ*10^3;// in mA
26  disp(I_CQ,"The value of I_CQ in mA is");
27  I_E = (1+Beta_dc)*I_B;// in mA
28  // V_CC − I_C*R_C − V_CE − I_E*R_E = 0;
29  V_CE = V_CC - (I_C*R_C) - (I_E*R_E);// in V
30  disp(V_CE,"The value of V_CE in V is");
31  R_L =R_C;// in ohm
32  Ai = -h_fe/(1+(h_oe*R_L));
33  disp(Ai,"The current gain is ");
34  Zi = h_ie + h_re*Ai*R_L;// in ohm
35  Zi= Zi*10^-3;// in k ohm
36  disp(Zi,"The input impedance in k ohm is");
37  Zi= Zi*10^3;// in ohm
38  A_V = Ai*(R_L/Zi);
39  disp(A_V,"The voltage gain is");
40  R_B= (R1*R2)/(R1+R2);// in ohm
41  Z_IS =(Zi*R_B)/(Zi+R_B);// in ohm
42  Z_IS= Z_IS*10^-3;// in kohm
43  disp(Z_IS,"The overall input impedance in k ohm is")
       ;
44  Z_IS= Z_IS*10^3;// in ohm
45  A_VS =A_V*(Z_IS/Z_IS);
46  disp(A_VS,"The overall voltage gain is");
47  A_IS =Ai * (R_B/(R_B+Zi));
48  disp(A_IS,"The overall current gain is");
```

Chapter 5

BJT At High Frequency

Scilab code Exa 5.1 Parameter of hybrid phi model

```
1  // Exa 5.1
2  clc ;
3  clear ;
4  close ;
5  format ( 'v' ,6)
6  // Given data
7  I_C = 2;// in mA
8  I_C =I_C * 10^-3;// in A
9  V_CEQ = 20;// in V
10 h_fe = 100;
11 I_BQ = 20;// in   A
12 I_BQ = I_BQ * 10^-6;// in A
13 Beta = 100;
14 f_T = 50;// in MHz
15 f_T = f_T * 10^6;// in Hz
16 Cob = 3;// in pF
17 Cob = Cob * 10^-12;// in F
18 h_ie = 1400;// in ohm
19 T = 300;// in K
20 // (i) Transconductance
21 g_m = 11600*(I_C/T);// in S
```

```
22  g_m=g_m*10^6;// in   S
23  disp(g_m,"The transconductance in   S is");
24  // (ii) Input resistance
25  g_m=g_m*10^-6;// in S
26  r_be = h_fe/g_m;  //in ohm
27  disp(r_be,"The input resistance in ohm is");
28  // (iii) Capacitance
29  Cbc = Cob ;// in F
30  Cbe = g_m/(2*%pi*f_T)-Cbc;// in F
31  Cbe= round(Cbe*10^12);// in pF
32  disp(Cbe,"The capacitance in pF is");
33  // (iv) Base Spreading Resistance
34  r_bb = round(h_ie - r_be);// in ohm
35  disp(r_bb,"The base spreading resistance in ohm is")
      ;
```

Scilab code Exa 5.2 Parameter of hybrid phi model

```
1   // Exa 5.2
2   clc;
3   clear;
4   close;
5   format('v',6)
6   // Given data
7   I_C = 10;// in mA
8   I_C =I_C * 10^-3;// in A
9   V_CE = 10;// in V
10  V_T= 26*10^-3;// in V
11  h_ie = 500;// in ohm
12  h_oe = 4*10^-5;// in S
13  h_fe  = 100;
14  g_be = 1/260;
15  h_re = 10^-4;
16  f_T = 50;// in MHz
17  f_T = f_T * 10^6;// in Hz
```

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```
18  T = 300;// in K
19  Cob =3;// in pF
20  Cob = Cob * 10^-12;// in F
21  // (i) Transconductance
22  g_m = I_C/V_T;// in A/V
23  g_m= round(g_m*10^3);// in mA/V
24  disp(g_m,"The Transconductance in mA/V is");
25  // (ii) Input resistance
26  g_m= g_m*10^-3;// in A/V
27  r_be = round(h_fe/g_m);// in ohm
28  disp(r_be,"The input resistance in ohm is");
29  // (iii) Base spreading resistance
30  r_bb = h_ie - r_be;// in ohm
31  disp(r_bb,"The base spreading resistance in ohm is")
        ;
32  // (iv) The feedback conductance
33  format('e',8)
34  g_bc = h_re*g_be;
35  disp(g_bc,"The feedback conductance is");
36  // (v) The output conductance
37  g_ce = h_oe - (1+h_fe)*g_bc
38  disp(g_ce,"The output conductance is : ")
39  // (vi) Capacitance
40  format('v',6)
41  Cbe= g_m/(2*%pi*f_T);// in F
42  Cbe= Cbe*10^12;// in pF
43  disp(Cbe,"The value of C_b''e in pF is : ")
44  Cc= Cob;// in F
45  Cc= Cc*10^12
46  disp(Cc,"The value of Cc in pF is : ")
```

Scilab code Exa 5.3 Emitter diffusion capacitance

```
1  // Exa 5.3
2  clc;
```

```
3  clear;
4  close;
5  format('v',5)
6  // Given data
7  W = 10^-6;// in m
8  I_E =2;// in mA
9  I_E = I_E * 10^-3;// in A
10 V_T = 26;// in mV
11 V_T = V_T * 10^-3;// in V
12 D_B = 47*10^-4;
13 //g_m = abs(I_C)/V_T = abs(I_E)/V_T;
14 // The emitter diffusion capacitance, Cbe = g_m*((W
      ^2)/(2*D_B));
15 Cbe = I_E/V_T*W^2/(2*D_B);// F
16 Cbe= Cbe*10^12;// in pF
17 disp(Cbe,"The emitter diffusion capacitance in pF is
      ");
18 Cbe= Cbe*10^-12;// in F
19 g_m = abs(I_E)/V_T;
20 // The transition frequency
21 f_T = g_m/(2*%pi*Cbe);// in Hz
22 f_T = f_T * 10^-6;// in MHz
23 disp(f_T,"The transition frequency in MHz is");
24
25 // Note: The answer in the book is not accurate.
```

Scilab code Exa 5.4 Bita cutoff frequency and gain bandwidth product

```
1  // Exa 5.4
2  clc;
3  clear;
4  close;
5  // Given data
6  I_CQ = 5;// in mA
7  I_CQ = I_CQ * 10^-3;// in A
```

```
8  V_VEQ = 10;// in V
9  h_ie = 600;// in ohm
10 h_fe = 100;
11 C_C = 3;// in pF
12 C_C = C_C * 10^-12;// in F
13 Ai = 10;// Ai(f)
14 f = 10;// in MHz
15 // Ai = h_fe/( sqrt( 1 + ((f/f_Beta)^2) ) );
16 f_Beta = f/(sqrt( ((h_fe/Ai)^2) - 1 ));// in MHz
17 disp(f_Beta,"The Beta cut off frequency in MHz is");
18 f_T = h_fe*f_Beta;// in MHz
19 disp(f_T,"The gain bandwidth product in MHz is");
20 g_m = 0.1923;
21 Ce = g_m/(2*%pi*f_T*10^6);// in F
22 disp(Ce,"The value of Ce in F is");
23 Cbe= Ce;// in F
24 disp(Cbe*10^12,"The value of C_b''e in pF is : ")
25 r_be = h_fe/g_m;// in ohm
26 disp(r_be,"The value of r_b''e in ohm is");
27 r_bb = h_ie - r_be;// in ohm
28 disp(r_bb,"The value of r_bb'' in ohm is");
```

Scilab code Exa 5.5 Base width of Si pnp transistor

```
1  // Exa 5.5
2  clc;
3  clear;
4  close;
5  // Given data
6  f_T = 400;// in MHz
7  D_Beta = 13;// in cm^2/sec
8  //Ce = (g_m*(W^2))/(2*D_B), so
9  //f_T = (g_m/(2*%pi))*( (2*D_B)/(g_m*(W^2)) ) = D_B
       /(%pi*(W^2));
10 W = sqrt( D_Beta/(%pi*f_T*10^6) );// in cm
```

```
11  W = W * 10^4;// in   m
12  disp(W,"The base width of silicon transistor in   m
       is");
```

