

Scilab Textbook Companion for  
Electronic Circuits  
by P. Raja<sup>1</sup>

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# Book Description

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

**Exa** Example (Solved example)

**Eqn** Equation (Particular equation of the above book)

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

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

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# Chapter 1

## Operational Amplifiers

Scilab code Exa 1.1 Value of Rf

```
1 // Exa 1.1
2 clc;
3 clear;
4 close;
5 // Given data
6 G= -100;
7 R1= 2.2; // in kohm
8 R1=R1*10^3; // in ohm
9 // Formula  $G=-R_f/R_1$ 
10 Rf= -G*R1;
11 disp(Rf*10^-3,"The value of Rf in kohm is ")
```

---

Scilab code Exa 1.2 Output voltage

```
1 // Exa 1.2
2 clc;
3 clear;
4 close;
```

```

5 // Given data
6 Rf= 200;// in kohm
7 R1= 2;// in kohm
8 vin=2.5;// in mV
9 vin=vin*10^-3;// in volt
10 G= -Rf/R1;
11 vo= G*vin;// in V
12 disp(vo,"The output voltage in volt is : ")

```

---

### Scilab code Exa 1.3 Inverting amplifier

```

1 // Exa 1.3
2 clc;
3 clear;
4 close;
5 // Given data
6 G=-10;
7 Ri= 100;// in kohm
8 R1= Ri;// in kohm
9 R1=R1*10^3;// in ohm
10 // Formula  $G=-R2/R1$ 
11 R2= R1*abs(G);// ohm
12 disp(R1*10^-3,"Value of R1 in kohm is : ")
13 disp(R2*10^-6,"and value of R2 in Mohm is : ")

```

---

### Scilab code Exa 2.3 Value of ID and VDS

```

1 // Exa 2.3
2 clc;
3 clear;
4 close;
5 // Given data
6 Vt= 0.7;// in V

```

```

7 I_D= 100; // in A
8 I_D=I_D*10^-6; // in A
9 // When
10 V_GS= 1.2; // in V
11 V_DS= V_GS; // in V
12 // At this condition, device is in saturation region
    , so      I_D= unCox*W/(2*L)*(V_GS-Vt)^2
13 unCoxWby2L= I_D/(V_GS-Vt)^2;
14 // For
15 V_DS= 3; // in V
16 V_GS= 1.5; // in V
17 // In this condition, device is in saturation region
    , so
18 I_D= unCoxWby2L*(V_GS-Vt)^2; // in A
19 disp(I_D*10^6,"For V_DS= 3V and V_GS= 1.5 V, The
    value of I_D in A is : ")
20 // For
21 V_GS= 3.2; // in V
22 r_DS= 1/(2*unCoxWby2L*(V_GS-Vt)); // in
23 disp(r_DS,"For V_GS = 3.2 V, Drain to source
    resistance in is : ")

```

---

#### Scilab code Exa 1.4 Output voltage

```

1 // Exa 1.4
2 clc;
3 clear;
4 close;
5 // Given data
6 R1= 100; // in kohm
7 R2= 500; // in kohm
8 V1= 2; // in volt
9 Vo= (1+R2/R1)*V1; // in volt
10 disp(Vo,"Output voltage for noninverting amplifier
    in volt")

```

---

Scilab code Exa 1.5 Output voltage

```
1 // Exa 1.5
2 clc;
3 clear;
4 close;
5 // Given data
6 Rf= 1; // in Mohm
7 Rf=Rf*10^6; //in ohm
8
9 // Part(a)
10 V1=1; //in volt
11 V2=2; //in volt
12 V3=3; //in volt
13 R1= 500; // in kohm
14 R1=R1*10^3; //in ohm
15 R2= 1; // in Mohm
16 R2=R2*10^6; //in ohm
17 R3= 1; // in Mohm
18 R3=R3*10^6; //in ohm
19 Vo= -Rf*(V1/R1+V2/R2+V3/R3); // in volt
20 disp(Vo, "(a) Output voltage in volt is : ")
21
22 // Part(b)
23 V1=-2; //in volt
24 V2=3; //in volt
25 V3=1; //in volt
26 R1= 200; // in kohm
27 R1=R1*10^3; //in ohm
28 R2= 500; // in kohm
29 R2=R2*10^3; //in ohm
30 R3= 1; // in Mohm
31 R3=R3*10^6; //in ohm
32 Vo= -Rf*(V1/R1+V2/R2+V3/R3); // in volt
```

33 `disp(Vo, "(b) Output voltage in volt is : ")`

---

#### Scilab code Exa 1.6 Maximum and minimum closed loop gain

```
1 // Exa 1.6
2 clc;
3 clear;
4 close;
5 // Given data
6 disp("Minimum closed loop voltage gain for R2=0 and
      R1= 2 kohm")
7 R2=0;
8 R1=2; // in kohm
9 R1=R1*10^3; // in ohm
10 Av_min= (1+R2/R1)
11 disp(Av_min)
12
13 disp("Maximum closed loop voltage gain for maximum
      value of R2=100 kohm and R1= 2 kohm")
14 R2=100; // in kohm
15 R1=2; // in kohm
16 Av_max= (1+R2/R1)
17 disp(Av_max)
```

---

#### Scilab code Exa 1.7 Output voltage

```
1 // Exa 1.7
2 clc;
3 clear;
4 close;
5 // Given data
6 V1= 745; // in V
7 V2= 740; // in V
```

```

8 V1=V1*10^-6; // in volt
9 V2=V2*10^-6; // in volt
10 CMRR=80; // in dB
11 Av=5*10^5;
12 // (i)
13 // CMRR in dB= 20*log(Ad/Ac)
14 Ad=Av;
15 Ac= Ad/10^(CMRR/20);
16 // (ii)
17 Vo= Ad*(V1-V2)+Ac*(V1+V2)/2;
18 disp(Vo,"Output voltage in volt is : ")
19
20 // Note:- In the book, there is calculation error to
    evaluate the value of Ac, so the value of Ac is
    wrong ans to evaluate the output voltage there is
    also calculation error

```

---

#### Scilab code Exa 1.8 Voltage gain

```

1 // Exa 1.8
2 clc;
3 clear;
4 close;
5 // Given data
6 R1= 1; // in Mohm
7 Ri=R1; // in Mohm
8 Rf=1; // in Mohm
9 A_VF= -Rf/R1;
10 disp(A_VF,"Voltage gain is : ")

```

---

#### Scilab code Exa 1.10 Output voltage

```

1 // Exa 1.10

```

```

2  clc;
3  clear;
4  close;
5  // Given data
6  V1=2; // in V
7  V2=3; // in V
8  Rf=3; // in kohm
9  R1=1; // in kohm
10 disp("Output voltage when only 2V voltage source is
      acting in volt")
11 Vo1= (1+Rf/R1)*V1;
12 disp(Vo1);
13 disp("Output voltage due to 3V voltage source in
      volt")
14 Vo2= (1+Rf/R1)*V2;
15 disp(Vo2);
16 Vo= Vo1+Vo2; // in volts
17 disp(Vo,"Total output voltage in volts")

```

---

#### Scilab code Exa 1.11 Range of voltage gain

```

1  // Exa 1.11
2  clc;
3  clear;
4  close;
5  // Given data
6  Rf=500; // in kohm
7  min_vvs= 0; // minimum value of variable resistor in
      ohm
8  max_vvs= 10; // maximum value of variable resistor in
      ohm
9  Ri_min= 10+min_vvs; // in kohm
10 Ri_max= 10+max_vvs; //in kohm
11 //  $A_v = V_o/V_i = -R_f/R_i$ 
12 disp("Closed loop voltage gain corresponding to Ri(

```

```

    min) is ")
13 Av=-Rf/Ri_min;
14 disp(Av)
15 disp("and closed loop voltage gain corresponding to
    Ri(max) is ")
16 Av=-Rf/Ri_max;
17 disp(Av)
18 disp("Thus the closed loop gain of the circuit can
    be adjusted at any value between -25 to -50 with
    the help of variable resistor.")

```

---

#### Scilab code Exa 1.12 Range of output voltage

```

1 // Exa 1.12
2 clc;
3 clear;
4 close;
5 // Given data
6 Rf=200; // in kohm
7 R1= 20; // in kohm
8 // Av= Vo/Vi= -Rf/Ri
9 Av= -Rf/R1;
10 Vi_min= 0.1; // in V
11 Vi_max= 0.5; // in V
12 // Vo= Av*Vi
13 Vo_min= Av*Vi_min; // in V
14 Vo_max= Av*Vi_max; // in V
15 disp("Output voltage ranges from "+string(Vo_min)+"V
    to "+string(Vo_max)+"V")

```

---

#### Scilab code Exa 1.13 The value of R1 and R2

```

1 // Exa 1.13

```



```

2  clc;
3  clear;
4  close;
5  // Given data
6  Rf= 250; // in kohm
7  // Output voltage expression , Vo= -5*Va+3*Vb
8  // and we know that for a difference amplifier
   circuit ,
9  // Vo= -Rf/R1*Va + [R2/(R1+R2)]*[1+Rf/R1]*Vb
10 // Comparing both the expression , we get
11 // -Rf/R1*Va= -5*Va, or
12 R1= Rf/5; // in kohm
13 disp(R1,"The value of R1 in kohm")
14 // and
15 R2= 3*R1^2/(R1+Rf-3*R1)
16 disp(R2,"The value of R2 in kohm")
17
18 // Note : Answer in the book is wrong

```

---

#### Scilab code Exa 1.14 Output voltage

```

1  // Exa 1.14
2  clc;
3  clear;
4  close;
5  // Given data
6  Vi_1= 150; // in V
7  Vi_2= 140; // in V
8  Vd= Vi_1-Vi_2; // in V
9  Vd=Vd*10^-6; // in V
10 Vc= (Vi_1+Vi_2)/2; // in V
11 Vc=Vc*10^-6; // in V
12 // Vo= Ad*Vd*(1+Vc/(CMRR*Vd))
13
14 // (i) For Ad=4000 and CMRR= 100

```

```

15 Ad=4000;
16 CMRR= 100;
17 Vo= Ad*Vd*(1+Vc/(CMRR*Vd)); // in volt
18 disp(Vo*10^3," Output voltage in mV")
19
20 // (ii) For Ad=4000 and CMRR= 10^5
21 Ad=4000;
22 CMRR= 10^5;
23 Vo= Ad*Vd*(1+Vc/(CMRR*Vd)); // in volt
24 disp(Vo*10^3," Output voltage in mV")

```

---

#### Scilab code Exa 1.15 Output voltage

```

1 // Exa 1.15
2 clc;
3 clear;
4 close;
5 // Given data
6 Rf=470; // in kohm
7 R1=4.3; // in kohm
8 R2=33; // in kohm
9 R3=33; // in kohm
10 Vi= 80; // in V
11 Vi=Vi*10^-6; // in volt
12 A1= 1+Rf/R1;
13 A2=-Rf/R2;
14 A3= -Rf/R3;
15 A=A1*A2*A3;
16 Vo= A*Vi; // in volt
17 disp(Vo," Output voltage in volts is : ")

```

---

#### Scilab code Exa 1.16 Ouptut voltage

```

1 // Exa 1.16
2 clc;
3 clear;
4 close;
5 // Given data
6 R1= 33; // in k
7 R2= 10; // in k
8 R3= 330; // in k
9 V1= '50mV sin(1000 t)';
10 V2= '10mV sin(3000 t)';
11 Vo1= R3/R1*50*10^-3;
12 Vo2= R3/R2*10*10^-3;
13 // Vo= -Vo1-Vo2;
14 disp("Output voltage is "+string(-Vo1)+" sin (1000 t
      )"+string(-Vo2)+" sin(3000 t)")

```

---

#### Scilab code Exa 1.17 Output voltage

```

1 // Exa 1.17
2 clc;
3 clear;
4 close;
5 // Given data
6 R1=10; // in kohm
7 R2=150; // in kohm
8 R3=10; // in kohm
9 R4=300; // in kohm
10 V1= 1; // in V
11 V2= 2; // in V
12 Vo= [(1+R4/R2)*(R3*V1/(R1+R3))-(R4/R2)*V2];
13 disp(Vo,"Output voltage in volts is : ")

```

---

#### Scilab code Exa 1.18 Output voltage

```

1 // Exa 1.18
2 clc;
3 clear;
4 close;
5 // Given data
6 R1=12; // in kohm
7 Rf=360; // in kohm
8 V1= -0.3; // in V
9 Vo= (1+Rf/R1)*V1; // in V
10 disp(Vo,"Output voltage result in volts is : ")
11
12 // Part(b)
13 Vo= 2.4; // in V
14 // We know, Vo= (1+Rf/R1)*V1
15 V1= Vo/(1+Rf/R1);
16 disp(V1*10^3,"Input voltage in mV to result in an
    output of 2.4 Volt is")

```

---

#### Scilab code Exa 1.19 Output voltage

```

1 // Exa 1.19
2 clc;
3 clear;
4 close;
5 // Given data
6 Rf=68; // in kohm
7 R1=33; // in kohm
8 R2=22; // in kohm
9 R3=12; // in kohm
10 V1= 0.2; // in V
11 V2=-0.5; // in V
12 V3= 0.8; // in V
13 Vo= -Rf/R1*V1 + (-Rf/R2)*V2 + (-Rf/R3)*V3; // in
    volts
14 disp(Vo,"Output voltage in volts is : ")

```

---

**Scilab code Exa 1.20** Output voltage

```
1 // Exa 1.20
2 clc;
3 clear;
4 close;
5 // Given data
6 Rf=100; // in kohm
7 R1=20; // in kohm
8 V1= 1.5; // in V
9 Vo1= V1;
10 Vo= -Rf/R1*Vo1; // in volts
11 disp(Vo,"Output voltage in volts is : ")
```

---

**Scilab code Exa 1.22** Inverting op amp

```
1 // Exa 1.22
2 clc;
3 clear;
4 close;
5 // Given data
6 vo= -10; // in V
7 i_f= 1; // in mA
8 i_f= i_f*10^-3; // in A
9 // Formula vo= -i_f*Rf
10 Rf= -vo/i_f; // in
11 // The output voltage, vo= -(v1+5*v2) (i)
12 // vo= -Rf/R1*v1 - Rf/R2*v2; (ii)
13 // Comparing equations (i) and (2)
14 R1= Rf/1; // in
15 R2= Rf/5; // in
```

```

16 disp(Rf*10^-3,"The value of Rf in k is : ")
17 disp(R1*10^-3,"The value of R1 in k is : ")
18 disp(R2*10^-3,"The value of R2 in k is : ")

```

---

#### Scilab code Exa 1.24 Output voltage

```

1 // Exa 1.24
2 clc;
3 clear;
4 close;
5 // Given data
6 R1= 9; // in k
7 R2= 1; // in k
8 R3= 2; // in k
9 R4= 3; // in k
10 // The output voltage , vo1= (1+R1/R2)*va
11 vo1BYva= (1+R1/R2); // (i)
12 // Voltage at node va= R4*v1/(R3+R4)
13 vaBYv1= R4/(R3+R4); // (ii)
14 // From (i) and (ii)
15 vo1BYv1= vo1BYva*vaBYv1; // (iii)
16 // The output voltage , vo2= (1+R1/R2)*va
17 vo2BYva= (1+R1/R2); // (iv)
18 // Voltage at node va= R3*v2/(R3+R4)
19 vaBYv2= R3/(R3+R4); // (v)
20 // From (i) and (ii)
21 vo2BYv2= vo2BYva*vaBYv2; // (iii)
22 // Total output vo= vo1 + vo2
23 disp("Total voltage is "+string(vo1BYv1)+" v1 + "+
      string(vo2BYv2)+" v2")

```

---

#### Scilab code Exa 1.25 Output voltage

```

1 // Exa 1.25
2 clc;
3 clear;
4 close;
5 // Given data
6 R1= 9; // in k
7 R2= 1; // in k
8 R3= 2; // in k
9 R4= 3; // in k
10 // The output voltage,  $vo1 = (1+R1/R2)*va$ 
11 vo1BYva= (1+R1/R2); // (i)
12 // Voltage at node va=  $R4*v1/(R3+R4)$ 
13 vaBYv1= R4/(R3+R4); // (ii)
14 // From (i) and (ii)
15 vo1BYv1= vo1BYva*vaBYv1; // (iii)
16 // The output voltage,  $vo2 = (1+R1/R2)*va$ 
17 vo2BYva= (1+R1/R2); // (iv)
18 // Voltage at node va=  $R3*v2/(R3+R4)$ 
19 vaBYv2= R3/(R3+R4); // (v)
20 // From (i) and (ii)
21 vo2BYv2= vo2BYva*vaBYv2; // (iii)
22 // The output voltage,  $vo3 = (-R1/R2)*v3$ 
23 vo3BYv3= (-R1/R2); // (i)
24
25 // Total output  $vo = vo1 + vo2 + vo3$ 
26 disp("Total voltage is "+string(vo1BYv1)+" v1 + "+
      string(vo2BYv2)+" v2 "+string(vo3BYv3)+" v3")