Scilab code Exa 5.6 Ce and fT

```
1   // Exa 5.6
2   clc;
3   clear;
4   close;
5   format('v',5)
6   // Given data
7   D_B = 47;// in cm^2/sec
8   I_C = 2;// in mA
9   I_C = I_C * 10^-3;// in A
10  V_CEQ = 15;// in V
11  W = 1;// in   m
12  W = W * 10^-4;// in cm
13  V_T = 0.026;// in V
14  g_m =I_C/(abs(V_T));// in ohm
15  Ce = (g_m*(W^2))/(2*D_B);// in F
16  Ce = Ce * 10^12;// in pF
17  disp(Ce,"The value of Ce in pF is");
18  f_T = g_m/(2*%pi*Ce*10^-12);// in Hz
19  f_T = f_T * 10^-6;// in MHz
20  disp(f_T,"The value of f_T in MHz is");
```

Chapter 6

The Field Effect Transistor And MOSFET

Scilab code Exa 6.1 Transfer curve

```
1  // Exa 6.1
2  clc;
3  clear;
4  close;
5  // Given data
6  I_DSS = 10;// in mA
7  V_P = -4;// in V
8  V_GS= V_P:0.1:0
9  I_D = I_DSS * ((1 - (V_GS/V_P))^2);// in A
10 plot(V_GS,I_D);
11 xlabel("V_GS in volts");
12 ylabel("I_D in mA")
13 title("Transfer curve")
14 disp("The transfer curve shown in the figure.")
```

Scilab code Exa 6.2 Transfer curve

```
1  // Exa 6.2
2  clc;
3  clear;
4  close;
5  // Given data
6  I_DSS = 4;// in mA
7  V_P = 3;// in V
8  V_GS= 0:0.1:V_P
9  I_D = I_DSS * ((1 - (V_GS/V_P))^2);// in A
10 plot(V_GS,I_D);
11 xlabel("V_GS in volts");
12 ylabel("I_D in mA")
13 title("Transfer curve")
14 disp("The transfer curve shown in the figure.")
```

Scilab code Exa 6.3 Value of ID

```
1  // Exa 6.3
2  clc;
3  clear;
4  close;
5  format('v',5)
6  // Given data
7  I_Don = 10;// in mA
8  I_Don = I_Don * 10^-3;// in A
9  V_GS = -12;// in V
10 V_GSt = -3;// in V
11 //From I_Don = Kn*((V_GS-V_GSt)^2);
12 Kn = I_Don/((V_GS-V_GSt)^2);// in A/V
13 Kn= Kn* 10^3;// in mA/V
14 V_GS = -6;// in V
15 I_D = Kn*((V_GS-V_GSt)^2);// in mA
16 disp(I_D,"The drain current in mA is");
```

Scilab code Exa 6.4 Minimum value of VDS

```
1  // Exa 6.4
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  I_DSS = 8;// in mA
8  I_DSS = I_DSS * 10^-3;// in A
9  V_P =-5;// in V
10  V_GS = -2;// in V
11  V_DSmin = V_GS - V_P;// in V
12  disp(V_DSmin,"The minimum value of V_DS in V is");
13  I_DS = I_DSS*((1 - (V_GS/V_P))^2);// in A
14  I_DS = I_DS * 10^3;// in mA
15  disp(I_DS,"The drain current in mA is");
```

Scilab code Exa 6.5 VGS and gm

```
1  // Exa 6.5
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  I_DSS = 1.65;// in mA
8  I_DSS = I_DSS * 10^-3;// in A
9  V_P = -2;// in V
10  I_D = 0.8;// in mA
11  I_D = I_D * 10^-3;// in A
12  V_DD = 24;// in V
```

```
13  V_GS = V_P * (1 - sqrt( I_D/I_DSS ));// in V
14  disp(V_GS,"The value of V_GS in V is");
15  g_mo = -2 * (I_DSS*10^3/V_P);// in ms
16  g_m = g_mo * (1 - V_GS/V_P);// in ms
17  disp(g_m,"The value of g_m in ms is");
```

Scilab code Exa 6.6 Drain current

```
1  // Exa 6.6
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  Vt = 2;// in V
8  unCox = 20;// in  A /V^2
9  Kdasn = unCox;// in  A /V^2
10 W = 100;// in  m
11 L = 10;// in  m
12 V_GS = 3;// in V
13 V_DS = 0.5;// in V
14 V_GS = 3;// in V
15 Vt = 2;// in V
16 del_V = V_GS-Vt;// in V
17 i_D = Kdasn*10^-6*(W/L)*( del_V*V_DS - 1/2*(V_DS^2)
        );// in A
18 i_D = i_D * 10^6;// in  A
19 disp("Part (a) For V_D= 0.5 V, NOMS is operating in
        Triode region.")
20 disp(i_D,"The drain current in  A is");
21 V_DS = 1;// in V
22 i_D = (1/2)* Kdasn*10^-6*(W/L)*( del_V^2 );// in A
23 i_D = i_D * 10^6;// in  A
24 disp("Part (b) For V_D= 1 V, NOMS is operating in
        saturation region.")
```

```
25  disp(i_D,"The drain current in   A is");
26  V_DS = 5;// in V
27  i_D = (1/2)* Kdasn*10^-6*(W/L)*( del_V^2 );// in A
28  i_D = i_D * 10^6;// in   A
29  disp("Part (c) For V_D= 5 V, NOMS is operating in
        saturation region.")
30  disp(i_D,"The drain current in   A is");
```

Scilab code Exa 6.7 Drain to source resistance

```
1   // Exa 6.7
2   clc;
3   clear;
4   close;
5   format('v',6)
6   // Given data
7   Vt = 2;// in V
8   i_D = 1;// in mA
9   i_D = i_D * 10^-3;// in A
10  V_GS = 3;// in V
11  // From i_D= 1/2*KnwByL*(V_GS-Vt)^2
12  KnwByL= 2*i_D/(V_GS-Vt)^2;
13  V_GS= 4;// in V
14  V_DS= 5;// in V
15  i_D= 1/2*KnwByL*(V_GS-Vt)^2;// in A
16  i_D= i_D*10^3;// in mA
17  disp(i_D,"The value of i_D in mA is : ")
18  r_DS= 1/(KnwByL*(V_GS-Vt));// in ohm
19  disp(r_DS,"The value of drain to source resistance
        in ohm is : ")
```

Scilab code Exa 6.8 Minimum VDS required

```
1  // Exa 6.8
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  Vt = -2;// in V
8  KnwByL = 2*10^-3;// in A/V^2
9  V_GS = 1;// in V
10 V_DS = V_GS-Vt;// in V
11 disp(V_DS,"The minimum value of V_DS in V is");
12 i_D = 1/2*KnwByL*V_DS^2;// in A
13 i_D = i_D * 10^3;// in mA
14 disp(i_D,"The value of i_D in mA is");
```

Chapter 7

FET Biasing

Scilab code Exa 7.1 Different values of VGSQ IDQ and VDS

```scilab
1  // Exa 7.1
2  clc ;
3  clear ;
4  close ;
5  format ('v',6)
6  // Given data
7  I_DSS = 8;// in mA
8  I_DSS = I_DSS * 10^-3;// in A
9  V_P = -8;// in V
10 V_DD = 16;// in V
11 R_D = 2;// in k ohm
12 R_D = R_D * 10^3;// in ohm
13 V_GG = 2;// in V
14 R_G = 1;// in Mohm
15 R_G = R_G * 10^6;// in ohm
16 I_G = 0;
17 // To calculate V_GS
18 V_GS = -V_GG;// in V
19 disp(V_GS,"The value of V_GS in V is");
20 // To calculate the drain current
21 I_DQ =I_DSS*((1 - (V_GS/V_P))^2);// in A
```

```
22  I_DQ = I_DQ * 10^3;// in mA
23  disp(I_DQ,"The value of I_DQ in mA is");
24  // To calculate V_DS
25  // V_DD = I_D*R_D + V_DS;
26  V_DS = V_DD - (I_DQ*10^-3*R_D);// in V
27  disp(V_DS,"The value of V_DS in V is");
```

Scilab code Exa 7.2 VGSQ IDQ and VDS

```
1   // Exa 7.2
2   clc;
3   clear;
4   close;
5   format('v',6)
6   // Given data
7   I_DSS = 10;// in mA
8   I_DSS = I_DSS * 10^-3;// in A
9   V_P = -4;// in V
10  V_DD= 20;// in V
11  R_S = 1;// in k ohm
12  R_S = R_S * 10^3;// in ohm
13  R_D = 2.7;// in k ohm
14  R_D = R_D * 10^3;// in ohm
15  I_DQ= poly(0,'I_DQ');
16  V_GS= -I_DQ*R_S;// in V
17  I_DQ= I_DQ-I_DSS*(1-V_GS/V_P)^2;// in A
18  I_DQ= roots(I_DQ);// in A
19  I_DQ= I_DQ(2);// in A
20  I_DQ= I_DQ*10^3;// in mA
21  disp(I_DQ,"The value of I_DQ in mA is : ")
22  I_DQ= I_DQ*10^-3;// in A
23  V_GSQ= -I_DQ*R_S;// in V
24  disp(V_GSQ,"The value of V_GSQ in volts is : ")
25  V_DS= V_DD-I_DQ*(R_D+R_S);// in V
26  disp(V_DS,"The value of V_DS in volts is : ")
```

Scilab code Exa 7.3 W by L ratio

```
1  // Exa 7.3
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  Kn = 20*10^-3;// in A/V^2
8  Vt = -1;// in V
9  V_DD = 5;// in V
10 I_D = 100;// in mA
11 I_D= I_D*10^-3;// in A
12 V_GS = 0;// in V
13 // I_D = (1/2)*Kdasn*(W/L)*((V_GS-Vt)^2);
14 WbyL = (I_D*2)/(Kn*((V_GS-Vt)^2));
15 disp(WbyL,"The (W/L) ratio is");
16 V_DS = V_GS-Vt;// in V
17 V_Dmin = V_DS;// in V
18 R_Dmax = (V_DD-V_Dmin)/I_D;// in ohm
19 disp("The range of R_D is : 0 to "+string(R_Dmax)+"
        ");
20
21 //Note: The unit of R_Dmax in the book is wrong.
```

Scilab code Exa 7.5 IDQ and VDSQ

```
1  // Exa 7.5
2  clc;
3  clear;
4  close;
```

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```scilab
5  format('e',8)
6  // Given data
7  I_Don = 6;// in mA
8  I_Don = I_Don * 10^-3;// in A
9  V_GSon = 8;// in V
10 Vt = 3;// in V
11 V_DD = 12;// in V
12 R_D= 2*10^3;// in ohm
13 // (i) To obtain the value of K
14 K = I_Don/( (V_GSon-Vt)^2 );// in A/V^2
15 disp(K,"The value of K in A/V^2 is");
16 format('v',7)
17 // To obtain the value of I_DQ
18 I_D= poly(0,'I_D');
19 V_GS= V_DD-I_D*R_D;// in V
20 I_D= I_D-K*(V_GS-Vt)^2;// in A
21 I_D= roots(I_D);// inA
22 I_D= I_D(2);// in A
23 I_D= I_D*10^3;// in mA
24 disp(I_D,"The value of I_D in mA is : ")
25 I_D= I_D*10^-3;// in A
26 // (iii) To obtain the value of V_DSQ
27 V_DSQ= V_DD-I_D*R_D;// in V
28 disp(V_DSQ,"The value of V_DSQ in volts is : ")
```

Scilab code Exa 7.6 IDQ VGSQ and VDS

```scilab
1 // Exa 7.6
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 V_DD = 40;// in V
8 Vt = 5;// in V
```

```
 9  R_D= 820;// in ohm
10  I_Don = 3;// in mA
11  I_Don = I_Don * 10^-3;// in A
12  V_GSon = 10;// in V
13  K = I_Don/( (V_GSon-Vt)^2 );// in A/V^2
14  R2 = 18;// in Mohm
15  R2 = R2 * 10^6;// in ohm
16  R1 = 22;// in Mohm
17  R1 = R1 * 10^6;// in ohm
18  R_S = 3*10^3;// in ohm
19  I_D= poly(0,'I_D');
20  V_G= R2/(R1+R2)*V_DD;
21  V_GS= V_G-I_D*R_D;// in V
22  I_D= I_D-K*(V_GS-Vt)^2;// in A
23  I_D= roots(I_D);// inA
24  I_D= I_D(2);// in A
25  I_D= I_D*10^3;// in mA
26  disp(I_D,"The value of I_D in mA is : ")
27  I_D= I_D*10^-3;// in A
28  V_GSQ= V_G-I_D*R_D;// in V
29  disp(V_GSQ,"The value of V_GSQ in volts is : ")
30  V_DSQ= V_DD-I_D*(R_D+R_S);// in V
31  disp(V_DSQ,"The value of V_DSQ in volts is : ")
```

Scilab code Exa 7.7 Value of RS

```
1  // Exa 7.7
2  clc;
3  clear;
4  close;
5  format('v',5)
6  // Given data
7  V_D = 12;// in V
8  V_GSQ = -2;// in V
9  V_DD = 16;// in V
```

```
10  R1 = 47;// in k ohm
11  R1 = R1 * 10^3;// in ohm
12  R2 = 91;// in k ohm
13  R2 = R2 * 10^3;// in ohm
14  V_G = (R1*V_DD)/(R1+R2);// in V
15  R_D = 1.8;// in k ohm
16  R_D = R_D * 10^3;// in ohm
17  I_D = (V_DD-V_D)/R_D;// in A
18  I_D = I_D * 10^3;// in mA
19  // V_GS = V_G - (I_D*R_S);
20  R_S = (V_G-V_GSQ)/(I_D*10^-3);// in ohm
21  R_S = R_S * 10^-3;// in k ohm
22  disp(R_S,"The value of R_S in k ohm is");
```

Scilab code Exa 7.8 VG and VSS

```
1  // Exa 7.8
2  clc;
3  clear;
4  close;
5  format('v',5)
6  // Given data
7  I_D = 12*10^-3;// in A
8  V_DS = 6;// in V
9  V_P = 3;// in V
10  R_SS= 1*10^3;// in ohm
11  I_DSS = 20*10^-3;// in A
12  V_GS= poly(0,'V_GS');
13  V_GS= I_D-I_DSS*(1-V_GS/V_P)^2;
14  V_GS= roots(V_GS);// in V
15  V_GS= V_GS(1);// in V
16  disp(V_GS,"The value of V_GS in volts is : ")
17  // Applying KVL on it's input section, V_G= V_GS+I_D
        *R_SS+V_SS or
18  // I_D*RSS+V_SS= V_G-V_GS    (i)
```

```
19  // V_DS+I_D*R_SS+V_SS= 0        ( i i )
20  // From  eq  ( i )  and  ( i i )
21  V_G= V_GS-V_DS;// in  V
22  disp(V_G,"The  value  of  V_G  in  volts  is  :  ")
23  V_SS= V_G-V_GS-I_D*R_SS;// in  V
24  disp(V_SS,"The  value  of  V_SS  in  V  is  :  ")
```

Scilab code Exa 7.9 IDQ VGSQ VD VS VDS and VDG

```
1  // Exa  7.9
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given  data
7  I_DSS = 8;// in  mA
8  I_DSS = I_DSS * 10^-3;// in  A
9  V_P = -4;// in  V
10 V_DD = 16;// in  V
11 R2 = 270;// in  k  ohm
12 R2 = R2 * 10^3;// in  ohm
13 R1 = 2.1;// in  Mohm
14 R1 = R1 * 10^6;// in  ohm
15 R_S = 1.5;// in  k  ohm
16 R_S = R_S * 10^3;// in  ohm
17 R_D = 2.4;// in  k  ohm
18 R_D = R_D * 10^3;// in  ohm
19 V_G = (R2*V_DD)/(R1+R2);// in  V
20 //V_GS = V_G - (I_D*R_S);
21 V_GS = V_G;// in  V  ( at  I_D=0  A)
22 I_D = V_G/R_S;// in  A  ( at  V_GS=0  V)
23 I_D = I_D * 10^3;// in  mA
24 I_DQ = 2.4;// in  mA
25 V_GSQ = -1.8;// in  V
26 V_D = V_DD - (I_DQ*10^-3*R_D);// in  V
```

```
27  V_S = I_DQ*10^-3*R_S;// in V
28  V_DS = V_DD - (I_DQ*10^-3*(R_S+R_D));// in V
29  V_DG = V_D-V_G;// in V
30  disp(I_DQ,"The value of I_DQ in mA is");
31  disp(V_GSQ,"The value of V_GSQ in V is");
32  disp(V_D,"The value of V_D in V is");
33  disp(V_S,"The value of V_S in V is");
34  disp(V_DS,"The value of V_DS in V is");
35  disp(V_DG,"The value of V_DG in V is");
```

Scilab code Exa 7.10 Value of Vo