```

---

#### Scilab code Exa 1.26 Gain

```

1 // Exa 1.26
2 clc;
3 clear;
4 close;
5 // Given data

```

```

6 // omega_t= Ao*omega_b
7 // 2*%pi*f_t = Ao*2*%pi*f_b
8 // f_t= Ao*f_b
9 // Part (i)
10 Ao1= 10^5;
11 f_b1= 10^2;// in Hz
12 f_t1= Ao1*f_b1;// in Hz
13 // Part (ii)
14 Ao2= 10^6;
15 f_t2= 10^6;// in Hz
16 f_b2= f_t2/Ao2;// in Hz
17 // Part (iii)
18 f_b3= 10^3;// in Hz
19 f_t3= 10^8;// in Hz
20 Ao3= f_t3/f_b3;
21 // Part (iv)
22 f_b4= 10^-1;// in Hz
23 f_t4= 10^6;// in Hz
24 Ao4= f_t4/f_b4;
25 // Part (v)
26 Ao5= 2*10^5;
27 f_b5= 10;// in Hz
28 f_t5= Ao5*f_b5;// in Hz
29 disp(f_t1,"The value of f_t1 in Hz is : ")
30 disp(f_b2,"The value of f_b2 in Hz is : ")
31 disp(Ao3,"The value of Ao3 is : ")
32 disp(Ao4,"The value of Ao4 is : ")
33 disp(f_t5,"The value of f_t5 in Hz is : ")

```

---

**Scilab code Exa 1.27** Value of Ao fb fr

```

1 // Exa 1.27
2 clc;
3 clear;
4 close;

```



```

5 // Given data
6 Ao= 86; // in dB
7 A= 40; // in dB
8 f=100; // in kHz
9 f=f*10^3; // in Hz
10 // From  $20 \cdot \log(S) = 20 \cdot \log(A_o/A)$ , where S, stands
    for  $\sqrt{1+(f/f_b)^2}$ 
11 S= 10^((Ao-A)/20);
12 // S=  $\sqrt{1+(f/f_b)^2}$ 
13 fb= f/sqrt(S^2-1); // in Hz
14 Ao= 10^(Ao/20);
15 ft= Ao*fb; // in Hz
16 disp(Ao,"The value of Ao is : ")
17 disp(fb,"The value of fb in Hz is : ")
18 disp(round(ft*10^-6),"The value of ft in MHz is : ")

```

---

#### Scilab code Exa 1.28 3dB frequency and gain

```

1 // Exa 1.28
2 clc;
3 clear;
4 close;
5 // Given data
6 Ao= 10^4; // in V/V
7 f_t= 10^6; // in Hz
8 R2byR1= 20;
9 omega_t= 2*%pi*f_t;
10 omega_3dB= omega_t/(1+R2byR1);
11 f3dB= omega_3dB/(2*%pi); // in Hz
12 disp(f3dB*10^-3,"3-dB frequency of the closed loop
    amplifier in kHz is : ")
13 f3dB= 0.1*f3dB; // in Hz
14 voBYvi= -R2byR1/sqrt(1+(2*%pi*f3dB/omega_3dB)^2);
15 voBYvi= abs(voBYvi); // in v/v
16 disp(voBYvi,"Gain in v/v is : ")

```



# Chapter 2

## MOSFET

Scilab code Exa 2.1 Device operate region

```
1 // Exa 2.1
2 clc;
3 clear;
4 close;
5 // Given data
6 V_S= 0; // As source is connected to ground
7 V_G= 1.5; // in V
8 V_D= 0.5; // in V
9 Vt= 0.7; // in V
10 // Part(a) V_D= 0.5; // in V
11 V_D= 0.5; // in V
12 V_DS= V_D-V_S; // in V
13 V_GS= V_G-V_S; // in V
14 if V_GS < Vt then
15     disp("At V_D = 0.5 , the device is in cut off
16         region")
17 elseif V_DS <= (V_GS-Vt) then
18     disp("At V_D = 0.5 , the device is in triode
19         region");
20 else
21     disp("At V_D = 0.5 , the device is in saturation
```

```

                region");
20
21 end
22
23 // Part(b) V_D= 0.9;// in V
24 V_D= 0.9;// in V
25 V_DS= V_D-V_S;// in V
26 V_GS= V_G-V_S;// in V
27 if V_GS < Vt then
28     disp("At V_D = 0.9 , the device is in cut off
           region")
29 elseif V_DS<= (V_GS-Vt) then
30     disp("At V_D = 0.9 , the device is in triode
           region");
31 else
32     disp("At V_D = 0.9 , the device is in saturation
           region");
33
34 end
35
36 // Part(c) V_D= 3;// in V
37 V_D= 3;// in V
38 V_DS= V_D-V_S;// in V
39 V_GS= V_G-V_S;// in V
40 if V_GS < Vt then
41     disp("At V_D = 3 , the device is in cut off
           region")
42 elseif V_DS<= (V_GS-Vt) then
43     disp("At V_D = 3 , the device is in triode
           region");
44 else
45     disp("At V_D = 3 , the device is in saturation
           region");
46
47 end

```

---

## Scilab code Exa 2.2 Drain current

```
1 // Exa 2.2
2 clc;
3 clear;
4 close;
5 // Given data
6 unCox= 100; // in A/V^2
7 unCox= unCox*10^-6; // in A/V^2
8 L= 1; // in m
9 L= L*10^-6; // in m
10 W=10; // in m
11 W=W*10^-6; // in m
12 V_GS= 1.5; // in V
13 Vt= 0.7; // in V
14 // For V_DS= 0.5 V
15 V_DS= 0.5; // in V
16 if V_DS<= (V_GS-Vt) then
17     I_D= unCox*W/L*[(V_GS-Vt)*V_DS-V_DS^2/2];
18     disp(I_D*10^6,"The device is in triode region.
19         SO the drain current in the triode region in
20         A is : ")
19 else
20     I_D= unCox*W/(2*L)*(V_GS-VT)^2
21     disp(I_D*10^6,"The device is in saturation
22         region. SO the drain current in the
23         saturation region in A is : ")
22 end
23 // For V_DS= 0.9 V
24 V_DS= 0.9; // in V
25 if V_DS<= (V_GS-Vt) then
26     I_D= unCox*W/L*[(V_GS-Vt)*V_DS-V_DS^2/2];
27     disp(I_D*10^6,"The device is in triode region.
28         So the drain current in the triode region in
```

```

        A is : ")
28 else
29     I_D= unCox*W/(2*L)*(V_GS-Vt)^2
30     disp(I_D*10^6,"The device is in saturation
        region. So drain current in the saturation
        region in A is : ")
31 end

```

---

#### Scilab code Exa 2.4 Value of VGS RS and RD

```

1 // Exa 2.4
2 clc;
3 clear;
4 close;
5 // Given data
6 I_D= 0.4; // in mA
7 I_D=I_D*10^-3; // in A
8 Vt= 0.7; // in V
9 V_SS= -2.5; // in V
10 V_DD= 2.5; // in V
11 unCox= 100; // in A/V^2
12 unCox= unCox*10^-6; // in A/V^2
13 W= 32; // in m
14 L= 1; // in m
15 // V_GS-Vt= V_OV
16 // I_D= unCox*W/(2*L)*(V_OV)^2
17 V_OV= sqrt(I_D/(unCox*W/(2*L))); // in V
18 V_GS= V_OV+Vt; // in V
19 disp(V_GS,"The value of V_GS in volt is : ")
20 V_G= 0;
21 // Formula V_GS= V_G-V_S
22 V_S= V_G-V_GS; // in V
23 R_S= (V_S-V_SS)/I_D // in
24 disp(R_S*10^-3,"The value of R_S in k is : ")
25 V_D= 0.5; // in V

```

```

26 R_D= (V_DD-V_D)/I_D; //in
27 disp(R_D*10^-3,"The value of R_D in k is : ")

```

---

### Scilab code Exa 2.5 Value required of R

```

1 // Exa 2.5
2 clc;
3 clear;
4 close;
5 // Given data
6 V_DD= 3; // in V
7 I_D= 80; // in A
8 I_D=I_D*10^-6; // in A
9 Vt= 0.6; // in V
10 unCox= 200; // in A/V^2
11 unCox= unCox*10^-6; // in A/V^2
12 L= 0.8; //in m
13 L= L*10^-6; // in m
14 W=4; // in m
15 W=W*10^-6; // in m
16 // V_GS-Vt= V_OV
17 // I_D= unCox*W/(2*L)*(V_OV)^2
18 V_OV= sqrt(I_D/(unCox*W/(2*L))); // in V
19 V_GS= V_OV+Vt; // in V
20 V_D= 1; // in V
21 V_G= V_D; // in V
22 R= (V_DD-V_D)/I_D; // in
23 disp(R*10^-3,"The value of R in k is : ")

```

---

### Scilab code Exa 2.6 Value of R and VD

```

1 // Exa 2.6
2 clc;

```

```

3 clear;
4 close;
5 // Given data
6 V_DD= 10; // in V
7 I_D= 0.4; // in mA
8 I_D=I_D*10^-3; // in A
9 Vt= 2; // in V
10 unCox= 20; // in A/V^2
11 unCox= unCox*10^-6; // in A/V^2
12 L= 10; // in m
13 L= L*10^-6; // in m
14 W=100; // in m
15 W=W*10^-6; // in m
16 V_S= 0; // in V as source is connected to ground
17 // I_D= unCox*W/(2*L)*(V_OV)^2
18 V_OV= sqrt(I_D/(unCox*W/(2*L))); // in V
19 V_GS= V_OV+Vt; // in V
20 V_D= V_GS; // in V
21 R= (V_DD-V_D)/I_D; // in
22 disp(R*10^-3, "The value of R in k is : ")

```

---

**Scilab code Exa 2.7** Effective resistance between drain and source

```

1 // Exa 2.7
2 clc;
3 clear;
4 close;
5 // Given data
6 KnWbyL= 1; // in mA
7 KnWbyL=KnWbyL*10^-3; // in A
8 Vt= 1; // in V
9 V_DS= 0.1; // in V
10 V_D= V_DS; // in V
11 V_GS= 5; // in V
12 V_DD= V_GS; // in V

```



```

13 // Formula  $I_D = K'nW/L * [(V_{GS} - V_t) * V_{DS} - V_{DS}^2/2]$ 
14 I_D= KnWbyL*[(V_GS-Vt)*V_DS-V_DS^2/2]; // in A
15 R_D= (V_DD-V_D)/I_D; // in
16 disp(R_D*10^-3,"The required value of R_D in k is
: ")

```

---

### Scilab code Exa 2.8 Voltages at all nodes

```

1 // Exa 2.8
2 clc;
3 clear;
4 close;
5 // Given data
6 KnWbyL= 1; // in mA/V^2
7 KnWbyL=KnWbyL*10^-3; // in A/V^2
8 Vt= 1; // in V
9 V_DD= 10; // in V
10 R_D= 6; // in k
11 R_D= R_D*10^3; // in
12 R_S= 6; // in k
13 R_S= R_S*10^3; // in
14 R_G1= 10; // in M
15 R_G1= R_G1*10^6; // in
16 R_G2= 10; // in M
17 R_G2= R_G2*10^6; // in
18 V_G= V_DD*R_G2/(R_G1+R_G2); // in V
19 // V_S= R_S*I_D
20 // V_GS= V_G-V_S= V_G-R_S*I_D
21 // Formula  $I_D = K'nW/2*L*(V_{GS} - V_t)^2$ , Putting the
    value of V_GS, We get
22 //  $18*I_D^2 - 25*I_D + 8 = 0$ 
23 //  $I_D = 0.89$  mA or  $I_D = 0.5$ 
24 I_D= 0.5; // in mA
25 I_D=I_D*10^-3; // in A
26 V_S= R_S*I_D; // in V

```

```

27 V_GS= V_G-V_S; // in V
28 V_D= V_DD-I_D*R_D; // in V
29 disp(I_D*10^3,"The value of I_D in mA is : ")
30 disp(V_S,"The value of V_S in volt is : ")
31 disp(V_GS,"The value of V_GS in volt is : ")
32 disp(V_D,"The value of V_D in volt is : ")
33 disp("Since V_D > V_G - Vt , the transistor is
operating in saturation , as initially assumed")

```

---

### Scilab code Exa 2.9 Value of ID and VDS

```

1 // Exa 2.9
2 clc;
3 clear;
4 close;
5 // Given data
6 R_D= 20; // in k
7 R_D= R_D*10^3; // in
8 R1= 30; // in k
9 R1= R1*10^3; // in
10 R2= 20; // in k
11 R2= R2*10^3; // in
12 V_DD= 5; // in V
13 Vtn= 1; // in V
14 Kn= 0.1; // in mA/V^2
15 Kn=Kn*10^-3; // in A/V^2
16 V_GS= R2*V_DD/(R1+R2); // in V
17 // I_D= 1/2* nCox*W/L*(V_GS-Vtm)^2
18 I_D = Kn*(V_GS-Vtn)^2 ; // in mA (As Kn= 1/2* nCox*
W/L)
19 V_DS= V_DD-I_D*R_D; // in V
20 disp(V_GS,"The value of V_GS in volt is : ")
21 disp(I_D*10^3,"The value of I_D in mA is : ")
22 disp(V_DS,"The value of V_DS in volt is : ")
23 disp("Since V_DS = 3V > V_DS(sat) = V_GS-Vtn = 2 - 1

```

V, the transistor is indeed biased in the saturation region”)

---

### Scilab code Exa 2.10 Design a bias circuit

```
1 // Exa 2.10
2 clc;
3 clear;
4 close;
5 // Given data
6 V_DD= 15; // in V
7 Vt= 1; // in V
8 V_D= 10; // in V
9 V_S= 5; // in V
10 KnWbyL= 1; // in mA/V^2
11 KnWbyL=KnWbyL*10^-3; // in A/V^2
12 R_G1= 8; // in M
13 R_G1= R_G1*10^6; // in
14 I_D= 0.5; // in mA
15 I_D=I_D*10^-3; //in A
16 R_D= (V_DD-V_D)/I_D; // in
17 R_S= V_S/I_D; // in
18 // Formul I_D= 1/2*KnWbyL*(V_OV)^2
19 V_OV= sqrt(2*I_D/KnWbyL); // in V
20 // Formula V_OV= V_GS-Vt
21 V_GS= V_OV+Vt; // in V
22 V_G= V_GS+V_S; // in V
23 // Formul V_G= R_G2*V_DD/(R_G1+R_G2)
24 R_G2= R_G1*V_G/(V_DD-V_G); //in
25 disp(R_D*10^-3,"The value of R_D in k is : ")
26 disp(R_S*10^-3,"The value of R_S in k is : ")
27 disp(V_OV,"The value of V_OV in volts is : ")
28 disp(V_GS,"The value of V_GS in volts is : ")
29 disp(R_G2*10^-6,"The value of R_G2 in M is : ")
```

---

### Scilab code Exa 2.11 Bias point

```
1 // Exa 2.11
2 clc;
3 clear;
4 close;
5 // Given data
6 V_DD= 15; // in V
7 KnWbyL= 0.25; // in mA/V^2
8 KnWbyL=KnWbyL*10^-3; // in A/V^2
9 Vt= 1.5; // in V
10 V_A= 50; // in V
11 R_D= 10; // in k
12 R_D= R_D*10^3; // in
13 R_L= 10; // in k
14 R_L= R_L*10^3; // in
15 R_G= 10; // in M
16 R_G= R_G*10^6; // in
17 // I_D= 1/2*KnWbyL*(V_D-Vt)^2 , (V_GS= V_D, as dc
    gate current is zero) (i)
18 // V_D= V_DD- I_D*R_D (ii)
19 I_D= 1.06; // in mA
20 I_D = I_D*10^-3; // in A
21 V_D= V_DD- I_D*R_D; // in V
22 V_GS=V_D; // in V
23 // The coordinates of operating point
24 V_GSQ= V_D; // in V
25 I_DQ= I_D*10^3; // in mA
26 disp("The coordinates of operating points are V_GSQ
    = "+string(V_GSQ)+" V and I_DQ= "+string(I_DQ)+"
    mA")
27 gm= KnWbyL*(V_GS-Vt); // in A/V
28 r_o= V_A/I_D; //in
29 // The gain is : Av= vo/vi = -gm*(R_D||R_L||r_o)
```

```

30 Av= -gm*[R_D*R_L*r_o/(R_D*R_L+R_D*r_o+R_L*r_o)];//
    in V/V
31 // i_i= (vi-vo)/R_G
32 // i_i= vi/R_G*(1-vo/vi) and Rin= vi/i_i = R_G/(1-Av
    )
33 Rin= R_G/(1-Av);// in
34 disp(Rin*10^-6,"The input resistance in M is : ")
35 disp("The largest allowable input signal vi is
    determined by the need to keep the MOSFET in
    saturation at all times")
36 disp("                                V_DS >= V_GS-
    vt")
37 disp("By enforcing this condition with equality at
    the point V_GS is maximum and V_DS is
    correspondingly minimum")
38 disp("                                V_DSmin=
    V_GSmax -Vt")
39 disp("                                V_DS-|Av| vi
    = V_GS + vi -Vt")
40 disp("                                4.4 - 3.3 vi
    = 4.4 + vi -1.5")
41 disp("which results in vi= 0.34V")

```

---

### Scilab code Exa 2.12 Largest value of RD

```

1 // Exa 2.12
2 clc;
3 clear;
4 close;
5 // Given data
6 I_D= 0.5;// in mA
7 I_D= I_D*10^-3;// in mA
8 V_D= 3;// in V
9 Vt= -1;// in V
10 KpWbyL= 1;// in mA/V^2