```
1  // Exa 7.10
2  clc;
3  clear;
4  close;
5  format('v',5)
6  // Given data
7  I_DSS = 5.6;// in mA
8  I_DSS = I_DSS * 10^-3;// in A
9  V_P = 4;// in V
10 Vi = 0;// in V
11 V_CC = 12;// in V
12 R_D = 10;// in  k ohm
13 R_D = R_D * 10^3;// in ohm
14 R_S= 10*10^3;// in ohm
15 I_D= poly(0,'I_D');
16 V_GS= I_D*R_D-V_CC;// in V
17 I_D= I_D-I_DSS*(1-V_GS/V_P)^2;// in A
18 I_D= roots(I_D);// in A
19 I_D= I_D(2);// in A
20 V_GS= I_D*R_D-V_CC;// in V
21 Vo= V_CC-I_D*R_S;// in V
22 I_D= I_D*10^3;// in mA
23 disp(I_D,"The value of I_D in mA is : ")
```

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```
24 disp(Vo,"The value of Vo in volts is : ")
25
26 // Note: In the book, there is calculation error to
      find the value of I_D this is why the value of Vo
       is also wrong.
```

Scilab code Exa 7.11 Value of Vo

```
1  // Exa 7.11
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  I_DSS = 5.6;// in mA
8  I_DSS = I_DSS * 10^-3;// in A
9  V_P = -4;// in V
10 R_S = 10;// in k ohm
11 R_S = R_S * 10^3;// in ohm
12 R_D = 4.7;// in k ohm
13 R_D = R_D * 10^3;// in ohm
14 V_CC = 12;// in V
15 V_DD = 22;// in V
16 // (a) Calculation to find the value of Vo at Vi = 0
      V
17 Vi = 0;// in V
18 V_GS= poly(0,'V_GS');
19 I_D= (V_CC-V_GS)/R_S;// in A
20 V_GS= I_D-I_DSS*(1-V_GS/V_P)^2;// in A
21 V_GS= roots(V_GS)
22 V_GS= V_GS(2);// in V
23 I_D= (V_CC-V_GS)/R_S;// in A
24 Vo= Vi-V_GS;// in V
25 disp(Vo,"For Vi=0 V, The value of Vo in volts is ; "
      )
```

```
26
27 // (a) Calculation to find the value of Vo at Vi =
        10 V
28 Vi = 10;// in V
29 V_GS= poly(0,'V_GS');
30 I_D= (V_DD-V_GS)/R_S;// in A
31 V_GS= I_D-I_DSS*(1-V_GS/V_P)^2;// in A
32 V_GS= roots(V_GS)
33 V_GS= V_GS(2);// in V
34 I_D= (V_CC-V_GS)/R_S;// in A
35 Vo= Vi-V_GS;// in V
36 disp(Vo,"For Vi=10 V, The value of Vo in volts is ;
        ")
37
38 // (a) Calculation to find the value of Vi at Vo =
        10 V
39 Vo= 0;// in V
40 I_D= V_CC/R_S;// in A
41 V_GS= V_P*(1-sqrt(I_D/I_DSS));// in V
42 Vi= V_GS+Vo;// in V
43 disp(Vi,"For Vo=0 V, The value of Vi in volts is ; "
        )
```

Scilab code Exa 7.12 Quuiescent value of IDS VDS and VGS

```
1 // Exa 7.12
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 I_DSS = 12;// in mA
8 V_P = 5;// in V
9 R_D = 3.3;// in k ohm
10 R_G = 1.5*10^3;// in k ohm
```

```
11  R_S = 1.2;// in k ohm
12  V_DD= 18;// in V
13  I_D= poly(0,'I_D');
14  V_GS= I_D*R_S;// in V
15  I_D= I_D-I_DSS*(1-V_GS/V_P)^2;
16  I_D= roots(I_D);
17  I_D= I_D(2);// in mA
18  V_GS= I_D*R_S;// in V
19  V_DS= V_DD-I_D*(R_S+R_D);// in V
20  disp(I_D,"The value of I_D in mA is : ")
21  disp(V_GS,"The value of V_GS in volts is : ");
22  disp(V_DS,"The value of V_DS in volts is : ")
```

Scilab code Exa 7.13 Value of rDS

```
1  // Exa 7.13
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  Vt = -1;// in V
8  KnWbyL = 1*10^-3;// in A/V^2
9  V_DS = 0.1;// in V
10 V_GS = 0;// in V
11 I_D = ( (V_GS-Vt)*V_DS-1/2*KnWbyL );// in mA
12 V = 9.9;// in V
13 R_D = V/I_D;// in k ohm
14 R_D= ceil(R_D);// in k ohm
15 disp(R_D,"The value of R_D in k ohm is : ")
16 V_DS = 0.1;// in V
17 r_DS = V_DS/(I_D*10^-3);// in ohm
18 r_DS= round(r_DS*10^-3);// in k ohm
19 disp(r_DS,"Effective resistance between source and
        drain in k ohm is");
```

Scilab code Exa 7.14 Value of RS

```
1  // Exa 7.14
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  V_DD = 5;// in V
8  V_SS = -5;// in V
9  Vt = 2;// in V
10 I_D = 0.4;// in mA
11 I_D = I_D * 10^-3;// in A
12 miu_nCox=20*10^-6;// in A/V^2
13 W = 400;// in  m
14 L = 10;// in  m
15 V_GS= poly(0,'V_GS');
16 V_GS=I_D-(1/2)*miu_nCox*(W/L)*( (V_GS-Vt)^2 );
17 V_GS= roots(V_GS)
18 V_GS= V_GS(1);// in V
19 V_S= -V_GS;// in V
20 R_S = (V_S-V_SS)/I_D;// in ohm
21 R_S = R_S * 10^-3;// in k ohm
22 disp(R_S,"The value of R_S in k ohm is");
23 V_D = 1;// in V
24 R_D = (V_DD-V_D)/I_D;// in ohm
25 R_D = R_D * 10^-3;// in k ohm
26 disp(R_D,"The value of R_D in k ohm is");
```

Scilab code Exa 7.15 Designing of a circuit

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```
1  // Exa 7.15
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  I_D= 0.4*10^-3;// in A
8  Vt = 2;// in V
9  miu_nCox = 20*10^-6;// in A/V^2
10 L = 10;// in   m
11 W = 100;// in   m
12 V_GS= poly(0,'V_GS');
13 V_GS= I_D - (1/2)*miu_nCox*(W/L)*( (V_GS-Vt)^2 );
14 V_GS= roots(V_GS)
15 V_GS= V_GS(1);// in V
16 V_D = V_GS;// in V
17 disp(V_D,"The DC voltage in V is");
18 V_DD = 10;// in v
19 R = (V_DD - V_D)/I_D;// in ohm
20 R = R * 10^-3;// in k ohm
21 disp(R,"The value R in k ohm is");
```

Scilab code Exa 7.16 Designing of a circuit

```
1  // Exa 7.16
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  Vt =  1;// in V
8  KnWbyL= 10*10^-3;// in A/V^2
9  V_DD = 5;// in V
10 V_D = 0.1;// in V
11 I_D = Vt*( (V_DD-Vt)*V_D - 1/2*KnWbyL );// in mA
```

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```
12  R_D = (V_DD-V_D)/(I_D*10^-3);// in ohm
13  R_D= R_D*10^-3;// in k ohm
14  disp(R_D,"The value of R_D in k ohm is : ")
15  V_DS = 0.1;// in V
16  r_DS =round(V_DS/(I_D*10^-3));// in ohm
17  disp(r_DS,"Effective resistance between drain and
        the source in ohm is");
```

Scilab code Exa 7.17 Designing of a circuit

```
1  // Exa 7.17
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  I_D = 0.5;// in mA
8  V_D = 3;// in V
9  Vt = -1;// in v
10  KnWbyL = 1;// in mA/V^2
11  V_DD = 5;// in V
12  V_D = 3;// in v
13  V_GS= poly(0,'V_GS');
14  V_GS= I_D -1/2*KnWbyL*(V_GS-Vt)^2;// in V
15  V_GS= roots(V_GS)// in V
16  V_GS= V_GS(1);// in V
17  R_G1 = 2;// in Mohm
18  R_G1 = R_G1 * 10^6;// in ohm
19  R_G2 = 3;// in Mohm
20  R_G2 = R_G2 * 10^6;// in ohm
21  V_GS = -2;// in V
22  R_D = V_D/I_D;// in k ohm
23  V_Dmax = V_D+abs(Vt);// in V
24  R_D = V_Dmax/I_D;// in k ohm
25  disp(R_D,"The largest value of R_D in k ohm is");
```