```

```

11 KpWbyL=KpWbyL*10^-3; // in A/V^2
12 // Formul I_D= 1/2*KpWbyL*(V_OV)^2
13 V_OV= sqrt(2*I_D/KpWbyL); // in V
14 // For PMOS
15 V_OV= -V_OV; // in V
16 V_GS= V_OV+Vt; // in V
17 R_D= V_D/I_D; // in
18 V_Dmax= V_D+abs(Vt); // in V
19 R_D= V_Dmax/I_D; // in
20 disp(R_D*10^-3,"The largest value that R_D can have
    while maintaining saturation-region operation in
    k is : ")

```

---

#### Scilab code Exa 2.14 Resistance value

```

1 // Exa 2.14
2 clc;
3 clear;
4 close;
5 // Given data
6 V_GS1= 1.5; // in V
7 Vt= 1; // in V
8 r_DS1= 1; // in k
9 r_DS1= r_DS1*10^3; // in
10 r_DS2= 200; // in k
11 // r_DS1= 1/(KnWbyL*(V_GS1-Vt)) (i)
12 // r_DS2= 1/(KnWbyL*(V_GS2-Vt)) (ii)
13 // dividing equation (i) by (ii)
14 V_GS2= (r_DS1/r_DS2)*(V_GS1-Vt)+Vt; // in V
15 disp(V_GS2,"To Obtain rDS= 200, The value of V_GS
    should be (in volt)")
16 // For V_GS= 1.5 ; // V
17 // W2= 2*W1;
18 // r_DS1/r_DS2= 2
19 r_DS2= r_DS1/2; // in

```

```

20 disp(r_DS2,"For V_GS= 1.5 V , the value of r_DS2 in
    is : ")
21 // For V_GS= 3.5 V
22 r_DS2= 200/2;// in
23 disp(r_DS2,"For V_GS= 3.5 V , the value of r_DS2 in
    is : ")

```

---

**Scilab code Exa 2.15** Required value of VGS and minimum value of VDS

```

1 // Exa 2.15
2 clc;
3 clear;
4 close;
5 // Given data
6 I_D= 0.2;// in mA
7 I_D= I_D*10^-3;// in mA
8 Vt= 1;// in V
9 KpWbyL= 0.1;// in mA/V^2
10 KpWbyL=KpWbyL*10^-3;// in A/V^2
11 // Formul I_D= 1/2*KpWbyL*(V_GS-VT)^2
12 V_GS= sqrt(2*I_D/KpWbyL)+Vt;// in V
13 V_DSmin= V_GS-Vt;// in V
14 disp(V_GS,"Required V_GS in volts is : ")
15 disp(V_DSmin,"The minimum required V_DS in volts is
    : ")
16 // For I_D= 0.8 mA
17 I_D = 0.8*10^-3;// in A
18 V_GS= sqrt(2*I_D/KpWbyL)+Vt;// in V
19 V_DSmin= V_GS-Vt;// in V
20 disp(V_GS,"Required V_GS in volts is : ")
21 disp(V_DSmin,"The minimum required V_DS in volts is
    : ")

```

---

### Scilab code Exa 2.16 Value of RD and RS

```
1 // Exa 2.16
2 clc;
3 clear;
4 close;
5 // Given data
6 V_SS= -5; // in V
7 unCox= 60; // in A/V^2
8 unCox= unCox*10^-6; // in A/V^2
9 Vt= 1; // in V
10 W= 100; // in m
11 L= 3; // in m
12 V_G=0; // in V
13 V_DD= 5; // in V
14 V_D=0; // in V
15 I_D= 1*10^-3; // in A
16 // I_D= (V_DD-V_D)/R_D
17 R_D= (V_DD-V_D)/I_D; // in
18 disp(R_D*10^-3, "The value of R_D in k is : ")
19 // Formul I_D= 1/2*unCox*W/L*(V_GS-Vt)^2
20 V_GS= sqrt(2*I_D*L/(unCox*W))+Vt; // in V
21 V_S= V_G-V_GS; // in V
22 R_S= (V_S-V_SS)/I_D; // in
23 disp(R_S*10^-3, "The resistance in k is ");
```

---

### Scilab code Exa 2.17 Required value of R and W

```
1 // Exa 2.17
2 clc;
3 clear;
4 close;
5 // Given data
6 V_D= 3.5; // in V
7 I_D= 115*10^-6; // in A
```



```

8 upCox= 60; // in A/V^2
9 upCox= upCox*10^-6; // in A/V^2
10 L= 0.8; // in m
11 V_GS= -1.5; // in V
12 Vt= 0.7; // in V
13 R= V_D/I_D; // in
14 disp(R*10^-3, "The value required for R in k is : ")
    )
15 // Formul I_D= 1/2*upCox*W/L*(V_GS-Vt)^2
16 W= 2*I_D*L/(upCox*(V_GS-Vt)^2)
17 disp(W, "The value required for W in m is : ")
18
19 // Note: Calculation of evaluating the value of W
    in the book is wrong , so the Answer of the book
    is wrong

```

---

#### Scilab code Exa 2.18 Required value of gate width

```

1 // Exa 2.18
2 clc;
3 clear;
4 close;
5 // Given data
6 Vt= 1; // in V
7 unCox= 120; // in A/V^2
8 unCox= unCox*10^-6; // in A/V^2
9 L1=1; // in m
10 L2=L1; // in m
11 I_D= 120; // in A
12 I_D= I_D*10^-6; // in A
13 V_GS1= 1.5; // in V
14 V_G2= 3.5; // in V
15 V_S2= 1.5; // in V
16 V_DD= 5; // in V
17 V_D2= 3.5; // in V

```

```

18 // Formul  $I_D = 1/2 * \mu_n C_{ox} * W/L * (V_{GS1} - V_t)^2$ 
19 W1= 2*I_D*L1/(unCox*(V_GS1-Vt)^2); // in m
20 disp(W1,"The value of W1 in m is : ")
21 V_GS2= V_G2-V_S2; //in V
22 // Formul  $I_D = 1/2 * \mu_n C_{ox} * W/L * (V_{GS1} - V_t)^2$ 
23 W2= 2*I_D*L2/(unCox*(V_GS2-Vt)^2); // in m
24 disp(W2,"The value of W2 in m is : ")
25 R= (V_DD-V_D2)/I_D; // in
26 disp(R*10^-3,"Resistance in k ");

```

---

### Scilab code Exa 2.19 Value of V1 V2 V3 V4 and V5

```

1 // Exa 2.19
2 clc;
3 clear;
4 close;
5 // Given data
6 Vt= 2; // in V
7 K1WbyL= 1; // in mA/V^2
8 K1WbyL= K1WbyL*10^-3; //in mA/V^2
9 I_D= 10; //in A
10 I_D= I_D*10^-6; //in A
11 V_DD= 10; // in V
12 R_D= 4; // in k
13 R_D= R_D*10^3; // in
14
15 // Formul  $I_D = 1/2 * K_1 W_{byL} * (V_{GS} - V_t)^2$ 
16 V_GS= sqrt(2*I_D/K1WbyL)+Vt; // in V
17 V1= -V_GS; // in V
18 // Part (b)
19 I_D= 2; // in mA
20 I_D= I_D*10^-3; // in A
21 V2= V_DD-I_D*R_D; //in V
22 // Formul  $I_D = 1/2 * K_1 W_{byL} * (V_{GS} - V_t)^2$ 
23 V_GS= sqrt(2*I_D/K1WbyL)+Vt; // in V

```

```

24 V3= -V_GS; // in V
25 // Part (c)
26 I_D= 1; // in mA
27 I_D= I_D*10^-3; // in A
28 // Formul I_D= 1/2*K1WbyL*(V_GS-Vt)^2
29 V_GS= sqrt(2*I_D/K1WbyL)+Vt; // in V
30 V4= V_GS; // in V
31 // Part (d)
32 I_D= 2; // in mA
33 R_D= 2.5; // in k
34 R_D= R_D*10^3; // in
35 V_SS= 10; // in V
36 I_D= I_D*10^-3; // in A
37 V_GS= sqrt(2*I_D/K1WbyL)+Vt; // in V
38 V5= -V_SS+I_D*R_D; // in V
39 disp(V1,"The value of V1 in volts is : ")
40 disp(V2,"The value of V2 in volts is : ")
41 disp(V3,"The value of V3 in volts is : ")
42 disp(V4,"The value of V4 in volts is : ")
43 disp(V5,"The value of V5 in volts is : ")

```

---

### Scilab code Exa 2.20 Labelled current and voltage

```

1 // Exa 2.20
2 clc;
3 clear;
4 close;
5 // Given data
6 unCox= 20*10^-6; //in A/V^2
7 upCox= unCox/2.5; // in A/V^2
8 V_DD= 3; //in V
9 Vt= 1; // in V
10 W= 30; // in m
11 L= 10; // in m
12

```

```

13
14 // V_GS1= V_GS2
15 // Formula V_DD= V_GS1+V_GS2
16 V_GS1= V_DD/2; // in V
17 V_GS2= V_GS1; // in V
18 V2= V_GS1; // in V
19 I1= 1/2*unCox*W/L*(V_GS1-Vt)^2; // in A
20 // Both transistor have V_D = V_G and therefore they
    are operating in saturation
21 // 1/2*unCox*W/L*(V4-Vt)^2 = 1/2*upCox*W/L*(V_DD-V4-
    Vt)
22 V4= (V_DD-Vt+sqrt(unCox/upCox))/(1+sqrt(unCox/upCox)
    );
23 I3= 1/2*unCox*W/L*(1.39-Vt)^2
24 disp(V2,"The value of V2 in volt is : ")
25 disp(I1*10^6,"The value of I1 in A is : ")
26 disp(V4,"The value of V4 in volt is : ")
27 disp(I3*10^6,"The value of I3 in A is : ")

```

---

### Scilab code Exa 2.22 Voltage gain

```

1 // Exa 2.22
2 clc;
3 clear;
4 close;
5 // Given data
6 Vt= 0.9; // in V
7 V_A= 50; // in V
8 V_D= 2; // in V
9 R_L= 10; // in M
10 R_L= R_L*10^3; // in
11 R_G= 10; // in M
12 R_G= R_G*10^6; // in
13 I_D= 500; // in A
14 I_D= I_D*10^-6; // in A

```

```

15 V_GS= V_D; // in V
16 ro= V_A/I_D; // in
17 gm= 2*I_D/(V_GS-Vt); // in A/V
18 // vo= -gm*vi*(ro || R_L)
19 vo_by_vi = -gm*(ro*R_L/(ro+R_L)); // in V/V
20 disp(vo_by_vi , "The voltage gain in V/V is : ")
21 // For I= 1 mA or twice the current
22 I_D1= I_D; // in A
23 I_D2= 2*I_D1; // in A
24 gm1= gm; // in A/V
25 // Effect on V_D
26 // I_D1/I_D2 = (V_GS1-Vt)^2/(V_GS2-Vt)^2
27 V_GS1= V_GS;
28 V_GS2= Vt+sqrt(2)*(V_GS1-Vt); // in V
29 disp(V_GS2, "The new value of V_GS in volts is : ")
30 // Effect on gm
31 // gm1/gm2= sqrt(I_D1/I_D2)
32 gm2= sqrt(I_D2/I_D1)*gm1; // in A/V
33 disp(gm2*10^3, "The new value of gm2 in mA/V is : ")
34 // Effect on ro
35 // ro1/ro2= I_D2/I_D1
36 ro1= ro; // in
37 ro2= I_D1*ro1/I_D2; // in
38 disp(ro2*10^-3, "The new value of ro in k /V is : ")
39 // Effect on gain
40 // Av= -gm*(ro2 || R_L)
41 Av= -gm*(ro2*R_L/(ro2+R_L)); // in V/V
42 disp(Av, "The new value of voltage gain in V/V is : "
)
43
44 // Note: There is some difference between the new
value of voltage gain in book and coding. The
reason behind this is that ,
45 // the accurate value of new value of gm is
1.2856487 and in the book 1.3 has taken at place
of 1.2856487.
46 // If we take this value of new value of gm 1.3 at
place of 1.2856487 then our new voltage gain

```

value will be same as in the book

---

### Scilab code Exa 2.23 Value of CS

```
1 // Exa 2.23
2 clc;
3 clear;
4 close;
5 // Given data
6 I_D= 1; // in mA
7 I_D= I_D*10^-3; // in A
8 gm= 1; //in mA/V
9 gm= gm*10^-3; //in A/V
10 f_L= 10; // in Hz
11 R_S= 6; // in k
12 R_S= R_S*10^3; // in
13 R_D= 10; // in k
14 R_D= R_D*10^3; // in
15 vo_by_vi= -gm*R_D/(1+gm*R_S); // in V/V
16 disp(vo_by_vi,"Mid band gain in V/V is : ");
17 // Formula f_L= 1/(2*%pi*(1/gm || R_S)) * CS
18 CS= 1/(2*%pi*(1/gm*R_S/(1/gm+R_S))*f_L) ; //in F
19 disp(CS*10^6,"The value of Cs in F is : ")
```

---

### Scilab code Exa 2.24 Midband gain and upper 3 dB frequency

```
1 // Exa 2.24
2 clc;
3 clear;
4 close;
5 // Given data
6 Rsig= 100; // in k
7 Rsig= Rsig*10^3; // in
```

```

8 R_G= 4.7; // in M
9 R_G= R_G*10^6; // in
10 R_D= 15; // in k
11 R_D= R_D*10^3; // in
12 R_L= R_D; // in
13 gm= 1; //in mA/V
14 gm= gm*10^-3; //in A/V
15 ro=150; // in k
16 ro=ro*10^3; // in
17 Cgs= 1; // in pF
18 Cgs=Cgs*10^-12; //in F
19 Cgd= 0.4; // in pF
20 Cgd=Cgd*10^-12; //in F
21 vgsBYvsig= R_G/(Rsig+R_G);
22 Rdesh_L= R_D*R_L/(R_D+R_L); // in
23 voBYvgs= -gm*Rdesh_L;
24 Av= voBYvgs/vgsBYvsig; // in V/V
25 disp(Av,"The Mid-band gain in V/V is :")
26 CM= Cgd*(1+gm*Rdesh_L); // in F
27 // f_H= 1/(2*%pi*(Rsig || R_G)*(Cgs*CM))
28 f_H= 1/(2*%pi*(Rsig * R_G/(Rsig + R_G))*(Cgs+CM)); //
    in Hz
29 disp(f_H*10^-3,"Frequency in kHz is : ")

```

---

# Chapter 3

## Bipolar Junction Transistors

Scilab code Exa 3.1 Value of IE IB IC and VC

```
1 // Exa 3.1
2 clc;
3 clear;
4 close;
5 // Given data
6 V_E= -0.7; // in V
7 Bita=50;
8 RC= 5; // in k
9 RE= 10; // in k
10 RE= RE*10^3; // in
11 RC= RC*10^3; // in
12 V_CC= 10; // in V
13 V_BE= -10; // in volt
14 I_E= (V_E-V_BE)/RE; // in A
15 disp(I_E*10^3,"Emitter current in mA is : ")
16 // I_E= I_B+I_C and I_C= Bita*I_B, so
17 I_B= I_E/(1+Bita); // in A
18 disp(I_B*10^6,"Base current in A is : ")
19 I_C= I_E-I_B; // in A
20 disp(I_C*10^3,"Collector current in mA is : ")
21 V_C= V_CC-I_C*RC; // in V
```



```
22 disp(V_C,"The value of V_C in volts is :")
```

---

### Scilab code Exa 3.2 Value of alpha and bita

```
1 // Exa 3.2
2 clc;
3 clear;
4 close;
5 // Given data
6 V_E= 1.7; // in V
7 V_B= 1; // in V
8 RC= 5; // in k
9 RE= 5; // in k
10 RE= RE*10^3; // in
11 RC= RC*10^3; // in
12 RB= 100; //in k \
13 RB= RB*10^3; // in
14 V_CC= 10; // in V
15 V_BE= -10; // in volt
16 I_E= (V_CC-V_E)/RE; // in A
17 I_B= V_B/RB; // in V
18 // Formula I_B= (1-alpha)*I_E
19 alpha= 1-I_B/I_E;
20 disp(alpha,"Value of alpha is : ")
21 bita= alpha/(1-alpha);
22 disp(bita,"Value of bita is : ")
23 V_C= (I_E-I_B)*RC-V_CC; // in volt
24 disp(V_C,"Collector voltage in volts is : ")
```

---

### Scilab code Exa 3.3 Bias voltage

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

```

3 clear;
4 close;
5 // Given data
6 V_CC= 10; // in V
7 V_CE= 3.2; // in V
8 RC= 6.8; // in k
9 RC= RC*10^3; // in
10 I_S= 1*10^-15; // in A
11 V_T= 25*10^-3; // in V
12 I_C1= (V_CC-V_CE)/RC; // in A
13 // Formula I_C= I_S*%e^(V_BE1/V_T)
14 V_BE1= V_T*log(I_C1/I_S); // in volt
15 disp(I_C1*10^3, "Collector current in mA is : ")
16 disp(V_BE1, "Value of V_BE in volts is : ")
17
18 // Part (b)
19 v_in= 5*10^-3; // in V
20 Av= -(V_CC-V_CE)/V_T; // in V/V
21 disp(Av, "Voltage gain in V/V is : ")
22 v_o= abs(Av)*v_in; // in V
23 disp(v_o, "Change in output voltage in volts is : ")
24
25 // Part (c) for V_CE= 0.3 V
26 V_CE= 0.3; // in V
27 I_C2= (V_CC-V_CE)/RC; // in A
28 // I_C1= I_S*%e^(V_BE1/V_T) (i)
29 // I_C2= I_S*%e^(V_BE2/V_T) (ii)
30 // divide the equation (ii) by (i)
31 delta_V_BE= V_T*log(I_C2/I_C1); // in volt ( where
    delta_V_BE = V_BE2-V_BE1 )
32 disp(delta_V_BE*10^3, "The positive increment in
    V_BE in mV is : ")
33
34 // Part (d)
35 v_o= 0.99*V_CC; // in V
36 I_C3= (V_CC-v_o)/RC; // in A
37 delta_V_BE= V_T*log(I_C3/I_C1); // in V
38 disp(delta_V_BE*10^3, "The negative increment in

```

V\_BE in mV is : ")

---

#### Scilab code Exa 3.4 Design a fixed bias circuit

```
1 // Exa 3.4
2 clc;
3 clear;
4 close;
5 // Given data
6 V_CC= 10; // in V
7 V_CE= 5; // in V
8 V_BE= 0.7; // in V
9 I_C= 5*10^-3; // in mA
10 bita= 100;
11 R_C= (V_CC-V_CE)/I_C; // in
12 I_B= I_C/bita; // in A
13 R_B= (V_CC-V_BE)/I_B; // in
14 disp(R_C*10^-3,"The value of R_C in k is : ")
15 disp(I_B*10^6,"The value of I_B in A is : ")
16 disp(R_B*10^-3,"The value of R_B in k is : ")
17
18 // Note: The value of base current in the book is
    wrong
```

---

#### Scilab code Exa 3.5 Operating point

```
1 // Exa 3.5
2 clc;
3 clear;
4 close;
5 // Given data
6 V_CC= 6; // in V
7 bita= 100;
```

```

8 R_C= 2; // in k
9 R_C= R_C*10^3; // in
10 R_B= 530; // in k
11 R_B= R_B*10^3; // in
12 // when I_C=0
13 I_C=0;
14 V_CE= V_CC-I_C*R_C; // in volt
15 V_CE= 0:0.1:6; // in Volt
16 I_C= (V_CC-V_CE)/R_C*1000; // in mA
17 plot(V_CE,I_C);
18 title("DC load line")
19 xlabel("V_CE in volts")
20 ylabel("I_C in mA")
21 disp("DC load line shown in figure")
22 // When V_CE= 0
23 I_C= V_CC/R_C; //in A
24 // Operating point for silicon transistor
25 V_BE= 0.7; // in V
26 I_B= (V_CC-V_BE)/R_B; //in A
27 I_CQ= beta*I_B; // in A
28 V_CEQ= V_CC-I_CQ*R_C; // in volt
29 disp("Operating point is "+string(V_CEQ)+" V and "+
      string(I_CQ*10^3)+" mA")

```

---

### Scilab code Exa 3.6 Q point values

```

1 // Exa 3.6
2 clc;
3 clear;
4 close;
5 // Given data
6 V_CC= 12; // in V
7 V_BE= 0.7; // in V
8 beta= 100;
9 R_C= 10; // in k

```

```

10 R_C= R_C*10^3; // in
11 R_B= 100; // in k
12 R_B= R_B*10^3; // in
13 I_BQ= (V_CC-V_BE)/((1+beta)*R_C+R_B); // in A
14 I_CQ= beta*I_BQ; // in A
15 V_CEQ= V_CC-(I_CQ+I_BQ)*R_C; // in volt
16 // For dc load line
17 // When
18 I_C=0;
19 V_CE= V_CC-(I_C+I_BQ)*R_C; // in volt
20 // When
21 V_CE= 0;
22 I_C= (V_CC-I_BQ*R_C)/R_C; //in A
23 disp("Q- point values for circuit is "+string(V_CEQ)
      +" V and "+string(I_CQ*10^3)+" mA")

```

---

### Scilab code Exa 3.7 Collector to base bias circuit

```

1 // Exa 3.7
2 clc;
3 clear;
4 close;
5 // Given data
6 V_CC= 15; // in V
7 V_BE= 0.7; // in V
8 V_CE= 5; // in V
9 I_C= 5; // in mA
10 I_C=I_C*10^-3; // in A
11 beta= 100;
12 I_B= I_C/beta; // in A
13 disp(I_B*10^6,"Base current in A is : ")
14 //Apply KVL to collector circuit , V_CC= (I_C+I_B)*
    R_C+V_CE
15 R_C= (V_CC-V_CE)/(I_C+I_B); // in
16 disp(R_C*10^-3,"The value of R_C in k is : ")

```

```

17 //Apply KVL to base or input circuit , VCC= (IC+
    IB)*RC+VCE + IB*RB
18 RB= (VCC-VBE-(IC+IB)*RC)/IB; // in ohm
19 disp(RB*10-3,"The value of RB in k is : ")

```

---

### Scilab code Exa 3.8 Value of RB

```

1 // Exa 3.8
2 clc;
3 clear;
4 close;
5 // Given data
6 VBE= 0.7; // in V
7 VCE= 3; // in V
8 IC= 1; // in mA
9 IC=IC*10-3; // in A
10 bita= 100;
11 IB= IC/bita; // in A
12 // VCE= VBE+VCB and VCB= IB*RB
13 RB= (VCE-VBE)/IB; // in
14 disp(RB*10-3,"The value of RB in k is : ")

```

---

### Scilab code Exa 3.9 Operating point

```

1 // Exa 3.9
2 clc;
3 clear;
4 close;
5 // Given data
6 R1= 10; // in k
7 R1=R1*103; // in
8 R2= 5; // in k
9 R2=R2*103; // in

```

```

10 RC= 1; // in k
11 RC=RC*10^3; // in
12 RE= 2; // in k
13 RE=RE*10^3; // in
14 V_CC= 15; // in V
15 V_BE= 0.7; // in V
16 // When
17 I_C=0;
18 V_CE= V_CC-I_C*(RC+RE); // in V
19 // When V_CE= 0
20 I_C= V_CC/(RC+RE); // in A
21 V_B= V_CC*R2/(R1+R2); // in V
22 I_E= (V_B-V_BE)/RE; // in A
23 I_C= I_E; // in A (approx)
24 I_CQ= I_C; // in A
25 V_CE= V_CC-I_C*(RC+RE); // in V
26 V_CEQ= V_CE; // in V
27 V_CE= 0:0.1:15; // in Volt
28 I_C= (V_CC-V_CE)/(RC+RE)*1000; // in mA
29 plot(V_CE, I_C);
30 title("DC load line")
31 xlabel("V_CE in volts")
32 ylabel("I_C in mA")
33 disp("DC load line shown in figure")
34 disp("Operating point is "+string(V_CEQ)+" V and "+
      string(I_CQ*10^3)+" mA")

```

---

### Scilab code Exa 3.10 Voltage gain

```

1 // Exa 3.10
2 clc;
3 clear;
4 close;
5 // Given data
6 V_CC= 10; // in V

```

```

7 V_BB= 3; // in V
8 V_BE= 0.7; // in V
9 V_T= 25*10^-3; // in V
10 bita=100;
11 RC= 3; // in k
12 RC=RC*10^3; // in
13 RB= 100; // in k
14 RB=RB*10^3; // in
15 I_B= (V_BB-V_BE)/RB; // in V
16 I_C= bita*I_B; // in A
17 V_C= V_CC-I_C*RC; // in V
18 gm= I_C/V_T; // in A/V
19 r_pi= bita/gm; // in
20 // v_be= r_pi/(RB+r_pi)*v_i
21 v_be_by_v_i= r_pi/(RB+r_pi);
22 // v_o= -gm*v_be*RC
23 v_o_by_v_i= -gm*v_be_by_v_i*RC; // in V/V
24 Av= v_o_by_v_i; // in V/V
25 disp(round(Av), "Voltage gain in V/V is : ")

```

---

### Scilab code Exa 3.11 All node voltages and currents

```

1 // Exa 3.11
2 clc;
3 clear;
4 close;
5 // Given data
6 V_B= 4; // in V
7 V_BE= 0.7; // in V
8 V_CC= 10; // in V
9 V_E= V_B-V_BE; // in V
10 R_E= 3.3; // in k
11 R_E=R_E*10^3; // in
12 RC= 4.7; // in k
13 RC=RC*10^3; // in

```



```

14 I_E= V_E/R_E;// in A
15 bita=100;
16 alpha= bita/(1+bita);
17 I_C= alpha*I_E;//in A
18 disp(I_C*10^3,"The value of I_C in mA is : ")
19 V_C= V_CC-I_C*RC;// in V
20 disp(V_C,"The value of V_C in volts is : ")
21 I_B= I_E/(1+bita);// in A
22 disp(I_B*10^3,"The value of I_B in mA is : ")

```

---

**Scilab code Exa 3.12** All node voltage and all branch current

```

1 // Exa 3.12
2 clc;
3 clear;
4 close;
5 // Given data
6 V_B= 5;// in V
7 V_BE= 0.7;// in V
8 V_CC= 10;// in V
9 bita=100;
10 R_B= 100;// in k
11 R_C= 2;// in k
12 R_B=R_B*10^3;// in
13 R_C=R_C*10^3;// in
14 I_B= (V_B-V_BE)/R_B;// in A
15 I_C= bita*I_B;//in A
16 V_C= V_CC-I_C*R_C;// in V
17 I_E= I_C;// in A (approx)
18 disp(I_B*10^3,"The value of I_B in mA is : ")
19 disp(I_C*10^3,"The value of I_C in mA is : ")
20 disp(V_C,"The value of V_C in volts is : ")
21 disp(I_E*10^3,"The value of I_E in mA is : ")

```

---

**Scilab code Exa 3.13** All node voltage and all branch current

```
1 // Exa 3.13
2 clc;
3 clear;
4 close;
5 // Given data
6 V_B= 0;// in V
7 V_EB= 0.7;// in V
8 bita=100;
9 V_EC= 0.2;// in V
10 V_E= V_EB+V_B;// in V
11 V_CC= 5;// in V
12 R_C= 1;// in k
13 R_C=R_C*10^3;// in
14 R_B= 10;// in k
15 R_B= R_B*10^3;// in
16 // V_E= V_B+V_EB (i)
17 // V_C= V_E-V_EC= V_B+V_EB-V_EC (ii)
18 // I_E= (V_CC-V_E)/R_C= (V_CC-V_B-V_EB)/R_C (iii)
19 // I_B= V_B/R_B (iv)
20 // I_C= (V_C+V_CC)/R_C= (V_B+V_EB-V_EC+V_CC)/R_B
21 // By using relationship , I_E= I_B+I_C
22 V_B= (9*V_CC-11*V_EB+V_EC)/12;// in V
23 V_E= V_B+V_EB;// in V
24 V_C= V_B+V_EB-V_EC;// in V
25 I_E= (V_CC-V_B-V_EB)/R_C// in amp
26 I_C= (V_B+V_EB-V_EC+V_CC)/R_B;// in amp
27 I_B= V_B/R_B;// in amp
28 disp(V_B,"The value of V_B in volts is : ")
29 disp(V_E,"The value of V_E in volts is : ")
30 disp(V_C,"The value of V_C in volts is : ")
```

```

31 disp(I_E*10^3,"The value of I_E in mA is : ")
32 disp(I_C*10^3,"The value of I_C in mA is : ")
33 disp(I_B*10^3,"The value of I_B in mA is : ")

```

---

**Scilab code Exa 3.14** Region in which Q point lie

```

1 // Exa 3.14
2 clc;
3 clear;
4 close;
5 // Given data
6 bita=100;
7 hFE= 100;
8 VCEsat= 0.2;// in V
9 VBEsat= 0.8;// in V
10 VBEactive= 0.7;// in V
11 VBB= 5;// in V
12 VCC= 10;// in V
13 R_C= 3;// in k
14 R_C=R_C*10^3;// in
15 R_B= 50;// in k
16 R_B=R_B*10^3;// in
17 // Formula VCC= ICsat*R_C+VCEsat
18 ICsat= (VCC-VCEsat)/R_C;//A
19 disp(ICsat*10^3,"The value of IC(sat) in mA is : ")
20 IBmin= ICsat/bita;// in A
21 // Apply KVL to input circuit , VBB= IB*R_B+VBEsat
22 IB= (VBB-VBEsat)/R_B;// in A
23 disp(IB*10^6,"Actual base current in A is : ")

```

---

**Scilab code Exa 3.16** Value of Bita

```

1 // Exa 3.16

```

```

2  clc;
3  clear;
4  close;
5  // Given data
6  // bita= alpha/(1-alpha)
7  // At alpha= 0.5
8  alpha= 0.5;
9  bita= alpha/(1-alpha);
10 disp(bita,"At alpha=0.5, the value of bita is : ")
11 // At alpha= 0.9
12 alpha= 0.9;
13 bita = alpha/(1-alpha);
14 disp(bita,"At alpha=0.9, the value of bita is : ")
15 // At alpha= 0.5
16 alpha= 0.999;
17 bita= alpha/(1-alpha);
18 disp(bita,"At alpha=0.999, the value of bita is : ")

```

---

### Scilab code Exa 3.17 Value of alpha

```

1  // Exa 3.17
2  clc;
3  clear;
4  close;
5  // Given data
6  // alpha= bita/(1+bita)
7  // At bita= 1
8  bita=1;
9  alpha= bita/(1+bita);
10 disp(alpha,"At bita=1, the value of alpha is : ")
11 // At bita= 2
12 bita=2;
13 alpha= bita/(1+bita);
14 disp(alpha,"At bita=2, the value of alpha is : ")
15 // At bita= 100

```

```

16 bita=100;
17 alpha= bita/(1+bita);
18 disp(alpha,"At bita=100, the value of alpha is : ")
19 // At bita= 200
20 bita=200;
21 alpha= bita/(1+bita);
22 disp(alpha,"At bita=200, the value of alpha is : ")

```

---

### Scilab code Exa 3.18 Value of Is Ic and VBE

```

1 // Exa 3.18
2 clc;
3 clear;
4 close;
5 // Given data
6 VBE= 0.76; // in V
7 VT= 0.025; // in V
8 I_C= 10*10^-3; // in A
9 // Formula I_C= I_S*%e^(VBE/VT)
10 I_S= I_C/(%e^(VBE/VT)); // in A
11 disp(I_S,"The value of I_S in amp is : ")
12 // Part(a) for VBE = 0.7 V
13 VBE= 0.7; // in V
14 I_C= I_S*%e^(VBE/VT)
15 disp(I_C*10^3,"For VBE = 0.7 V , The value of I_C in
    mA is : ")
16
17 // Part (b) for I_C= 10 A
18 I_C= 10*10^-6; // in A
19 // Formula I_C= I_S*%e^(VBE/VT)
20 VBE= VT*log(I_C/I_S);
21 disp(VBE,"For I_C = 10 A , The value of VBE in V is
    : ")

```

---

### Scilab code Exa 3.19 Transistor model

```
1 // Exa 3.19
2 clc;
3 clear;
4 close;
5 // Given data
6 VBE= 0.7; // in V
7 VT= 0.025; // in V
8 I_B= 100; // in A
9 I_B=I_B*10^-6; // in A
10 I_C= 10*10^-3; // in A
11 // Formula I_C= I_S*%e^(VBE/VT)
12 I_S= I_C/(%e^(VBE/VT)); // in A
13 alpha= I_C/(I_C+I_B);
14 bita= I_C/I_B;
15 IS_by_alpha= I_S/alpha; // in A
16 IS_by_bita= I_S/bita; // in A
17 disp(alpha,"The value of alpha is : ");
18 disp(bita,"The value of bita is : ");
19 disp(IS_by_alpha,"The value of Is/alpha in A is :");
20 disp(IS_by_bita,"The value of Is/bita in A is : ");
```

---

### Scilab code Exa 3.20 Labelled current and voltage

```
1 // Exa 3.20
2 clc;
3 clear;
4 close;
5 // Given data
6 VBE= 0.7; // in V
7 VCC= 10.7; // in V
```

```

8 R_C= 10; //in k
9 R_C=R_C*10^3; // in
10 R_B= 10; //in k
11 R_B=R_B*10^3; // in
12 I1= (VCC-VBE)/R_C; // in A
13 disp(I1*10^3,"The value of I1 in mA is : ")
14 // Part (b)
15 VC= -4; //in V
16 VB= -10; // in V
17 R_C= 5.6; //in k
18 R_C=R_C*10^3; // in
19 R_B= 2.4; //in k
20 R_B=R_B*10^3; // in
21 VCC=12; // V
22 I_C= (VC-VB)/R_B; // in A
23 V2= VCC- (R_C*I_C);
24 disp(V2,"The value of V2 in volt is : ");
25 // Part (c)
26 VCC= 0;
27 VCE= -10; // in V
28 R_C= 10; //in k
29 R_C=R_C*10^3; // in
30 I_C= (VCC-VCE)/R_C; // in A
31 V4= 1; // in V
32 I3= I_C; // in A (approx)
33 disp(V4,"The value of V4 in volt is : ");
34 disp(I3*10^3,"The value of I3 in mA is : ")
35 // Part (d)
36 VBE= -10; // in V
37 VCC= 10; // in V
38 R_B= 5; //in k
39 R_B=R_B*10^3; // in
40 R_C= 15; //in k
41 R_C=R_C*10^3; // in
42 // I5= I_C and
43 // I5= (V6-0.7-VBE)/R_B and I_C= (VCC-V6)/R_C
44 V6= (VCC*R_B+R_C*(0.7+VBE))/(R_C+R_B);
45 disp(V6,"The value of V6 in volt is : ")