Chapter 8

Field Effect Transistor Amplifiers

Scilab code Exa 8.1 Input impedance

```
1  // Exa 8.1
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  V_P = -4;// in V
8  r_d = 40*10^3;// in ohm
9  I_DSS = 10*10^-3;// in A
10 V_GG = 1;// in V
11 R_D = 1.8*10^3;// in ohm
12 R_G = 1*10^6;// in ohm
13 g_mo = 2*I_DSS/(abs(V_P));// in S
14 V_GSQ = -1.5;// in V
15 g_m = g_mo*(1-(V_GSQ/V_P));// in S
16 Zi = R_G;// in ohm
17 Zi= Zi*10^-6;// in M ohm
18 disp(Zi,"The input impedance in M ohm is");
19 Zo = (r_d*R_D)/(r_d+R_D);// in ohm
```

```
20  Zo = R_D;// in ohm (as r_d >10*R_D)
21  Zo= Zo*10^-3;// in k ohm
22  disp(Zo,"The output impedance in k ohm is");
23  //Av = Vo/Vi = -g_m*R_D;
24  Av = -g_m*R_D;
25  disp(Av,"The voltage gain is");
```

Scilab code Exa 8.2 Zi Zo and Av

```
1  // Exa 8.2
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  I_DSS = 6;// in mA
8  I_DSS = I_DSS * 10^-3;// in A
9  V_P = -6;// in V
10 Y_DS = 40;// in  S
11 R_D = 3.3;// in k ohm
12 R_D = R_D * 10^3;// in ohm
13 R_S = 1.1;// in k ohm
14 R_S = R_S * 10^3;// in ohm
15 R_G = 10;// in Mohm
16 R_G =R_G * 10^6;// in ohm
17 g_mo = (2*I_DSS)/(abs(V_P));// in S
18 I_D= poly(0,'I_D');
19 V_GS = -I_D*R_S;// in V
20 I_D=  I_D - I_DSS*((1 - (V_GS/V_P))^2);
21 I_D= roots(I_D)
22 I_D= I_D(2);// in A
23 V_GSQ = -I_D*R_S;// in V
24 g_m = g_mo*( 1-(V_GSQ/V_P) );// in S
25 Zi = R_G;// in ohm
26 Zi= Zi*10^-6;// in M ohm
```

```
27  disp(Zi,"The value of Zi in M ohm is");
28  r_d = 40;// in k ohm assumed
29  r_d = r_d * 10^3;// in ohm
30  Zo = (r_d*R_D)/(r_d+R_D);// in ohm
31  Zo=R_D;// in ohm (as r_d > 10 *R_D)
32  Zo= Zo*10^-3;// in k ohm
33  disp(Zo,"The value of Zo in k ohm is");
34  Av = abs(-g_m*R_D);
35  disp(Av,"The value of Av is");
```

Scilab code Exa 8.3 Zi Zo Av

```
1  // Exa 8.3
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  V_DD = 20;// inV
8  I_DSS = 8;// in mA
9  I_DSS = I_DSS * 10^-3;// in mA
10  V_P = -6;// in V
11  R_G = 1;// in Mohm
12  R_G = R_G * 10^6;// in ohm
13  R_S = 1;// in k ohm
14  R_S = R_S * 10^3;// in ohm
15  r_d = 50;// in k ohm
16  r_d = r_d * 10^3;// in ohm
17  V_GS = -2.6;// in V
18  I_D = 2.6;// in mA
19  I_D = I_D * 10^-3;// in A
20  g_mo = (2*I_DSS)/(abs(V_P));// in S
21  g_m = g_mo*(1 - (V_GS/V_P));// in S
22  Zi = R_G;// in ohm
23  Zi= Zi*10^-6;// in M ohm
```

```
24  disp(Zi,"The value of Zi in M ohm is");
25  Zo = R_S*1/g_m/(R_S+1/g_m);
26  disp(Zo,"The value of Zo is");
27  Av = g_m*R_S/(1 + (g_m*R_S));
28  disp(Av,"The value of Av is");
```

Scilab code Exa 8.4 gm Zi Zo And Av

```
1  // Exa 8.4
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  V_GSQ = -2.6;// in V
8  I_DQ = 3.8*10^-3;// in A
9  V_DD = 12;// in V
10 R_D = 1.5*10^3;// in ohm
11 R_S = 680;// in ohm
12 I_DSS = 12*10^-3;// in A
13 r_d = 20*10^3;// in ohm
14 V_P = -6;// in V
15 // (a) Transconductance
16 g_mo = (2*I_DSS)/(abs(V_P));// in S
17 g_m = g_mo*(1-(V_GSQ/V_P));// in mS
18 g_m= g_m*10^3;// in mS
19 disp(g_m,"The value of g_m in mS is");
20 // (b) Input impedance
21 g_m= g_m*10^-3;// in S
22 Zi=R_S*((r_d+R_D)/(1+g_m*r_d))/(R_S+((r_d+R_D)/(1+
     g_m*r_d)))
23 disp(Zi,"The value of Zi in ohm is");
24 // (c) Output impedance
25 Zo = (R_D*r_d)/(R_D+r_d);// in ohm
26 Zo= Zo*10^-3;// in k ohm
```

```
27  disp(Zo,"The value of Zo in k ohm is");
28  // Voltage gain
29  //Av = Vo/Vi = (R_D*(1 + (g_m*10^-3*r_d)))/(R_D+r_d)
       ;
30  Av = (R_D*(1 + (g_m*r_d)))/(R_D+r_d);
31  disp(Av,"The value of Av is");
```

Scilab code Exa 8.6 Input impedance output impedance and voltage gain

```
1   // Exa 8.6
2   clc;
3   clear;
4   close;
5   format('v',6)
6   // Given data
7   V_DD = 10;// in V
8   R_D = 5.1;// in  k ohm
9   R_D = R_D * 10^3;// in ohm
10  g_m = 2*10^-3;// in S
11  r_d = 50;// in k ohm
12  r_d = r_d * 10^3;// in ohm
13  Vi = 0;// in V
14  R_G = 1;// in Mohm
15  R_G = R_G * 10^6;// in ohm
16  // (i) Input impedance
17  Zi = R_G;// in ohm
18  Zi= Zi*10^-6;// in M ohm
19  disp(Zi,"The input impedance in Mohm is");
20  // (ii) Output impedance
21  Zo = (r_d*R_D)/(r_d+R_D);// in ohm
22  disp(Zo,"The output impedance in ohm is");
23  // (iii) Voltage gain
24  Av = -g_m*Zo;
25  disp(Av,"The voltage gain is");
```

Scilab code Exa 8.7 gm rd Zi Zo and Av

```
1  // Exa 8.7
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  V_GSQ = -2;// in V
8  I_DSS = 8;// in mA
9  I_DSS = I_DSS * 10^-3;// in A
10 V_P = -8;// in V
11 YoS = 20;// in   S
12 YoS = YoS * 10^-6;// in S
13 R_D = 5.1;// in k ohm
14 R_D = R_D * 10^3;// in ohm
15 R_G = 1;// in Mohm
16 R_G = R_G * 10^6;// in ohm
17 g_mo = (2*I_DSS)/(abs(V_P));// in S
18 g_m = g_mo * (1 - (V_GSQ/V_P));// in S
19 g_m= g_m*10^3;// in mS
20 disp(g_m,"The value of g_m in mS is");
21 g_m= g_m*10^-3;// in S
22 r_d = 1/YoS;// in ohm
23 r_d= r_d*10^-3;// in k ohm
24 disp(r_d,"The value of r_d in k ohm is");
25 r_d= r_d*10^3;// in ohm
26 Zi = R_G;// in ohm
27 Zi= Zi*10^-6;// in M ohm
28 disp(Zi,"The value of Zi in M ohm is");
29 V_GS = 0;// in V
30 Zo = (r_d*R_D)/(r_d+R_D);// in ohm
31 disp(Zo,"The value of Zo in ohm is");
32 Av = -g_m*Zo;
```

```
33  disp(Av,"The value of Av is");
```