```

```

46 I5= (V6-0.7-VBE)/R_B; // in A
47 disp(I5*10^3,"The value of I5 in mA is : ")

```

---

**Scilab code Exa 3.21** Value of Beta and labelled voltage

```

1 // Exa 3.21
2 clc;
3 clear;
4 close;
5 // Given data
6 // Part (a)
7 V_C= 2; // in V
8 R_C= 1; // in k
9 R_C=R_C*10^3; // in
10 V_B= 4.3; // in V
11 R_B= 200; // in k
12 R_B=R_B*10^3; // in
13 I_C= V_C/R_C; // in A
14 I_B= V_B/R_B; // in A
15 bita= I_C/I_B;
16 disp("Part (a)")
17 disp(I_C*10^3,"Collector current in mA is : ")
18 disp(I_B*10^6,"Base current in A is : ")
19 disp(bita,"The value of bita is : ")
20
21 // Part (b)
22 V_C= 2.3; // in V
23 R_C= 230; // in k
24 R_C=R_C*10^3; // in
25 V_B= 4.3; // in V
26 R_B= 20; // in k
27 R_B=R_B*10^3; // in
28 I= V_C/R_C; // current through 230 resistor i.e.
    I_C + I_B in A
29 I_B= (V_B-V_C)/R_B; // in A

```



```

30 I_C= I-I_B;// in A
31 bita= abs(I_C/I_B);
32 disp("Part (b)")
33 disp(I_C*10^3,"Collector current in mA is : ")
34 disp(I_B*10^3,"Base current in mA is : ")
35 disp(bita,"The value of bita is : ")
36
37 // Part (c)
38 V_E= 10;// in V
39 R_E= 1;// in k
40 R_E=R_E*10^3;// in
41 V_1= 7;// in V
42 R_C= 1;// in k
43 R_C=R_C*10^3;// in
44 V_B= 6.3;// in V
45 R_B= 100;// in k
46 R_B=R_B*10^3;// in
47 I_E= (V_E-V_1)/R_C;//in A
48 I_C=I_E;// in A (approx)
49 V_C= I_C*R_C;// in V
50 I_B= (V_B-V_C)/R_B;// in A
51 bita= I_E/I_B-1;
52 disp("Part (c)")
53 disp(I_E*10^3,"Emitter current in mA is : ")
54 disp(I_B*10^6,"Base current in A is : ")
55 disp(V_C,"Collector voltage in volts is : ")
56 disp(bita,"The value of bita is : ")
57
58 // Note : In the book the value of base current in
           the first part is wrong due to calculation error.
59 //           In the part (b) the values of collector
           current and bita are wrong due to calculation
           error in the first line of part (b)

```

---

**Scilab code Exa 3.22** The emitter base and collector voltage and current

```

1 // Exa 3.22
2 clc;
3 clear;
4 close;
5 // Given data
6 // Part (a)
7 bita= 30;
8 R_C= 2.2; // in k
9 R_C=R_C*10^3; // in
10 R_B= 2.2; // in k
11 R_B=R_B*10^3; // in
12 VCC= 3; // in V
13 VCE= -3; // in V
14 VBE= 0.7; // in V
15 V_B= 0; // in V
16 V_E= V_B-VBE; // in V
17 I_E= (V_E-VCE)/R_B; // in A
18 I_C= I_E; // in A
19 V_C= VCC-I_E*R_C; // in V
20 I_B= I_C/bita; // in A
21 disp("Part (a)")
22 disp(V_B,"The value of V_B in V is : ")
23 disp(V_E,"The value of V_E in V is : ")
24 disp(I_E*10^3,"The value of I_E in mA is : ")
25 disp(V_C,"The value of V_C in V is : ")
26 disp(I_B*10^3,"The value of I_B in mA is : ")
27 // Part (b)
28 R_C= 560; // in
29 R_B= 1.1; // in k
30 R_B=R_B*10^3; // in
31 VCC= 9; // in V
32 VCE= 3; // in V
33 V_B= 3; // in V
34 V_E= V_B+VBE; // in V
35 I_E= (VCC-V_E)/R_B; // in A
36 alpha= bita/(1+bita);
37 I_C= I_E*alpha; // in A
38 V_C= I_C*R_C; // in V

```

```

39 I_B= I_C/bita;// in A
40 disp("Part (b)")
41 disp(V_B,"The value of V_B in V is : ")
42 disp(V_E,"The value of V_E in V is : ")
43 disp(I_C*10^3,"The value of I_E in mA is : ")
44 disp(V_C,"The value of V_C in V is : ")
45 disp(I_B*10^3,"The value of I_B in mA is : ")

```

---

### Scilab code Exa 3.23 Value of VE VC and alpha bita

```

1 // Exa 3.23
2 clc;
3 clear;
4 close;
5 // Given data
6 VBE= 0.7;// in V
7 VCC= 9;// in V
8 VCE= -9;// in V
9 V_B= -1.5;// in V
10 R_C= 10;// in k
11 R_C=R_C*10^3;// in
12 R_B= 10;// in k
13 R_B=R_B*10^3;// in
14 I_B= abs(V_B)/R_B;// in A
15 V_E= V_B-VBE;// in V
16 disp(V_E,"The value of V_E in volt is : ")
17 I_E= (V_E-VCE)/R_B;// in A
18 bita= I_E/I_B-1;
19 alpha= bita/(1+bita);
20 disp(alpha,"The value of alpha in volt is : ")
21 disp(bita,"The value of bita in volt is : ")
22 V_C= VCC-I_E*alpha*R_C;// in V
23 disp(V_C,"The value of V_C in volt is : ")
24 // When bita = infinite then
25 alpha= 1 ;// As infinite/(1+infinite) = 1

```

```

26 I_B= 0;
27 V_B=0;
28 V_C= VCC-I_E*R_C;// in volt
29 disp("When Beta = infinite then :-")
30 disp(V_B,"The value of V_B in volt is : ")
31 disp(V_E,"The value of V_E in volt is : ")
32 disp(V_C,"The value of V_C in volt is : ")

```

---

#### Scilab code Exa 3.24 Current flow

```

1 // Exa 3.24
2 clc;
3 clear;
4 close;
5 // Given data
6 VBE_1= 0.7;// in V
7 VBE_2= 0.5;// in V
8 V_T= 0.025;// in V
9 I_C1= 10;// in mA
10 I_C1= I_C1*10^-3;// in A
11 // I_C1= I_S*%e^(VBE_1/V_T) (i)
12 // I_C2= I_S*%e^(VBE_2/V_T) (ii)
13 // Devide equation (ii) by (i)
14 I_C2= I_C1*%e^((VBE_2-VBE_1)/V_T);// in A
15 disp(I_C2*10^6,"The value of I_C2 in A is : ")

```

---

#### Scilab code Exa 3.25 Voltage gain

```

1 // Exa 3.25
2 clc;
3 clear;
4 close;
5 // Given data

```

```

6 R1= 10; // in k
7 R1=R1*10^3; // in
8 R2= 10; // in k
9 R2=R2*10^3; // in
10 I_C=.5; // mA
11 V_T= 0.025; //in V
12 I_C= I_C*10^-3; // in A
13 V= 10; // in V
14 Vth= V*R1/(R1+R2); // in V
15 Rth= R1*R2/(R1+R2); //in
16 vo= I_C*Rth; // in V
17 vi=V_T; // in V
18 vo_by_vi= vo/vi; //in V/V
19 disp(vo_by_vi,"The value of vo/vi in V/V is : ")

```

---

### Scilab code Exa 3.27 Value of VB VC and VE

```

1 // Exa 3.27
2 clc;
3 clear;
4 close;
5 // Given data
6 V_B= 2; // in V
7 V_CC=5; // in V
8 V_BE= 0.7; // in V
9 R_E= 1*10^3; // in
10 R_C= 1*10^3; // in
11 V_E= V_B-V_BE; // in V
12 I_E= V_E/R_E; // in A
13 I_C= I_E; // in A
14 V_C= V_CC-I_C*R_C; //in V
15 disp("At V_B= +2 V")
16 disp(V_E,"The value of V_E in volts is : ")
17 disp(V_C,"The value of V_C in volts is : ")
18

```

```

19 // Part (b)
20 V_B= 0; //in V
21 V_E= 0; // in V
22 I_E= 0; // in A
23 V_C= 5; // in V
24 disp("At V_B= 0 V")
25 disp(V_E,"The value of V_E in volts is : ")
26 disp(V_C,"The value of V_C in volts is : ")

```

---

### Scilab code Exa 3.28 Value of VE and VC

```

1 // Exa 3.28
2 clc;
3 clear;
4 close;
5 // Given data
6 V_B= 0; // in V
7 R_E=1*10^3; //in
8 R_C=1*10^3; //in
9 V_CC=5; // in V
10 V_BE= 0.7; // in V
11 V_E= V_B-V_BE; // in V
12 I_E= (1+V_E)/R_E; // in A
13 I_C= I_E; // (approx) in A
14 V_C= V_CC-I_C*R_C; //in V
15 disp("Part (i)")
16 disp(V_E,"The value of V_E in volt is : ");
17 disp(V_C,"The value of V_C in volt is : ");
18 // For saturation
19 V_CE=0.2 ; // V
20 V_CB= -0.5; // in V
21 // I_C= 5-V_C/R_C and V_C= V_E-VCE, So
22 // I_C= (5.2-V_E)/R_C
23 // I_E= (V_E+1)/R_E and at the edge of saturation
    I_C=I_E,

```

```

24 V_E= 4.2/2; /// in V
25 V_B= V_E+0.7; // in V
26 V_C= V_E+0.2; // in V
27 disp("Part (ii) ")
28 disp(V_E,"The value of V_E in volts is : ");
29 disp(V_B,"The value of V_B in volts is : ");
30 disp(V_C,"The value of V_C in volts is : ");
31
32 // Note: In the book , there is a miss print in the
    last line of this question because V_E+0.2=
    2.1+0.2 = 2.3 (not 2.8) , so answer in the book
    is wrong

```

---

**Scilab code Exa 3.29** Value of VB IB IE IC VC alpha and bita

```

1 // Exa 3.29
2 clc;
3 clear;
4 close;
5 // Given data
6 V_CC=5; // in V
7 V_E= 1; // in V
8 V_BE= 0.7; // in V
9 R_E=5*10^3; //in
10 R_C=5*10^3; //in
11 R_B= 20*10^3; // in
12 I_E= (V_CC-V_E)/R_E; // in A
13 // For pnp transistor V_BE= V_E-V_B
14 V_B= V_E-V_BE; // in V
15 I_B= V_B/R_B; // in A
16 I_C= I_E-I_B; // in A
17 V_C= I_C*R_C-V_CC; // in V
18 bita= I_C/I_B;
19 alpha= I_C/I_E;
20 disp(V_B,"The value of V_B in volts is : ");

```

```

21 disp(I_B*10^3,"The value of I_B in mA is : ");
22 disp(I_E*10^3,"The value of I_E in mA is : ");
23 disp(I_C*10^3,"The value of I_C in mA is : ");
24 disp(V_C,"The value of V_C in volts is : ");
25 disp(bita,"The value of bita is : ");
26 disp(alpha,"The value of alpha is : ");

```

---

### Scilab code Exa 3.30 DC voltage and value of gm

```

1 // Exa 3.30
2 clc;
3 clear;
4 close;
5 // Given data
6 V_CC=5; // in V
7 V_T= 0.025; // in V
8 R_C=7.5*10^3; //in
9 I_C= 0.5; // in mA
10 I_C= I_C*10^-3; // in A
11 I_E=I_C; // (approx) in A
12 V_C= V_CC-I_C*R_C; // in V
13 disp(V_C,"dc voltage at the collector in volt is : "
    )
14 gm= I_C/V_T; // in A/V
15 disp(gm*10^3,"The value of gm in mA/V is : ")
16 // v_be= -v_i
17 // v_c= -gm*v_be*R_C
18 vcbyvi= gm*R_C; // in V/V
19 disp(vcbyvi,"The value of vc/vi in V/V is : ")

```

---

### Scilab code Exa 3.31 Input resistance and overall voltage gain

```

1 // Exa 3.31

```



```

2  clc;
3  clear;
4  close;
5  // Given data
6  V_T= 0.025; // in V
7  I_E= 0.5; // in mA
8  I_E= I_E*10^-3; // in mA
9  R_sig= 50; // in
10 R_C= 5*10^3; // in
11 re= V_T/I_E; // in ohm
12 Rin= R_sig+re; // in ohm
13 disp(Rin,"Input resistance in      is : ")
14 // Part(b)
15 // vo= -0.99*ie*R_C and ie= -v_sig/Rin
16 vo_by_v_sig= 0.99*R_C/Rin; // in V/V
17 disp(vo_by_v_sig,"The value of vo/vsig in V/V is : "
      )

```

---

### Scilab code Exa 3.32 Input resistance and overall voltage gain

```

1  // Exa 3.32
2  clc;
3  clear;
4  close;
5  // Given data
6  bita= 200;
7  alpha= bita/(1+bita);
8  R_C= 100; // in
9  R_B= 10; // in k
10 R_sig= 1; // in k
11 R_sig= R_sig*10^3; // in
12 R_B= R_B*10^3; // in
13 V_T= 25*10^-3;
14 V=1.5; // in V
15 I_E= 10; // in mA

```

```

16 I_E= I_E*10^-3; // in A
17 I_C= alpha*I_E; // in A
18 V_C= I_C*R_C; // in V
19 I_B= I_C/bita; // in A
20 V_B= V-(R_B*I_B)
21 gm= I_C/V_T; // in A/V
22 rpi= bita/gm; // in
23 Rib= rpi; // in
24 disp(Rib,"The value of Rib in      is : ")
25 Rin= R_B*rpi/(R_B+rpi); // in
26 disp(Rin,"The value of Rin in      is : ")
27 // vbe= v_sig*Rin/(Rsig+Rin);
28 vbe_by_vsig= Rin/(Rsig+Rin);
29 // vo= -gm*vbe*R_C and = -gm*v_sig*Rin/(Rsig+Rin)
30 vo_by_vsig= -gm*R_C*vbe_by_vsig; // in V/V
31 disp(vo_by_vsig,"Overall voltage gain in V/V is : ")
32 // if
33 vo= 0.4; //( ) in V
34 vs= vo/abs(vo_by_vsig); // in V
35 vbe= vbe_by_vsig*vs; // in V
36 disp(vs*10^3,"The value of v_sig in mV is : ")
37 disp(vbe*10^3,"The value of v_be in mV is : ")
38
39 // Note: There is some difference between in this
      coding and book solution. But Coding is correct.

```

---

### Scilab code Exa 3.33 Value of alpha bita and Is

```

1 // Exa 3.33
2 clc;
3 clear;
4 close;
5 // Given data
6 V_T= 0.025; // in V
7 // Part(a)

```

```

8 disp(" Part (a)")
9 V_BE= 690; // in mV
10 V_BE=V_BE*10^-3; // in V
11 I_C= 1; // in mA
12 I_B= 50; // in A
13 I_C=I_C*10^-3; // in A
14 I_B=I_B*10^-6; // in A
15 bita= I_C/I_B;
16 alpha= bita/(1+bita);
17 I_E= I_C/alpha; // in A
18 // I_C= I_S*%e^(V_BE/V_T)
19 I_S= I_C/(%e^(V_BE/V_T));
20 disp(bita,"The value of bita is : ")
21 disp(alpha,"The value of alpha is : ")
22 disp(I_E*10^3,"The value of I_E in mA is : ")
23 disp(I_S,"The value of I_S in amp is : ")
24
25 // Part(b)
26 disp(" Part (b)")
27 V_BE= 690; // in mV
28 V_BE=V_BE*10^-3; // in V
29 I_C= 1; // in mA
30 I_C=I_C*10^-3; // in A
31 I_E= 1.070; // in mA
32 I_E=I_E*10^-3; // in A
33 bita= I_C/I_B;
34 alpha= I_C/I_E;
35 bita= alpha/(1-alpha);
36 I_B= I_C/bita; // in A
37 // I_C= I_S*%e^(V_BE/V_T)
38 I_S= I_C/(%e^(V_BE/V_T));
39 disp(bita,"The value of bita is : ")
40 disp(alpha,"The value of alpha is : ")
41 disp(I_B*10^6,"The value of I_B in A is : ")
42 disp(I_S,"The value of I_S in amp is : ")
43
44 // Part(c)
45 disp(" Part (C)")

```

```

46 V_BE= 580; // in mV
47 V_BE=V_BE*10^-3; // in V
48 I_E= 0.137; // in mA
49 I_B= 7; // in A
50 I_E=I_E*10^-3; // in A
51 I_B=I_B*10^-6; // in A
52 // I_C= alpha*I_E = beta*I_B
53 beta= I_E/I_B-1;
54 alpha= beta/(1+beta);
55 I_C= beta*I_B; // in A
56 // I_C= I_S*%e^(V_BE/V_T)
57 I_S= I_C/(%e^(V_BE/V_T));
58 disp(beta,"The value of beta is : ")
59 disp(alpha,"The value of alpha is : ")
60 disp(I_C*10^3,"The value of I_C in mA is : ")
61 disp(I_S,"The value of I_S in amp is : ")
62
63 // Part(d)
64 disp("Part (d)")
65 V_BE= 780; // in mV
66 V_BE=V_BE*10^-3; // in V
67 I_C= 10.10; // in mA
68 I_B= 120; // in A
69 I_C=I_C*10^-3; // in A
70 I_B=I_B*10^-6; // in A
71 beta= I_C/I_B;
72 alpha= beta/(1+beta);
73 I_E= I_C/alpha; // in A
74 // I_C= I_S*%e^(V_BE/V_T)
75 I_S= I_C/(%e^(V_BE/V_T));
76 disp(beta,"The value of beta is : ")
77 disp(alpha,"The value of alpha is : ")
78 disp(I_E*10^3,"The value of I_E in mA is : ")
79 disp(I_S,"The value of I_S in amp is : ")
80
81 // Part(e)
82 disp("Part (e)")
83 V_BE= 820; // in mV

```

```
84 V_BE=V_BE*10^-3; // in V
85 I_E= 75; // in mA
86 I_B= 1050; // in A
87 I_E=I_E*10^-3; // in A
88 I_B=I_B*10^-6; // in A
89 // I_C= alpha*I_E = beta*I_B
90 beta= I_E/I_B-1;
91 alpha= beta/(1+beta);
92 I_C= beta*I_B; // in A
93 // I_C= I_S*%e^(V_BE/V_T)
94 I_S= I_C/(%e^(V_BE/V_T));
95 disp(beta,"The value of beta is : ")
96 disp(alpha,"The value of alpha is : ")
97 disp(I_C*10^3,"The value of I_C in mA is : ")
98 disp(I_S,"The value of I_S in amp is : ")
```

---

# Chapter 4

## Differential Amplifiers

Scilab code Exa 4.1 Value of  $i_{c1}$  and  $v_{ce1}$

```
1 // Exa 4.1
2 clc;
3 clear;
4 close;
5 // Given data
6 V_CC= 10; // in volt
7 V_EE= -10; // in volt
8 I= 1; // in mA
9 I=I*10^-3; // in A
10 R_C= 10; // in kohm
11 R_C=R_C*10^3; // in kohm
12 V_BE=0.7; // in volt
13
14 i_C1= I/2; // in A
15 i_C2= i_C1; // in A
16 disp(i_C1*10^3, "Value of i_C1 in mA is : ")
17
18 V_C1= V_CC-i_C1*R_C; // in V
19 // For V_cm=0 volt
20 V_E= -0.7; // in volt
21 V_CE1= V_C1-V_E; // in volt
```

```

22 disp(V_CE1,"For V_cm =0 , The alue of V_CE1 in volt
    is ")
23
24 // For V_cm= -5 volt
25 V_cm= -5;// in V
26 V_B= V_cm;// in V
27 // From V_BE= V_B-V_E
28 V_E= V_B-V_BE;// in volt
29 V_CE1= V_C1-V_E;// in volt
30 disp(V_CE1,"For V_cm =-5V , The alue of V_CE1 in
    volt is ")
31
32 // For V_cm= 5 volt
33 V_cm= 5;// in V
34 V_B= V_cm;// in V
35 V_E= V_B-V_BE;// in volt
36 V_CE1= V_C1-V_E;// in volt
37 disp(V_CE1,"For V_cm =5V , The alue of V_CE1 in volt
    is ")

```

---

#### Scilab code Exa 4.2 Value of VOV and VGS

```

1 // Exa 4.2
2 clc;
3 clear;
4 close;
5 // Given data
6 V_DD= 1.5;// in V
7 V_SS= V_DD;// in V
8 KnWL= 4;// in mA/V^2
9 KnWL=KnWL*10^-3;// in A/V^2
10 Vt= 0.5;// in V
11 I=0.4;// in mA
12 I=I*10^-3;//in A
13 R_D= 2.5;// in k

```

```

14 R_D= R_D*10^3; // in
15
16 // Part (a)
17 disp("Part (a)")
18 V_OV= sqrt(I/KnWL); // in V
19 V_GS= V_OV+Vt; // in V
20 disp(V_OV,"Value of V_OV in volt is : ")
21 disp(V_GS,"Value of V_GS in volt is : ")
22
23 // Part (b)
24 disp("Part (b)")
25 V_CM= 0; // in volt
26 V_S= -V_GS; // in volt
27 disp(V_S,"Value of V_S in volt is : ")
28 I=0.4; // in mA
29 i_D1= I/2; // in mA
30 disp(i_D1,"Value of i_D1 in mA is : ")
31 i_D1=i_D1*10^-3; // in A
32 V_D1= V_DD-i_D1*R_D; // in V
33 V_D2=V_D1; // in V
34 disp(V_D1,"Value of V_D1 in volt is ")
35 disp(V_D2,"Value of V_D2 in volt is ")
36
37
38 // Part (c)
39 disp("Part (c)")
40 V_CM=1; // in V
41 V_GS= 0.82; // in V
42 V_G= 1; // in V
43 V_S= V_G-V_GS; // in V
44 disp(V_S,"Value of V_S in volt is : ")
45 i_D1= I/2; // in mA
46 disp(i_D1,"Value of i_D1 in mA is : ")
47 i_D1=i_D1*10^-3; // in A
48 V_D1= V_DD-i_D1*R_D; // in V
49 V_D2=V_D1; // in V
50 disp(V_D1,"Value of V_D1 in volt is ")
51 disp(V_D2,"Value of V_D2 in volt is ")

```



```

52
53 // Part (d)
54 disp("Part (d)")
55 V_CM_max= Vt+V_DD-i_D1*R_D
56 disp(V_CM_max,"Highest value of V_CM in volt is :")
57
58 // Part (e)
59 V_S= 0.4;// in V
60 disp("Part (e)")
61 V_CM_min= -V_SS+V_S+Vt+V_OV;// in V
62 disp(V_CM_min,"Lowest value of V_CM in volt is")
63 V_Smin= V_CM_min-V_GS;// in volt
64 disp(V_Smin,"Lowest value of V_S in volt is")

```

---

#### Scilab code Exa 4.3 Required values of WbyL

```

1 // Exa 4.3
2 clc;
3 clear;
4 close;
5 format('v',5)
6 // Given data
7 I= 0.4;// in mA
8 unCox= 0.2;// in mA/V^2
9 i_D= I/2;// in mA
10 V_OV1= 0.2;// in V
11 V_OV2= 0.3;// in V
12 V_OV3= 0.4;// in V
13 WbyL1= 2*i_D/(unCox*V_OV1^2);
14 gm1= I/V_OV1;// in mA/V
15 WbyL2= 2*i_D/(unCox*V_OV2^2);
16 gm2= I/V_OV2;// in mA/V
17 WbyL3= 2*i_D/(unCox*V_OV3^2);
18 gm3= I/V_OV3;// in mA/V
19 disp("Vov (in V) " +string(V_OV1)+")

```

```

                "+string(V_OV2)+"                "+string(
V_OV3))
20 disp("W/L                "+string(WbyL1)+"
                "+string(WbyL2)+"                "+string(
WbyL3))
21 disp("gm(in mA/V)                "+string(gm1)+"                "
        "+string(gm2)+"                "+string(gm3))

```

---

#### Scilab code Exa 4.4 Value of VOV gm ro and Ad

```

1 // Exa 4.4
2 clc;
3 clear;
4 close;
5 // Given data
6 format('v',11)
7 V_A= 20; // in V
8 R_D= 5; // in k
9 R_D= R_D*10^3; // in
10 I= 0.8; // in mA
11 I=I*10^-3; // in A
12 i_D= I/2; // in A
13 unCox= 0.2; // mA/V^2
14 unCox= unCox*10^-3; // in A/V^2
15 WbyL= 100;
16 // Formula i_D= 1/2*unCox*WbyL*V_OV^2
17 V_OV= sqrt(2*i_D/(unCox*WbyL)); // in V
18 disp(V_OV,"The value of V_OV in volts is : ")
19 gm= I/V_OV; // in A/V;
20 disp(gm*10^3,"The value of gm in mA/V is : ")
21 r_o= V_A/i_D; // in
22 disp(r_o*10^-3,"The value of r_o in k is : ")
23 // Ad= v_o/v_id = gm*(R_D || r_o)
24 Ad= gm*(R_D*r_o/(R_D+r_o)) ; // in V/V
25 disp(Ad,"Differential gain in V/V is : ")

```

---

Scilab code Exa 4.5 Differential gain

```
1 // Exa 4.5
2 clc;
3 clear;
4 close;
5 // Given data
6 R_D= 5; // in k
7 R_D= R_D*10^3; // in
8 R_SS= 25; // in k
9 R_SS= R_SS*10^3; // in
10 I= 0.8; // in mA
11 I=I*10^-3; // in A
12 i_D= I/2; // in A
13 unCox= 0.2; // mA/V^2
14 unCox= unCox*10^-3; // in A/V^2
15 WbyL= 100;
16 // Formula i_D= 1/2*unCox*WbyL*V_OV^2
17 V_OV= sqrt(2*i_D/(unCox*WbyL)); // in V
18 gm= i_D/V_OV; // in A/V;
19
20 // Part (a)
21 Ad= 1/2*gm*R_D; // in V/V
22 disp(Ad,"Differential gain in V/V is : ")
23 Acm= -R_D/(2*R_SS); // in V/V
24 disp(Acm,"Common mode gain in V/V is ")
25 CMRR= abs(Ad)/abs(Acm);
26 CMRRindB= round(20*log10(CMRR)); // in dB
27 disp(CMRRindB,"Common mode rejection ratio in dB is
    : ")
28
29
30 // Part (b)
31 disp("Part (b) when output is taken differentially")
```

```

32 Ad= gm*R_D;// in V/V
33 disp(Ad," Differential gain in V/V is : ")
34 Acn= 0;
35 disp(Acn,"Common mode gain in V/V is ")
36 // CMRRindB= 20*log10(Ad/Acn) = infinite ;// in dB
37 disp("Common mode rejection ratio in dB is : ")
38 disp("infinite");
39
40 // Part (c)
41 disp("Part (c) when output is taken differentially
      but the drain resistance have a 1% mismatch.")
42 Ad= gm*R_D;// in V/V
43 disp(Ad," Differential gain in V/V is : ")
44 // delta_R_D= 1% of R_D
45 delta_R_D= R_D*1/100;// in
46 Acn= R_D/(2*R_SS)*delta_R_D/R_D;// in V/V
47 disp(Acn,"Common mode gain in V/V is ")
48 CMRRindB= 20*log10(abs(Ad)/abs(Acn));// in dB
49 disp(CMRRindB,"Common mode rejection ratio in dB is
      : ")
50
51 // Note: In the book, there is putting wrong value
      of Ad (20 at place of 10) to evaluate the value
      of CMRR in dB in part(c) , So the answer of CMRR
      in dB of Part (c) is wrong

```

---

#### Scilab code Exa 4.6 CMRR

```

1 // Exa 4.6
2 clc;
3 clear;
4 close;
5 // Given data (From Exa 4.4)
6 R_D= 5;// in k
7 R_D= R_D*10^3;// in

```

```

8 R_SS= 25; // in k
9 R_SS= R_SS*10^3; // in
10 I= 0.8; // in mA
11 I=I*10^-3; // in A
12 i_D= I/2; // in A
13 unCox= 0.2; // mA/V^2
14 unCox= unCox*10^-3; // in A/V^2
15 WbyL= 100;
16 // Formula i_D= 1/2*unCox*WbyL*V_OV^2
17 V_OV= sqrt(2*i_D/(unCox*WbyL)); // in V
18 gm= i_D/V_OV; // in A/V;
19 // gm mismatch have a negligible effect on Ad
20 Ad= gm*R_D; // in V/V(approx)
21 // delta_gm= 1% of gm
22 delta_gm = gm*1/100; // in A/V
23 Acm= R_D/(2*R_SS)*delta_gm/gm;
24 CMRRindB= 20*log10(Ad/Acm);
25 disp(CMRRindB,"CMRR in dB is : ")

```

---

#### Scilab code Exa 4.7 Value of VE VC1 and VC2

```

1 // Exa 4.7
2 clc;
3 clear;
4 close;
5 // Given data
6 V_CM= 0;
7 V_BE= -0.7; // in volt
8 v_E= V_CM-V_BE; // in volt
9 disp(v_E," Value of v_E in volts is : ")
10
11 I_E= (5-0.7)/10^3; // in A
12 v_B1= 0.5; // in V
13 v_B2= 0; // in V
14 // Due to Q1 is off; therefore

```

```

15 v_C1= -5; // in V
16 v_C2= I_E*10^3-5; // in V
17 disp(v_C1,"Value of v_C1 in volts is : ")
18 disp(v_C2,"Value of v_C2 in volts is : ")

```

---

#### Scilab code Exa 4.8 Input differential signal

```

1 // Exa 4.8
2 clc;
3 clear;
4 close;
5 // Given data
6 iE1_by_I= 0.99; // as it is given that iE1= 0.99 *I
7 VT= 0.025; // in volt
8 // Formula iE1= I/(1+%e^(-vid/VT))
9 // %e^(-vid/VT)= 1/iE1_by_I-1
10 vid= log( 1/iE1_by_I-1)*(-VT); // in volt
11 disp(round(vid*10^3),"Input differential signal in
      mVis : ")

```

---

#### Scilab code Exa 4.9 Input differential resistance

```

1 // Exa 4.9
2 clc;
3 clear;
4 close;
5 // Given data
6 Bita= 100;
7
8 // Part (a)
9 RE= 150; // in
10 VT= 25; // in mV
11 VT= VT*10^-3; // in V

```

```

12 IE= 0.5; // in mA
13 IE=IE*10^-3; // in A
14 re1= VT/IE; //in
15 R_id= 2*(Beta+1)*(re1+RE); // in
16 R_id= round(R_id*10^-3); // in k
17 disp(R_id,"The input differential resistance in k
    is :")
18
19 // Part (b)
20 RC=10; //in k
21 RC=RC*10^3; //in
22 Rsig= 5+5; // in k
23 VoltageGain1= R_id/(Rsig+R_id); //voltage gain from
    the signal source to the base of Q1 and Q2 in V/V
24 VoltageGain2= 2*RC/(2*(re1+RE)); // voltage gain from
    the bases to the output in V/V
25 Ad= VoltageGain1*VoltageGain2; //in V/V
26 disp(Ad,"The overall differential voltage gain in V/
    V is ");
27
28 // Part (c)
29 delta_RC= 0.02*RC;
30 R_EE= 200; //in k
31 R_EE=R_EE*10^3; //in
32 Acm= RC/(2*R_EE)*delta_RC/RC; //in V/V
33 disp(Acm,"Common mode gain in V/V is :")
34
35 // Part (d)
36 CMRRindB= 20*log10(Ad/Acm); // in dB
37 disp(CMRRindB,"CMRR in dB is : ")
38
39 // Part (e)
40 V_A= 100; // in V
41 r_o= V_A/(IE); // in
42 // Ricm= (Beta+1)*(R_EE || r_o/2)
43 Ricm= (Beta+1)*(R_EE*(r_o/2)/(R_EE+(r_o/2)));
44 disp(Ricm*10^-6,"Input common mode resistance in M
    is : ")

```

---

**Scilab code Exa 4.10** Three components of input offset voltage

```
1 // Exa 4.10
2 clc;
3 clear;
4 close;
5 // Given data
6 delta_RDbyRD= 2/100;
7 delta_WLbyWL= 2/100;
8 delta_Vt= 2; //in mV
9 delta_Vt= delta_Vt*10^-3; // in V
10 // (From Exa 4.4)
11 V_A= 20; // in V
12 R_D= 5; // in k
13 R_D= R_D*10^3; // in
14 I= 0.8; // in mA
15 I=I*10^-3; // in A
16 i_D= I/2; // in A
17 unCox= 0.2; // mA/V^2
18 unCox= unCox*10^-3; // in A/V^2
19 WbyL= 100;
20 // Formula i_D= 1/2*unCox*WbyL*V_OV^2
21 V_OV= sqrt(2*i_D/(unCox*WbyL)); // in V
22 V_OS1= V_OV/2*delta_RDbyRD; // in V
23
24 // V_OS due to W/L ratio
25 V_OS2= V_OV/2*delta_WLbyWL; // in V
26
27 // V_OS due to threshold voltage
28 V_OS3= delta_Vt; // in V
29 // Total offset voltage
30 V_OS= sqrt(V_OS1^2+V_OS2^2+V_OS3^2); // in V
31 V_OS= V_OS*10^3; // in mV
32 disp(V_OS,"Total offset voltage in mV is : ")
```