Scilab code Exa 8.8 Input impedance output impedance and voltage gain

```
1  // Exa 8.8
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  gm= 6000*10^-6;// in S
8  R1 = 2;// in M ohm
9  R1 = R1 * 10^6;// in ohm
10 R2 = 500;// in k ohm
11 R2 = R2 * 10^3;// in ohm
12 R_S= 4*10^3;// in ohm
13 R_L= 33*10^3;// in ohm
14 r_d= 50*10^3;// in ohm
15 Zi = (R1*R2)/(R1+R2);// in ohm
16 Zi= Zi*10^-3;// in k ohm
17 disp(Zi,"The input impedance in k ohm is");
18 Zo = (1/gm*R_S)/(1/gm+R_S);// in ohm
19 disp(Zo,"The output impedance in ohm is");
20 // Let Req= r_d || R_S || R_L;// in ohm
21 Req= r_d*R_S*R_L/(r_d*R_S+R_S*R_L+R_L*r_d);// in ohm
22 Av=gm*(r_d*R_S*R_L/(r_d*R_S+R_S*R_L+r_d*R_L))/(1+gm
       *(r_d*R_S*R_L/(r_d*R_S+R_S*R_L+r_d*R_L)))
23 disp(Av,"The voltage gain is : ")
```

Scilab code Exa 8.9 Input and output impedance and voltage gain

```
1  // Exa 8.9
2  clc;
```

```
 3  clear;
 4  close;
 5  format('v',7)
 6  // Given data
 7  R1 = 3.3* 10^-3;// in ohm
 8  R2 = 1.2* 10^6;// in ohm
 9  R_D = 3.9* 10^3;// in ohm
10  R_S = 3.9* 10^3;// in ohm
11  R_L = 82* 10^3;// in ohm
12  g_m = 6000* 10^-6;// in S
13  r_d = 70* 10^3;// in ohm
14  Zi = (R_S*( (r_d+R_D)/(1+(g_m*r_d)) ))/(R_S+( (r_d+
        R_D)/(1+(g_m*r_d)) ));// in ohm
15  disp(Zi,"The input impedance in ohm is");
16  Zo = (r_d*R_D)/(r_d+R_D);// in ohm
17  disp(Zo,"The output impedance in ohm is");
18  R = (R_D*R_L)/(R_D+R_L);// in ohm
19  Av = (R*(1+(g_m*r_d)))/( r_d+R );
20  disp(Av,"The voltage gain is");
```

Chapter 9

Frequency Response

Scilab code Exa 9.2 Overall voltage gain

```
1  // Exa 9.2
2  clc;
3  clear;
4  close;
5  format('v',5)
6  // Given data
7  bita= 100;
8  V_B1= 5;// in V
9  V_E1= 4.3;// in V
10 R_E1= 4.3*10^3;// in ohm
11 V_E2= 3.6;// in V
12 R_E2= 3.6*10^3;// in ohm
13 R_C=4*10^3;// in ohm
14 R_L= 4*10^3;// in ohm
15 R1= 100*10^3;// in ohm
16 R2= 100*10^3;// in ohm
17 gm= 40*10^-3;// in A/V
18 re= 25;// in W
19 r_pie= 2.5*10^3;// in W
20 f_r= 400*10^6;// in Hz
21 C_miu= 2*10^-12;// in F
```

```
22  omega_T= 2*%pi*f_r;// in radian
23  Rin= 38*10^3;// in ohm
24  R_S= 4*10^3;// in ohm
25  R_pie1= 80;//in ohm
26  Ve1ByVb1= 0.98;// in V/V
27  I_E1= V_E1/R_E1;// in A
28  I_E2= V_E2/R_E2;// in A
29  // We know, C_pie + C_miu= gm/ometa_T or
30  C_Pie= gm/omega_T-C_miu;// in F
31  Vb1ByVs= Rin/(Rin+R_S);// in V/V
32  //Ve1ByVb1= R_E1*r_pie2/(R_E1*r_pie2)/(R_E1*r_pie2/(
      R_E1*r_pie2)+r_e1);
33  VeByVb1= R_E1*r_pie/(R_E1*r_pie)/(R_E1*
      r_pie)+R_E1);// in V/V
34  // The gain of the common-emitter amplifier Q2
35  VoByVe1= -gm*R_C*R_L/(R_C+R_L);// in V/V
36  // The overall gain
37  VoByVs= Vb1ByVs*Ve1ByVb1*VoByVe1;// in V/V
38  RdeshS= R1*R2*R_S/(R1*R2+R2*R_S+R_S*R1);
39  RdeshE1= R_E1*r_pie/(R_E1+r_pie);// in k ohm
40  R_miu1= R_S*Rin/(R_S+Rin)*10^-3;// in k ohm
41  R_pi1= (r_pie*(RdeshS+RdeshE1)/(1+gm*RdeshE1))/r_pie
      +(RdeshS+RdeshE1)/(1+gm*RdeshE1);
42  R_T=round( RdeshE1*(r_pie+RdeshS)/(bita+1)/(RdeshE1
      +(r_pie+RdeshS)/(bita+1)));// in ohm
43  disp(VoByVs,"The overall voltage gain in V/V is : ")
44  disp(R_miu1,"The value of R_miu1 in ohm is : ")
45  disp(R_pie1,"The value of R_pie1 in ohm is : ")
46  disp(R_T,"The value of R_T in ohm is : ")
```

Scilab code Exa 9.3 Value of k

```
1  // Exa 9.3
2  clc;
3  clear;
```

```
4  close;
5  format('v',5)
6  // Given data
7  wH= '0.9*wp1';
8  wp2='wp1*k';
9  //wH= 1/sqrt(1/wp1^1+1/(k*wp1)^2)
10 k= sqrt(0.9^2/(1-0.9^2));
11 disp(k,"The value of k is : ")
```

Scilab code Exa 9.4 Value of Cs and gm

```
1  // Exa 9.4
2  clc;
3  clear;
4  close;
5  // Given data
6  Rs = 1;// in k ohm
7  Rs = Rs * 10^3;// in ohm
8  omega_z = 10;// in rad/sec
9  omega_p = 100;// in rad/sec
10 //omega_z = 1/(Rs*Cs);
11 Cs = 1/(Rs*omega_z);// in F
12 disp(Cs*10^6,"The value of Cs in  F is");
13 //omega_p = (g_m + (1/Rs))/Cs;
14 g_m = omega_p*Cs-1/Rs;// in A/V
15 g_m= g_m*10^3;// in mA/V
16 disp(g_m,"The value of g_m in mA/V is")
17
18 // Note: The unit of g_m in the book is wrong. It
       will be in mA/V not in nA/V.
```

Chapter 10

Feedback Amplifiers

Scilab code Exa 10.1 Change in overall gain of the feedback amplifier

```
1  // Exa 10.1
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  A = 60;// in dB
8  A= 10^(A/20)
9  Beta = 0.005;
10 dAbyA = -12/100;
11 // On putting the value of A, bita and dA/A
12 dAfbyAf = (1/(1+A*Beta))*(dAbyA);
13 disp(dAfbyAf,"The change in overall gain is");
```

Scilab code Exa 10.2 Input impedance

```
1  // Exa 10.2
2  clc;
```

```
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  A = 1000;
8  Zi = 1;// in k ohm
9  Zi = Zi * 10^3;// in ohm
10 Beta = 0.01;
11 Zdesh_i = (1+A*Beta)*Zi;// in ohm
12 Zdesh_i =Zdesh_i *10^-3;// in k ohm
13 disp(Zdesh_i,"The input impedance of the feedback
       amplifier in k ohm is");
```

Scilab code Exa 10.3 Feedback factor and percentage change in overall gain

```
1  // Exa 10.3
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  A = 60;// in dB
8  A= 10^(A/20);
9  Zo = 12000;// in ohm
10 Zdesh_o = 600;// in ohm
11 //Zdesh_o = Zo/(1+(A*Beta));
12 Beta = (((Zo/Zdesh_o)-1)/A)*100;// in %
13 disp(Beta,"The feedback factor in % is");
14 Beta = Beta/100;
15 DAbyA = 0.1;
16 dAfbyAf = (1/(1 + (A*Beta)))*DAbyA*100;// in %
17 disp(dAfbyAf,"The percentage change in the overall
       gain in % is");
```

Scilab code Exa 10.4 Gain of a negative feedback amplifier

```
1  // Exa 10.4
2  clc;
3  clear;
4  close;
5  format('v',5)
6  // Given data
7  A = 100;
8  Beta = 1/10;
9  Af = A/(1 + (A*Beta));
10 disp(Af,"The gain of negative feedback amplifier is"
     );
```