---

**Scilab code Exa 4.11** Value of Gm Ro Ad Acm and CMRR

```
1 // Exa 4.11
2 clc;
3 clear;
4 close;
5 // Given data
6 WLn= 100;
7 WLp= 200;
8 unCox= 0.2; // mA/V^2
9 unCox=unCox*10^-3; // in A/V^2
10 RSS= 25; // in k
11 RSS= RSS*10^3; // in
12 I=0.8; // in mA
13 I=I*10^-3; // in A
14 V_A= 20; // in V
15 i_D= I/2; // in A
16 // Formula i_D= 1/2*unCox*WLn*V_OV^2
17 V_OV= sqrt(2*i_D/(unCox*WLn)); // in V
18 gm= I/V_OV; // in A/V
19 disp(gm*10^3, "Value of Gm in mA/V is : ")
20 ro2= V_A/(I/2); // in ohm
21 ro4= ro2; // in ohm
22 Ro= ro2*ro4/(ro2+ro4); // in ohm
23 disp(Ro*10^-3, "Value of Ro in k is : ")
24 Ad= gm*Ro; // in V/V
25 disp(Ad, "Value of Ad in V/V is :")
26 // Finding the value of gm3
27 upCox= 0.1; // mA/V^2
28 upCox=upCox*10^-3; // in A/V^2
29 // Formula i_D= 1/2*upCox*WLp*V_OV^2
30 V_OV= sqrt(2*i_D/(upCox*WLp)); // in V
31 gm3= I/V_OV; // in A/V
32 Acm= 1/(2*gm3*RSS); // in V/V
```

```

33 disp(abs(Acm)," Value of |Acm| in V/V is : ")
34 CMRRindB= 20*log10(abs(Ad)/abs(Acm)); //in dB
35 disp(round(CMRRindB),"CMRR in dB is :")

```

---

#### Scilab code Exa 4.12 Value of Gm Ro Ad and Rid

```

1 // Exa 4.12
2 clc;
3 clear;
4 close;
5 // Given data
6 I=0.8; // in mA
7 I=I*10^-3; //in A
8 V_A= 100; // in V
9 Beta=160;
10 VT=25; // in mV
11 VT= VT*10^-3; //in V
12 gm= (I/2)/VT; // in A/V
13 Gm= gm; // Short circuit trnsconductance in mA/V
14 disp(Gm*10^3,"The value of Gm in mA/V")
15 ro2= V_A/(I/2); // in ohm
16 ro4= ro2; // in ohm
17 Ro= ro2*ro4/(ro2+ro4); // in ohm
18 disp(Ro*10^-3,"The value of Ro in k is :")
19 Ad= Gm*Ro; // in V/V
20 disp(Ad," Value of Ad in V/V is :")
21 r_pi= Beta/gm; //in
22 Rid= 2*r_pi; // in
23 disp(Rid*10^-3,"The value of Rid in k is :")

```

---

#### Scilab code Exa 4.13 Value of VOV and VGS

```

1 // Exa 4.13

```

```

2  clc;
3  clear;
4  close;
5  // Given data
6  Vtp= -0.8; // in V
7  KpWL= 3.5; // in mA/V^2
8  I=0.7; // in mA
9  I=I*10^-3; // in A
10 R_D= 2; // in k
11 R_D=R_D*10^3; // in
12 KpWL=KpWL*10^-3; //in A/V^2
13 v_G1= 0; // in V
14 v_G2=v_G1; // in V
15 VSS= 2.5; // in V
16 VDD=VSS; // in V
17 VCS= 0.5; // in V
18 // Part (a)
19 V_OV= -sqrt(I/KpWL); // in V
20 disp(V_OV,"The value of V_OV in volts is : ")
21 V_GS= V_OV+Vtp; // in V
22 disp(V_GS,"The value of V_GS in volts is : ")
23 V_G= 0; // as gate is connected ground
24 v_S1= V_G-V_GS; // in V
25 v_S2= v_S1; // in V
26 disp(v_S1,"The value of V_S in volts is : ")
27 v_D1= I/2*R_D-VDD; // in V
28 v_D2=v_D1; // in V
29 disp(v_D1,"The value of v_D1 in V is : ")
30 disp(v_D2,"The value of v_D2 in V is : ")
31
32 // Part (b)
33 V_CMmin= I*R_D/2-VDD+Vtp; // in V
34 V_CMmax= VSS-VCS+Vtp+V_OV; // in V
35 disp(V_CMmin,"The value of V_CMmin in volt is : ")
36 disp(V_CMmax,"The value of V_CMmax in volt is : ")

```

---

#### Scilab code Exa 4.14 Ratio of W and L

```
1 // Exa 4.14
2 clc;
3 clear;
4 close;
5 // Given data
6 V_OV= 0.2; // in V
7 gm=1; // in mA/V
8 gm=gm*10^-3; // in A/V
9 Vt=0.8; // in V
10 unCox= 90; // in A/V^2
11 unCox=unCox*10^-6; // in A/V^2
12 // gm= I/V_OV
13 I= gm*V_OV; // in A
14 disp(I*10^3,"Bias current in mA is : ")
15 I_D= I/2; // in A
16 // Formula I_D= 1/2*unCox*WLn*V_OV^2
17 WbyL= 2*I_D/(unCox*V_OV^2);
18 disp(WbyL,"W/L ratio is : ")
```

---

#### Scilab code Exa 4.15 Value of VOV gm ro and Ad

```
1 // Exa 4.15
2 clc;
3 clear;
4 close;
5 // Given data
6 I=0.5; // in mA
7 I=I*10^-3; // in A
8 WbyL= 50;
9 unCox= 250; // in A/V^2
```

```

10 unCox=unCox*10^-6; // in A/V^2
11 V_A= 10; // in V
12 R_D= 4; //in k
13 R_D= R_D*10^3; //in
14 V_OV= sqrt(I/(WbyL*unCox)); //in V
15 disp(V_OV,"The value of V_OV in V is : ")
16 gm= I/V_OV; // in A/V
17 disp(gm*10^3,"The value of gm in mA/V is ")
18 I_D=I/2; // in A
19 ro= V_A/I_D; // in
20 disp(ro*10^-3,"The value of ro in k is : ")
21 Ad= gm*(R_D*ro/(R_D+ro)); // in V/V
22 disp(Ad,"The value of Ad in V/V is : ")

```

---

#### Scilab code Exa 4.16 Voltage at emitter and outputs

```

1 // Exa 4.16
2 clc;
3 clear;
4 close;
5 // Given data
6 I=1; // in mA
7 I=I*10^-3; // in A
8 i_C=1; // in mA
9 i_C=i_C*10^-3; // in A
10 V_CC= 5; // in V
11 V_CM= -2; // in V
12 V_BE= 0.7; // in V
13 R_C= 3; // in k
14 R_C= R_C*10^3; // in
15 Alpha=1;
16 Beta=100;
17 V_B= 1; // in V
18 i_C1= Alpha*I; // in A
19 i_C2=0;

```

```
20 v_E= V_B-V_BE; // in V
21 disp(v_E,"Emitters voltage in volts is : ")
22 v_C1= V_CC-i_C1*R_C; // in V
23 v_C2= V_CC-i_C2*R_C; // in V
24 disp("Output voltage is "+string(v_C1)+" V and "+
       string(v_C2)+" V")
```

---

# Chapter 5

## Feedback Amplifiers

Scilab code Exa 5.1 Percentage of output which is feedback to input

```
1 // Exa 5.1
2 clc;
3 clear;
4 close;
5 // Given data
6 A= 800;// unit less
7 Af= 50;// unit less
8 // Formula Af= A/(1+Beta*A)
9 Beta= 1/Af-1/A;
10 disp(Beta*100,"Percentage of output which is
    feedback to the input in % is ")
```

---

Scilab code Exa 5.2 Value of alpha and beta

```
1 // Exa 5.2
2 clc;
3 clear;
4 close;
```

```

5 // Given data
6 Af= 100;// unit less
7 Vi= 50;// in mV
8 Vi= Vi*10^-3;// in V
9 Vs= 0.5;// in V
10 // Formula Af= Vo/Vs
11 Vo= Af*Vs;// in V
12 A= Vo/Vi;
13 disp(A,"Value of A is : ")
14 // Formula Af= A/(1+B*A)
15 B= 1/Af-1/A;
16 B=B*100;// in %
17 disp(B,"Value of B is in percent : ")

```

---

### Scilab code Exa 5.3 Value of fL and fH

```

1 // Exa 5.3
2 clc;
3 clear;
4 close;
5 // Given data
6 Bita= 5/100;
7 f_H= 50;// in kHz
8 f_H= f_H*10^3;// in Hz
9 f_L= 50;// in kHz
10 Amid= 1000;
11 f_LF= f_L/(1+Bita*Amid);// in Hz
12 f_HF= f_H*(1+Bita*Amid);// in Hz
13 disp(f_LF,"Value of f_LF in Hz is : ")
14 disp(f_HF*10^-6,"Value of f_LF in MHz is : ")

```

---

### Scilab code Exa 5.4 Value of Bita and Af



```

1 // Exa 5.4
2 clc;
3 clear;
4 close;
5 // Given data
6 dAf_by_Af= 0.2/100;
7 dA_by_A= 150/2000;
8 A=2000;
9 // Formula dAf_by_Af = 1/(1+Beta*A) * dA_by_A
10 Beta= dA_by_A/(A*dAf_by_Af )-1/A;
11 Af= A/(1+Beta*A);
12 disp(Beta*100,"Value of Beta in percent is ")
13 disp(Af,"Value of Af is : ")

```

---

**Scilab code Exa 5.5** Fraction of the output that is feedback to input

```

1 // Exa 5.5
2 clc;
3 clear;
4 close;
5 // Given data
6 Av= 140;
7 Avf= 17.5;
8 // Formula Avf= Av/(1+Av*Beta)
9 Beta= 1/Avf-1/Av;
10 disp(Beta,"Fraction of the output is ")

```

---

**Scilab code Exa 5.6** Fraction of the output voltage feedback

```

1 // Exa 5.6
2 clc;
3 clear;
4 close;

```

```

5 // Given data
6 Av= 100;
7 Avf= 50;
8 // Formula Avf= Av/(1+Av*Beta)
9 Beta= 1/Avf-1/Av;
10 disp(Beta,"The vlaue of beta is ")
11
12 // Part(ii)
13 Avf= 75;
14 // Formula Avf= Av/(1+Av*Beta)
15 Av= Avf/(1-Beta*Avf)
16 disp(Av,"Value of amplifier gain is : ")

```

---

#### Scilab code Exa 5.7 Percentage reduction in stage gain

```

1 // Exa 5.7
2 clc;
3 clear;
4 close;
5 // Given data
6 Av= 50;
7 Avf= 25;
8 // Formula Avf= Av/(1+Av*Beta)
9 Beta= 1/Avf-1/Av;
10 // Part(i)
11 Av=50;
12 Avf= 40;
13 Perc_reduction= (Av-Avf)/Av*100; // Percentage of
    reduction in stage gain in %
14 disp(Perc_reduction,"Without feedback , percentage of
    reduction in stage gain in % is : ")
15
16 // Part(ii)
17 Av= 40;
18 Avf= 25;

```

```

19 gain_with_neg_feed= Av/(1+Bit*Av);
20 Perc_reduction= (Avf-gain_with_neg_feed)/Avf*100; //
    in %
21 disp(Perc_reduction,"With feedback , percentage
    reduction in stage gain in % is : ")

```

---

### Scilab code Exa 5.8 Bandwidth of a feedback amplifiers

```

1 // Exa 5.8
2 clc;
3 clear;
4 close;
5 // Given data
6 Ao= 10^4;
7 Afo= 50;
8 omega_H= 2*%pi*100; // in rad/s
9 // Formula Afo= Ao/(1+Ao*Bit)
10 Bit= 1/Afo-1/Ao;
11 omega_f_H= omega_H*(1+Ao*Bit);
12 disp("Closed loop bandwidth in rad/s is : ")
13 disp(string(omega_f_H)+" or 2*%pi*20*10^3");
14 disp("So the bandwidth increase form 100 Hz to 20
    kHz on the gain decreases form 104 to 50")

```

---

### Scilab code Exa 5.10 Value of Av bita Avf Ri Rif Ro Rof

```

1 // Exa 5.10
2 clc;
3 clear;
4 close;
5 // Given data
6 gm=50;
7 R_E= 100; // in ohm

```

```

8 R_S= 1;// in kohm
9 R_S=R_S*10^3;// in ohm
10 r_pi= 1100;// in ohm
11 h_ie= r_pi;
12 // Formula Av= Vo/Vs, But Vo= gm*vpi*R_E and Vs= Ib
    *(Ri+rpi), so
13 Av= gm*R_E/(R_S+h_ie)
14 // As Vo=Vf, so
15 Bita=1;
16 D= 1+Bita*Av;
17 Avf= Av/D;
18 Ri= R_S+r_pi;// in ohm
19 Ri= Ri*10^-3;// in kohm
20 R_if= Ri*D;// in kohm
21 // Ro= infinite , so
22 // Rof= infinite
23 disp(Av," Value of Av is : ")
24 disp(Bita," Value of Bita is : ")
25 disp(Avf," Value of Avf is : ")
26 disp(Ri," Value of Ri in kohm")
27 disp(R_if," Value of R_if in kohm is : ")
28 disp(" Value of Rof is : ")
29 disp(" infinite")

```

---

**Scilab code Exa 5.11** Value of Avf Rif Rof and bita

```

1 // Exa 5.11
2 clc;
3 clear;
4 close;
5 // Given data
6 gm=2;// in mA/V
7 gm=gm*10^-3;// in A/V
8 r_d= 40;// in kohm
9 r_d= r_d*10^3;// in ohm

```

```

10 Rs= 3;// in kohm
11 Rs= Rs*10^3;// in ohm
12 miu= gm*r_d;
13 Bita=1;
14 Av= miu*Rs/(r_d+Rs);
15 D= 1+Bita*Av;
16 Avf= Av/D;
17 // Ri=infinite , so R_if = Ri*D = infinite
18 Rof= r_d/D;// in ohm
19 disp(Av,"Value of Av is : ")
20 disp(D,"Value of D is ")
21 disp(Avf,"Value of Avf is : ")
22 disp("Value of R_if is ")
23 disp("infinite")
24 disp(Rof,"Value of Rof in ohm is : ")

```

---

#### Scilab code Exa 5.12 Value of D Gmf Rif and Rof

```

1 // Exa 5.12
2 clc;
3 clear;
4 close;
5 // Given data
6 gm=75;// in A/V
7 Rs= 1;// in kohm
8 Rs= Rs*10^3;// in ohm
9 R_E= 1;// in kohm
10 R_E= R_E*10^3;// in ohm
11 rpi= 1;// in kohm
12 rpi= rpi*10^3;// in ohm
13 hie=rpi;
14
15 Io= -gm;
16 Vi= Rs+R_E+rpi;
17 Gm= Io/Vi;

```

```

18 disp(Gm," Value of Gm is : ")
19 Bita=-R_E;
20 disp(Bita," Value of Bita is : ")
21 D= 1+Bit*Gm;
22 disp(D," Value of D is : ")
23 Gmf= Gm/D;
24 disp(Gmf," Value of Gmf is : ")
25 Ri= Rs+R_E+hie;// in ohm
26 Rif= Ri*D;// in ohm
27 Rif=Rif*10^-3;// in kohm
28 disp(Rif," Value of Rif in kohm is : ")
29 // Ro=infinite , so R_of = Ro*D = infinite
30 disp(" Value of R_of is ")
31 disp(" infinite")

```

---

#### Scilab code Exa 5.19 Percentage change in Af

```

1 // Exa 5.19
2 clc;
3 clear;
4 close;
5 // Given data
6 A= 10^5;
7 Af= 100;
8 // Formula Af= A/(1+A*Bit)
9 Bit= 1/Af-1/A;
10
11 //when A= 10^3
12 A=10^3;
13 Af_desh= A/(1+A*Bit);
14
15 delta_Af= Af_desh-Af;
16 Perc_Change_inAf= delta_Af/Af*100;// in %
17 disp(Perc_Change_inAf," Percentage change in Af is :
    ")

```

---

**Scilab code Exa 5.20** Percentage gain deduction

```
1 // Exa 5.20
2 clc;
3 clear;
4 close;
5 // Given data
6 A= 100;
7 Vs=1; // in volt
8 Bita=1; // as in the voltage follower, the output
    voltage is same as input
9 Af= A/(1+Bita*A);
10 CLG= 1+A*Bita; // closed loop gain
11 disp(CLG,"Closed loop gain is : ")
12 CLG_dB= 20*log10(CLG);
13 disp(CLG_dB,"Closed loop gain in dB is : ")
14 Vo= Af*Vs; // in V
15 disp(Vo,"Value of Vo in volt is : ")
16 Vi= Vs-Vo; // in V
17 disp(round(Vi*10^3),"Value of Vi in mV is : ")
18 // If A decrease 10%, i.e.
19 A=90;
20 Af_desh= A/(1+Bita*A);
21 Per_gain_reduction= (Af_desh-Af)/Af*100; // in %
22 disp(Per_gain_reduction,"Percentage of gain
    reduction in %")
```

---

**Scilab code Exa 5.21** Open loop gain and loop gain

```
1 // Exa 5.21
2 clc;
```

```

3 clear;
4 close;
5 // Given data
6 // Part (a)
7 PerError= 1;// in %
8 A= 10^5;// (Assumed value)
9 ABita= 1/PerError*100;
10 Bita= 1/(PerError*A);
11 disp("% error          A          A
          1+ A ")
12 disp(string(PerError)+"          "+string(
          A)+"          "+string(ABita)+"
          "+string(1+ABita))

13 // Part (b)
14 PerError= 5;// in %
15 ABita= 1/PerError*100;
16 Bita= 1/(PerError*A);
17 disp(string(PerError)+"          "+string(
          A)+"          "+string(ABita)+"
          "+string(1+ABita))

18 // Part (c)
19 PerError= 50;// in %
20 ABita= 1/PerError*100;
21 Bita= 1/(PerError*A);
22 disp(string(PerError)+"          "+string(A)
          +"          "+string(ABita)+"
          "+string(1+ABita))

```

---

### Scilab code Exa 5.22 Value of AB

```

1 // Exa 5.22
2 clc;
3 clear;
4 close;
5 // Given data

```



```

6 S= -20; // sensitivity of closed to open loop gain in
      dB
7 // sensitivity of closed to open loop gain = 1/(1+AB
      ) = S
8 // or (1+AB) = -S
9 AB= 10^(-S/20) - 1;
10 disp(AB,"The loop gain AB for which the sensitivity
      of closed loop gain to open loop gain is -20 dB,
      is : ")
11
12 // Part (b) when
13 S= 1/2; // sensitivity of closed to open loop gain in
      dB
14 //S= 1/(1+AB)
15 AB= 1/S-1;
16 disp(AB,"The loop gain AB for which the sensitivity
      of closed loop gain to open loop gain is 1/2 ,is
      : ")

```

---

### Scilab code Exa 5.23 Gain density factor

```

1 // Exa 5.23
2 clc;
3 clear;
4 close;
5 // Given data
6 A=10^5;
7 Af= 10^3;
8 // Af= A/(1+A*BitA)
9 BitA= 1/Af-1/A;
10 GDF= 1+A*BitA; // gain density factor
11 disp(GDF,"Gain density factor is : ")
12 // Part (a) when A drops 10 %
13 A_desh= A-A*10/100;
14 Af_desh= A_desh/(1+A_desh*BitA);

```

```

15 CorresPer= (Af-Af_desh)/Af*100; // corresponding
    percentage in %
16 disp(CorresPer,"When A drops by 10 % then
    corresponding percentage is ")
17 // Part (b) when A drops 30 %
18 A_desh= A-A*30/100;
19 Af_desh= A_desh/(1+A_desh*Beta);
20 CorresPer= (Af-Af_desh)/Af*100; // corresponding
    percentage in %
21 disp(CorresPer,"When A drops by 30 % then
    corresponding percentage is ")

```

---

#### Scilab code Exa 5.24 Upper and lower 3dB frequency

```

1 // Exa 5.24
2 clc;
3 clear;
4 close;
5 // Given data
6 A=100;
7 Af= 10;
8 f_L= 100; // in Hz
9 f_H= 10; // in kHz
10 // Af= A/(1+A*Beta)
11 Beta= 1/Af-1/A;
12 f_desh_L= f_L/(1+A*Beta); // in Hz
13 f_desh_H= f_H/(1+A*Beta); // in kHz
14 disp(f_desh_L,"Low frequency in Hz is : ")
15 disp(f_desh_H,"High frequency in kHz is : ")
16
17 // Note: In the book Calculation to find the value
    of high frequency i.e. f_desh_H is wrong so the
    answer in the book is wrong

```

---

**Scilab code Exa 5.25** Value of alpha and bita

```
1 // Exa 5.25
2 clc;
3 clear;
4 close;
5 // Given data
6 Vs= 100;// in mV
7 Vf= 95;// in mV
8 Vs= Vs*10^-3;// in V
9 Vf= Vf*10^-3;// in V
10 Vo=10;// in V
11 Vi= Vs-Vf;// in V
12 Av= Vo/Vi;// in V/V
13 disp(Av,"Value of A in V/V is : ")
14 Bita= Vf/Vo;// in V/V
15 disp(Bita,"Value of Bita in V/V is : ")
16
17 // Note: In the book Calculation to find the value
    of Bita is wrong so the asnwer in the book is
    wrong
```

---

**Scilab code Exa 5.26** Value of alpha and bita

```
1 // Exa 5.26
2 clc;
3 clear;
4 close;
5 // Given data
6 Is= 100;// in A
7 Is= Is*10^-6;// in A
8 If= 95;// in A
```

```

 9 If= If*10^-6; // in A
10 Io= 10; // in mA
11 Io= Io*10^-3; // in A
12 A= Io/(Is-If); // n A/A
13 Bita= If/Io; // A/A
14 disp(A,"Value of A in A/A is : ")
15 disp(Bita,"Value of Bita in A/A is : ")
16
17 // Note: In the book , to evaluating the value of
    Bita , they putted wrong value of If (95 at place
    of 90)

```

---

**Scilab code Exa 5.28** Gain input resistance and output resistance of the closed loop amp

```

1 // Exa 5.28
2 clc;
3 clear;
4 close;
5 // Given data
6 A=2000; //V/V
7 Bita= 0.1; // in V/V
8 Ri= 1; // in kohm
9 Ri= Ri*10^3; // in ohm
10 Ro= 1; // in kohm
11 Ro= Ro*10^3; // in ohm
12 Af= A/(1+A*Bita);
13 disp(Af,"The gain Af in volt is : ")
14 Rif= Ri*(1+A*Bita); // in ohm
15 disp(Rif*10^-3,"The input resistance in kohm is : ")
16 Rof= Ro/(1+A*Bita); // in ohm
17 disp(Rof*10^-3,"The output resistance in kohm is : ")
    )
18
19

```

```
20 // Note: In the book, to finding the value of Af,  
    Rif and Rof there is missprinting to putting the  
    value of Bita but value of Af and Rif is correct  
    because to calculating Af and Rif , the value of  
    Bita is taken .1 (not .01)  
21 //           but to evaluating the value of Rof  
    calculation is also wrong so the answer in the  
    book is wrong
```

---

### Scilab code Exa 5.29 Closed loop voltage gain

```
1 // Exa 5.29  
2 clc;  
3 clear;  
4 close;  
5 // Given data  
6  
7 // Part (b)  
8 Af= 10;  
9 A= 10^4;  
10 // Af= A/(1+A*Bita);  
11 Bita= 1/Af-1/A;  
12 // Bita= R1/(R1+R2)  
13 R2_by_R1= 1/Bita-1;  
14 disp(R2_by_R1," Value of R2/R1 is : ")  
15  
16 // Part (c)  
17 Vs= 1; // in V  
18 Vo= (1+R2_by_R1)*Vs;  
19 disp(Vo," Value of Vo in volt is : ")  
20 Vf= Vo/(1+R2_by_R1)  
21 disp(Vf," Value of Vf in volt is : ")
```

---

# Chapter 6

## Oscillators

Scilab code Exa 6.1 Minimum gain of the amplifier to provide oscillation

```
1 // Exa 6.1
2 clc;
3 clear;
4 close;
5 // Given data
6 Vf= 0.0125;// in volt
7 Vo= 0.5;// in volt
8 Bita= Vf/Vo;
9 // For oscillator A*Bita= 1
10 A= 1/Bita;
11 disp(" Amplifier Should have a minimum gain of "+
      string(A)+" to provide oscillation")
```

---

Scilab code Exa 6.2 The frequency of oscillation

```
1 // Exa 6.2
2 clc;
3 clear;
```

```

4 close;
5 // Given data
6 R1= 50; // in kohm
7 R1=R1*10^3; // in ohm
8 R2=R1; // in ohm
9 R3=R2; // in ohm
10 C1= 60; // in pF
11 C1= C1*10^-12; // in F
12 C2=C1; // in F
13 C3=C2; // in F
14 f= 1/(2*%pi*R1*C1*sqrt(6));
15 disp(f*10^-3,"Frequency of oscilltions in kHz is : ")
    )

```

---

### Scilab code Exa 6.3 Wein Bridge oscillator

```

1 // Exa 6.3
2 clc;
3 clear;
4 close;
5 // Given data
6 f=2; // in kHz
7 f=f*10^3; // in Hz
8 // Let
9 R= 10; // in kohm (As R should be greater than 1
    kohm)
10 R=R*10^3; // in ohm
11 // Formula f= 1/(2*%pi*R*C)
12 C= 1/(2*%pi*f*R); // in F
13 C= C*10^9; // in nF
14 // For Beta to be 1/3, Choose
15 R4= R; // in ohm
16 R3= 2*R4; // in ohm
17 disp(C,"Value of C in nF is : ")
18 disp(R3*10^-3,"Value of R3 in kohm is : ")

```

```
19 disp(R4*10^-3,"Value of R4 in kohm is : ")
```

---

#### Scilab code Exa 6.4 Frequency of oscillations

```
1 // Exa 6.4
2 clc;
3 clear;
4 close;
5 // Given data
6 R1= 200; // in kohm
7 R1=R1*10^3; // in ohm
8 R2=R1; // in ohm
9 C1= 200; // in pF
10 C1= C1*10^-12; // in F
11 C2=C1; // in F
12 f= 1/(2*pi*R1*C1); // in Hz
13 disp(f*10^-3,"Frequency of oscilltions in kHz is : ")
14 )
15 // Note: Calculation to find the value of f in the
    book is wrong, so answer in the book is wrong
```

---

#### Scilab code Exa 6.5 Operating frequency

```
1 // Exa 6.5
2 clc;
3 clear;
4 close;
5 // Given data
6 L= 100; // in H
7 L= L*10^-6; // in H
8 C1= .001; // in F
9 C1= C1*10^-6; // in F
```



```

10 C2= .01;// in F
11 C2= C2*10^-6;// in F
12 C= C1*C2/(C1+C2);// in F
13 // (i)
14 f= 1/(2*%pi*sqrt(L*C));// in Hz
15 disp(round(f*10^-3),"Operating frequency in kHz is :
      ")
16 // (ii)
17 Beta= C1/C2;
18 disp(Beta,"Feedback fraction is : ")
19 // (iii)
20 // A*Beta >=1, so Amin*Beta= 1
21 Amin= 1/Beta;
22 disp(Amin,"Minimum gain to substain oscillations is
      : ")

```

---

#### Scilab code Exa 6.6 Operating frequency

```

1 // Exa 6.6
2 clc;
3 clear;
4 close;
5 // Given data
6 L= 15;// in H
7 L= L*10^-6;// in H
8 C1= .004;// in F
9 C1= C1*10^-6;// in F
10 C2= .04;// in F
11 C2= C2*10^-6;// in F
12 C= C1*C2/(C1+C2);// in F
13 f= 1/(2*%pi*sqrt(L*C));// in Hz
14 disp(f*10^-3,"Frequency of oscillations in kHz is :
      ")

```

---

### Scilab code Exa 6.7 Frequency of oscillation

```
1 // Exa 6.7
2 clc;
3 clear;
4 close;
5 // Given data
6 L= 0.01; // in H
7 C= 10; // in pF
8 C= C*10^-12; // in F
9 f= 1/(2*pi*sqrt(L*C)); // in Hz
10 disp(f*10^-3, "Frequency of oscillations in kHz is :
    ")
11
12 // Note: Calculation to find the value of f in the
    book is wrong, so answer in the book is wrong
```

---

### Scilab code Exa 6.8 Value of fs and fp

```
1 // Exa 6.8
2 clc;
3 clear;
4 close;
5 // Given data
6 L= 0.8; // in H
7
8 C= .08; // in pF
9 C= C*10^-12; // in F
10 C_M= 1.9; // in pF
11 C_M= C_M*10^-12; // in F
12 C_T= C*C_M/(C+C_M); // in F
13 R=5; // in kohm
```

```

14 f_s= 1/(2*%pi*sqrt(L*C));// in Hz
15 disp(f_s*10^-3,"Series resonant frequency in kHz is
    : ")
16 // (ii)
17 f_p= 1/(2*%pi*sqrt(L*C_T));// in Hz
18 disp(f_p*10^-3,"parallel resonant frequency in kHz
    is : ")
19
20 // Note: Calculation to find the value of parallel
    resonant frequency in the book is wrong, so
    answer in the book is wrong

```

---

#### Scilab code Exa 6.10 Frequency of oscillation

```

1 // Exa 6.10
2 clc;
3 clear;
4 close;
5 // Given data
6 R1= 220;// in kohm
7 R1=R1*10^3;// in ohm
8 R2=R1;// in ohm
9 C1= 250;// in pF
10 C1= C1*10^-12;// in F
11 C2=C1;// in F
12 f= 1/(2*%pi*R1*C1);
13 disp(f,"Frequency of oscillations in Hz is : ")

```

---

#### Scilab code Exa 6.11 Value of C

```

1 // Exa 6.11
2 clc;
3 clear;

```

```

4 close;
5 // Given data
6 R= 10;// in kohm
7 R=R*10^3;// in ohm
8 f=1000;
9 fie= 60;// in
10 // The impedance of given circuit , Z= R+j*1/(omega*
    C)
11 // the phase shift , tan(fie)= imaginary part/ Real
    part
12 // tand(fie) = 1/(omega*R*C)
13 C= 1/(2*%pi*R*tand(fie));
14 disp(C*10^12,"The value of C in pF is : ")
15
16 // Note : There is an calculation error to evaluate
    the value of C, So the answer in the book is
    wrong

```

---

#### Scilab code Exa 6.12 Frequency of oscillation and minimum gain

```

1 // Exa 6.12
2 clc;
3 clear;
4 close;
5 // Given data
6 L= 50;// in H
7 L= L*10^-6;// in H
8 C1= 300;// in pF
9 C1= C1*10^-12;// in F
10 C2= 100;// in pF
11 C2= C2*10^-12;// in F
12 C_eq= C1*C2/(C1+C2);// in F
13 f= 1/(2*%pi*sqrt(L*C_eq));// in Hz
14 disp(f*10^-6,"Frequency of oscillations in MHz is :
    ")

```

```

15 Bita= C2/C1;
16 // (iii)
17 // A*Bita >=1, so A*Bita= 1 (for sustained
    oscillations)
18 Amin= 1/Bita;
19 disp(Amin,"Minimum gain to substain oscillations is
    : ")

```

---

#### Scilab code Exa 6.14 The range of capacitance

```

1 // Exa 6.14
2 clc;
3 clear;
4 close;
5 // Given data
6 L1= 2; // in mH
7 L1= L1*10^-3; // in H
8 L2= 1.5; // in mH
9 L2= L2*10^-3; // in H
10 // Formula  $f = 1/(2*\%pi*\sqrt{(L1+L2)*C})$ 
11 // For f= 1000 kHz, C will be maximum
12 f=1000; // in kHz
13 f=f*10^3; // in Hz
14 Cmax= 1/((2*%pi*f)^2*(L1+L2)); // in F
15 // For f= 2000 kHz, C will be maximum
16 f=2000; // in kHz
17 f=f*10^3; // in Hz
18 Cmin= 1/((2*%pi*f)^2*(L1+L2)); // in F
19 disp(Cmin*10^12,"Minimum Capacitance in pF is : ")
20 disp(Cmax*10^12,"Maximum Capacitance in pF is : ")

```

---

# Chapter 7

## Examintion Paper

Scilab code Exa 1.b The value of V1 and V0

```
1 // Exa 1.b
2 clc;
3 clear;
4 close;
5 // Given data
6 R1= 10;// in k
7 R2= 10;// in k
8 Rf= 50;// in k
9 V= 2;// in V
10 V1= V*R1/(R1+R2);// in V
11 V01= -Rf/R1*V1;// in V
12 disp(V1,"The value of V1 in volts is : ")
13 disp(V01,"The value of V01 in volts is : ")
14 disp("Only 2 V source then the circuit acts as non-
    inverting amplifier")
```

---

Scilab code Exa 2.a The value of ID and VD

```

1 // Exa 2.a
2 clc;
3 clear;
4 close;
5 // Given data
6 V_P= -4; // in V
7 I_DSS= 10; // in mA
8 V_GS= 0; // in V
9 R_D= 1.8; // in k
10 V_DD= 20; // in V
11 I_D= I_DSS*(1-V_GS/V_P)^2; // in mA
12 // Applying KVL to the circuit, we get V_DD= I_D*R_D
    +V_D
13 V_D= V_DD-I_D*R_D; // in V
14 disp(I_D,"The value of I_D in mA is : ")
15 disp(V_D,"The value of V_D in volts is : ")

```

---

**Scilab code Exa 2.c** ON resistance of an NMOS transistor

```

1 // Exa 2.c
2 clc;
3 clear;
4 close;
5 // Given data
6 V_GS= 3; // in V
7 Vth= 1; // in V
8 unCox= 25; // in mA/V^2
9 unCox= unCox*10^-3; // in A/V^2
10 W=3; // in m
11 L=1; // in m
12 r_DS= 1/(unCox*W/L*(V_GS-Vth)); // in
13 disp(r_DS,"The value of r_DS in      is : ")

```

---

**Scilab code Exa 3.b** The value of RE RB and delta ICQ

```
1 // Exa 3.b
2 clc;
3 clear;
4 close;
5 // Given data
6 I_CQ= 10; // in mA
7 I_CQ= I_CQ*10^-3; // in A
8 V_CQ= 5; // in V
9 V_CC= 10; // in V
10 R_C= 0.4; // in k
11 R_C= R_C*10^3; // in
12 V_BE= 0.075; // in V
13 V_BB= 0.175; // in V
14 bita=100;
15 bita_max=120;
16 bita_min= 40;
17 // Applying KVL we get , V_CQ= V_CC-I_C*(R_C+R_E)
18 R_E= (V_CC-V_CQ)/I_CQ-R_C; // in
19 disp(R_E,"The value of R_E in      is :")
20 I_B= I_CQ/bita; // in A
21 R_B= (V_BB-V_BE)/I_B; // in
22 disp(R_B*10^-3,"The value of R_B in k ")
23 I_Cmax= bita_max*I_B; // in A
24 I_Cmin= bita_min*I_B; // in A
25 delta_I_CQ= I_Cmax-I_Cmin; // in A
26 disp(delta_I_CQ*10^3,"The value of delta_I_C in mA
    is : ")
```

---