Scilab code Exa 10.5 Value of A and bita

```
1  // Exa 10.5
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  Af = 100;
8  Vi = 0.6;// in V
9  Vdesh_o = Af*Vi;// in V
10 Vi = 50;// in mV
11 Vi = Vi * 10^-3;// in V
12 A = Vdesh_o/Vi;
13 disp(A,"The value of A is");
14 // Af = A/( 1 +(A*Beta) );
15 Beta = (((A/Af)-1)/A)*100;// in %
16 Beta= (A-Af)/(Af*A/100);
```

```
17 Beta= Beta*100;// in %
18 disp(Beta,"The value of Beta in % is");
```

Scilab code Exa 10.6 Voltage gain

```
1 // Exa 10.6
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 A = 1000;
8 Af = A - (0.40*1000);
9 //Af = A/( 1+(A*Beta) );
10 Beta = ((A/Af)-1)/A;
11 A_desh = 800;
12 A_desh_f= A_desh/( 1+(A_desh*Beta) );
13 disp(A_desh_f,"The voltage gain with feedback is");
14 // percentage reduction without feedback
15 P = ((A-A_desh)/A)*100;//in %
16 // percentage reduction with feedback
17 P1 = ((Af-A_desh_f)/Af)*100;// in %
18 disp(P1,"The percentage reduction with feedback in %
        is");
```

Scilab code Exa 10.7 Small change in gain

```
1 // Exa 10.7
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
```

```
7 dAbyA = 10/100;
8 A = 200;
9 Beta = 0.25;
10 // Af = A/(1+(A*Beta))          (i)
11 // differentiating w.r.to A we get, dAf = dA/((1+(
       Beta*A))^2)     (ii)
12 // From eq(i) and (ii)
13 dAfbyAf =   1/(1+A*Beta)*dAbyA
14 disp(dAfbyAf,"The small change in gain is");
```

Scilab code Exa 10.8 New input voltage

```
1 // Exa 10.8
2 clc;
3 clear;
4 close;
5 format('v',6)
6 // Given data
7 A = 100;
8 Beta = 1/25;
9 Af = A/(1 + (A*Beta));
10 disp(Af,"The gain with feedback is");
11 disp((A*Beta),"The feed back factor is");
12 Vi = 50;// in mV
13 Vo =Af*Vi*10^-3;// in V
14 disp(Vo,"The output voltage in V is");
15 V_feedback= (Beta*Vo);// feedback voltage in V
16 disp(V_feedback,"The feed back voltage in V is");
17 Vi = Vi*(1+(A*Beta));// in mV
18 disp(Vi,"The new input voltage in mV is");
```

Scilab code Exa 10.9 Small change in gain

```
1  // Exa 10.9
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  Beta = 0.25;
8  A = 100;
9  dA= 10;// in %
10 // Af = A/(1+(A*Beta))          (i)
11 //dAf = dA/((1+(Beta*A))^2) (ii)
12 // From eq (i) and (ii)
13 dAbyA = dA/A;
14 disp(dAbyA,"The small change in gain is");
```

Scilab code Exa 10.10 New value of input voltage

```
1  // Exa 10.10
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  A = 200;
8  Beta = 5/100;
9  Af =A/(1 + (A*Beta));
10 disp(Af,"The gain of the amplifier with negative
       feedback is : ")
11 Dn = 10;// in %
12 Ddesh_n = Dn/(1+(A*Beta));// in %
13 disp(Ddesh_n,"The distortion with negative feedback
       in % is : ");
14
15 // Note: In the book, the calculation to find the
       gain of the amplifier with negative feedback i.e
```

Scilab code Exa 10.11 Percentage of feedback

```
1  // Exa 10.11
2  clc;
3  clear;
4  close;
5  format('e',8)
6  // Given data
7  Af = 10;
8  A = 50;
9  // Af =A/(1 + (A*Beta) );
10 Beta = ((A/Af)-1)/A*100;// in %
11 dAfByAf = 1/( 1+100/4 )*Af/100;
12 disp(dAfByAf,"The percentage of feedback is");
```

Scilab code Exa 10.12 Upper and lower cutoff frequency

```
1  // Exa 10.12
2  clc;
3  clear;
4  close;
5  format('v',5)
6  // Given data
7  Ao = 100;
8  f_L = 20;// in Hz
9  f_H = 40;// in kHz
10 f_H = f_H*10^3;// in Hz
11 Beta = 0.1;
12 Af = Ao/(1 + (Beta*Ao));
13 disp(Af,"The overall gain at mid frequency is");
14 f_Hf = f_H*(1+(Ao*Beta));// in Hz
```

```
15  f_Hf = f_Hf * 10^-3; // in kHz
16  disp(f_Hf,"The upper cutoff frequency with negative
        feedback in kHz is");
17  f_Lf = f_L/(1+(Ao*Beta)); // in Hz
18  disp(f_Lf,"The lower cutoff frequency with negative
        feedback in Hz is");
19
20  // Note: The calculated value of lower cutoff
        frequency with negative feedback i.e f_Lf is
        wrong. So the answer in the book is wrong.
```

Scilab code Exa 10.13 Value of A B Rif Af and loop gain

```
1   // Exa 10.13
2   clc;
3   clear;
4   close;
5   format('v',6)
6   // Given data
7   R1 = 20; // in k ohm
8   R1 = R1 * 10^3; // in ohm
9   R2 = 20; // in k ohm
10  R2 = R2 * 10^3; // in ohm
11  h_ie = 2; // in k ohm
12  h_ie = h_ie * 10^3; // in ohm
13  R_L = 1; // in k ohm
14  R_L = R_L * 10^3; // in ohm
15  R_E = 100; // in ohm
16  h_fe = 80;
17  A = (-h_fe*R_L)/h_ie;
18  disp(A,"The value of A is");
19  Beta = R_E/R_L;
20  disp(Beta,"The value of Beta is");
21  Rif = h_ie + (1+h_fe)*R_E; // in ohm
22  Rif = Rif * 10^-3; // in k ohm
```

```
23  disp(Rif,"The value of R_if in k ohm is");
24  Af = (-h_fe*R_L)/(Rif*10^3);
25  disp(Af,"The value of Af is");
26  AB = A*Beta;
27  AB= real(20*log10(AB));// in  d
28  disp(AB,"The value of loopgain in d   is");
```

Scilab code Exa 10.14 Feedback gain and new band width

```
 1  // Exa 10.14
 2  clc;
 3  clear;
 4  close;
 5  format('v',5)
 6  // Given data
 7  A = 200;
 8  BW = 10;// in kHz
 9  Beta = 10/100;
10  Af =A/(1+(A*Beta));
11  disp(Af,"The gain with negative feedback is");
12  BWf = BW*(1+(A*Beta));// in kHz
13  disp(BWf,"The bandwidth with negative feedback in
        kHz is");
```

Chapter 11

Oscillators

Scilab code Exa 11.1 Oscillation frequency

```
1  // Exa 11.1
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  w=poly(0,'w');
8  // For sustained oscillation,
9  w= 4*w*10^6-w^3;
10 w= roots(w);
11 w= w(1);// in rad/sec
12 f= round(w/(2*%pi));// in Hz
13 disp(f,"The frequency of oscillation in Hz is : ")
14 disp("Hence the system will oscillate")
```

Scilab code Exa 11.2 A RC phase shift oscillators

```
1  // Exa 11.2
```

```
 2  clc;
 3  clear;
 4  close;
 5  format('v',5)
 6  // Given data
 7  Av= 29;
 8  I_Bmax = 0.5*10^-6;// in A
 9  I1= 100*I_Bmax
10  Vo_sat = 0.9;// in V
11  V_CC = 9.0;// in V
12  V_EE= -9;// in V
13  V1= 9/Av;// in V
14  R1= V1/I1;// in ohm
15  R1= 5.6*10^3;// in ohm (standard value)
16  Rf= Av*R1;// in ohm
17  Rf= 180*10^3;// in ohm
18  R3= Rf;// in ohm
19  R=R1;// in ohm
20  C= 1/(2*%pi*R*sqrt(6)*1000);// in F
21  R= R*10^-3;// in k ohm
22  Rf= Rf*10^-3;// in k ohm
23  C= C*10^6;// in   F
24  disp(R,"The value of R and R1 in k ohm is : ")
25  disp(Rf,"The value of Rf and R3 in k ohm is : ")
26  disp(C,"The value of C in   F is : ")
27  disp(V_CC,"The value of V_CC in volts is : ")
28  disp(V_EE,"The value of V_EE in volts is : ")
```

Scilab code Exa 11.3 Value of R and C

```
 1  // Exa 11.3
 2  clc;
 3  clear;
 4  close;
 5  format('v',5)
```

```scilab
6  // Given data
7  f = 5;// in kHz
8  f = f * 10^3;// in Hz
9  miu = 55;
10 r_d = 5.5;// in k ohm
11 r_d = r_d * 10^3;// in ohm
12 A= 29;
13 // abs(A) = g_m*R_L = (g_m*r_d*R_D)/(r_d+R_D) = (miu
      *R_D)/(r_d+R_D);
14 // miu*R_D = abs(A)*(r_d+R_D);
15 R_D = (abs(A)*r_d)/(miu-A);// in ohm
16 R_D= R_D*10^-3;// in k ohm
17 disp(R_D,"Minimum value of R_D in  k ohm is");
18 R_D= R_D*10^3;// in ohm
19 Alpha = sqrt(6);
20 // Alpha = 1/(2*%pi*f*R_C);
21 RC = 1/(2*%pi*f*Alpha);// in sec
22 RC= round(RC*10^6);// in  sec
23 disp(RC,"The value of RC in  sec is");
24 RC= RC*10^-6;// in sec
25 R_L = (r_d*R_D)/(r_d+R_D);// in ohm
26 R = 30*10^3;// in ohm
27 C = RC/R;// in F
28 C = C * 10^12;// in pF
29 R= R*10^-3;// in k ohm
30 disp(R,"The value of R in k ohm is");
31 disp(C,"The value of C in pF is");
```

Scilab code Exa 11.4 BJT RC phase shift oscillator

```scilab
1  // Exa 11.4
2  clc;
3  clear;
4  close;
5  format('v',5)
```

```scilab
 6  // Given data
 7  f= 100*10^3;// in Hz
 8  h_fe = 100;
 9  h_ie = 1* 10^3;// in ohm
10  V_CE = 5;// in V
11  V_BE= 0.7;// in V
12  I_C = 1* 10^-3;// in A
13  I_B= 0.01*10^-3;// in A
14  V_CC = 20;// in V
15  R_E = 1* 10^3;// in ohm
16  I_E = I_C;// in A
17  R_C = (V_CC-V_CE-(I_E*R_E))/I_C;// in ohm
18  R = 10*10^3;// in k ohm
19  k = R_C/R;
20  h_fe=(23+29/k+4*k);
21  // Formula f= 1/(2*%pi*R*C*sqrt(6+4*k))
22  C= 1/(2*%pi*R*f*sqrt(6+4*k));// in F
23  // R= R3+R1 || R2+h_ie = R3+h_ie (approx)
24  R3= R-h_ie;// in ohm
25  V_B= V_BE+I_E*R_E;// in V
26  R2= 10*10^3;// in ohm (assumed value)
27  I_R2= V_B/R2;// current in R2 in A
28  V_R1= V_CC-V_B;// drop across R1 in V
29  I_R1= I_R2+I_B;// in A
30  R1= V_R1/I_R1;// in ohm
31  R_E= R_E*10^-3;// in k ohm
32  R_C= R_C*10^-3;// in k ohm
33  R= R*10^-3;// in k ohm
34  R1= R1*10^-3;// in k ohm
35  R2= R2*10^-3;// in k ohm
36  R3= R3*10^-3;// in k ohm
37  C=C*10^12;// in pF
38  disp(R_E,"The value of R_E in k ohm is");
39  disp(R_C,"The value of R_C in k ohm is");
40  disp(R,"The value of R in k ohm is");
41  disp("The value of h_fe >= "+string(h_fe));
42  disp(C,"The value of C in pF is : ")
43  disp(R3,"The value of R3 in k ohm is : ")
```

```
44 disp(R2,"The value of R2 in k ohm is : ")
45 disp(R1,"The value of R1 in k ohm is : ")
```

Scilab code Exa 11.5 Transistor gain

```
1  // Exa 11.5
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  f = 5;// in kHz
8  f = f * 10^3;// in Hz
9  R1 = 14;// in k ohm
10 R2 = 75;// in k ohm
11 R_C = 18;// in k ohm
12 R = 6;// in k ohm
13 h_ie = 2;// in k ohm
14 k = R_C/R;// in k ohm
15 // f = 1/( 2*%pi*RC*sqrt(6+(4*k)) );
16 C = 1/( 2*%pi*R*10^3*f*sqrt(6+(4*k)) );// in F
17 C = C * 10^9;// in nF
18 disp(C,"The value of capacitor in nF is");
19 h_fe= 23+(29/k)+(4*k);
20 disp("The value of h_fe >= "+string(h_fe))
21 disp("Thus the transistor used mush have a minimum
       current gain of 45")
```

Scilab code Exa 11.7 Component values of wein bridge

```
1  // Exa 11.7
2  clc;
3  clear;
```

```
 4  close ;
 5  format ( 'v' ,6)
 6  // Given data
 7  f_max = 10;// in kHz
 8  f_max = f_max * 10^3;// in Hz
 9  R = 100*10^3;// in k ohm
10  C = 1/(2*%pi*f_max*R);// in F
11  C= C*10^9;// in nF
12  disp (C, "For maximum frequency , the value of C in nF
       is" );
13  f_min = 100;// in Hz
14  C = 1/(2*%pi*f_min*R);// in F
15  C= C*10^9;// in nF
16  disp (C, "For minimum frequency , the value of C in nF
       is" );
```

Scilab code Exa 11.8 Oscillation frequency

```
 1  // Exa 11.8
 2  clc ;
 3  clear ;
 4  close ;
 5  format ( 'v' ,4)
 6  // Given data
 7  R4 = 220;// in k ohm
 8  R4 = R4 * 10^3;// in ohm
 9  R3 = R4;// in ohm
10  R = R4;// in ohm
11  C1 = 250* 10^-12;// in F
12  C2 = C1;// in F
13  C = C1;// in F
14  f = 1/(2*%pi*R*C);// in Hz
15  f= f*10^-3;// in k Hz
16  disp (f, "The frequency of oscillation in kHz is" );
```

Scilab code Exa 11.9 Q of the crystal

```
1  // Exa 11.9
2  clc ;
3  clear ;
4  close ;
5  format ('v',5)
6  // Given data
7  L = 0.33;
8  Cs = 0.65;// in pF
9  Cs = Cs * 10^-12;// in F
10 C_M = 1;// in pF
11 C_M = C_M * 10^-12;// in F
12 R = 5.5;// in k ohm
13 R = R * 10^3;// in ohm
14 f_s = 1/(2*%pi*sqrt( L*Cs ));// in Hz
15 f_s= f_s*10^-6;// in MHz
16 disp(f_s,"The series resonant frequency in MHz is");
17 f_s= f_s*10^6;// in Hz
18 Ceq = (Cs*C_M)/(Cs+C_M);// in F
19 f_P = 1/(2*%pi*sqrt( L*Ceq ));// in Hz
20 f_P= f_P*10^-6;// in MHz
21 disp(f_P,"The parallel resonant frequency in MHz is
       : ")
22 f_P= f_P*10^6;// in Hz
23 P = ((f_P-f_s)/f_s)*100;// in %
24 disp("The parallel resonant frequency exceds series
       resonant frequency by "+string(P)+" % ");
25 Q = (sqrt(L/Cs))/R;
26 disp(Q,"The Q factor of the crystal is");
```

Scilab code Exa 11.10 Parallel resonant frequency

```
1  // Exa 11.10
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  Cs = 0.04;// in pF
8  C_M = 2;// in pF
9  Per = (1/2)*(Cs/C_M)*100;// in %
10 disp("Parallel resonant frequency is greater than
       series resonant frequency by "+string(Per)+" %")
```

Scilab code Exa 11.12 Frequency of oscillation and minimum value of R

```
1  // Exa 11.12
2  clc;
3  clear;
4  close;
5  format('v',6)
6  // Given data
7  C = 0.01;// in pF
8  C = C * 10^-12;// in F
9  L = 10;// in mH
10 L = L * 10^-3;// in H
11 f_o = 1/(2*%pi*sqrt(L*C));// in Hz
12 f_o = f_o * 10^-6;// in MHz
13 disp(f_o,"The oscillation frequency in MHz is");
14 R1 = 100;// in k ohm
15 R2 = 5;// in k ohm
16 A = 1 + (R1/R2);
17 // Beta = R/10;
18 // loopgain = A*Beta A*R/10 >=1
19 R= 10/A;// in k ohm
20 R=round(R*10^3);// in ohm
21 disp("The value of R is >= "+string(R)+" ohm")
```