

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

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Chapter 1

Operational Amplifiers

Scilab code Exa 1.1 Value of Rf

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

Scilab code Exa 1.2 Output voltage

```
1 // Exa 1.2
2 format('v',7);
```

```

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

```

Scilab code Exa 1.3 Inverting amplifier

```

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

```

Scilab code Exa 1.4 Inverting amplifier

```

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

```

Scilab code Exa 1.5 Output voltage

```

1 // Exa 1.5
2 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 Rf= 1;// in Mohm
8 Rf=Rf*10^6;//in ohm
9
10 // Part(a)
11 V1=1;//in volt
12 V2=2;//in volt
13 V3=3;//in volt
14 R1= 500;// in kohm
15 R1=R1*10^3;//in ohm
16 R2= 1;// in Mohm
17 R2=R2*10^6;//in ohm
18 R3= 1;// in Mohm
19 R3=R3*10^6;//in ohm
20 Vo= -Rf*(V1/R1+V2/R2+V3/R3);// in volt

```

```

21 disp(Vo,"(a) Output voltage in volt is : ")
22
23 // Part(b)
24 V1=-2;//in volt
25 V2=3;//in volt
26 V3=1;//in volt
27 R1= 200;// in kohm
28 R1=R1*10^3;//in ohm
29 R2= 500;// in kohm
30 R2=R2*10^3;//in ohm
31 R3= 1;// in Mohm
32 R3=R3*10^6;//in ohm
33 Vo= -Rf*(V1/R1+V2/R2+V3/R3);// in volt
34 disp(Vo,"(b) Output voltage in volt is : ")

```

Scilab code Exa 1.6 Maximum and minimum closed loop gain

```

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

```

```
17 Av_max= (1+R2/R1)
18 disp(Av_max)
```

Scilab code Exa 1.7 Output voltage

```
1 // Exa 1.7
2 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 V1= 745; // in V
8 V2= 740; // in V
9 V1=V1*10^-6; // in volt
10 V2=V2*10^-6; // in volt
11 CMRR=80; // in dB
12 Av=5*10^5;
13 // (i)
14 // CMRR in dB= 20*log(Ad/Ac)
15 Ad=Av;
16 Ac= Ad/10^(CMRR/20);
17 // (ii)
18 Vo= Ad*(V1-V2)+Ac*(V1+V2)/2;
19 disp(Vo,"Output voltage in volt is : ")
20
21 // 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 R1= 1; // in Mohm
8 Ri=R1; // in Mohm
9 Rf=1; // in Mohm
10 A_VF= -Rf/R1;
11 disp(A_VF,"Voltage gain is : ")

```

Scilab code Exa 1.10 Output voltage

```

1 // Exa 1.10
2 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 V1=2; // in V
8 V2=3; // in V
9 Rf=3; // in kohm
10 R1=1; // in kohm
11 disp("Output voltage when only 2V voltage source is
      acting in volt")
12 Vo1= (1+Rf/R1)*V1;
13 disp(Vo1);
14 disp("Output voltage due to 3V voltage source in
      volt")
15 Vo2= (1+Rf/R1)*V2;
16 disp(Vo2);
17 Vo= Vo1+Vo2; // in volts
18 disp(Vo,"Total output voltage in volts")

```

Scilab code Exa 1.11 Range of voltage gain

```
1 // Exa 1.11
2 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 Rf=500; // in kohm
8 min_vvs= 0; // minimum value of variable resistor in
   ohm
9 max_vvs= 10; // maximum value of variable resistor in
   ohm
10 Ri_min= 10+min_vvs; // in kohm
11 Ri_max= 10+max_vvs; // in kohm
12 //  $A_v = V_o/V_i = -R_f/R_i$ 
13 disp("Closed loop voltage gain corresponding to Ri(
   min) is ")
14 Av=-Rf/Ri_min;
15 disp(Av)
16 disp("and closed loop voltage gain corresponding to
   Ri(max) is ")
17 Av=-Rf/Ri_max;
18 disp(Av)
19 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 format('v',7);
```

```

3  clc;
4  clear;
5  close;
6  // Given data
7  Rf=200; // in kohm
8  R1= 20; // in kohm
9  // Av= Vo/Vi= -Rf/Ri
10 Av= -Rf/R1;
11 Vi_min= 0.1; // in V
12 Vi_max= 0.5; // in V
13 // Vo= Av*Vi
14 Vo_min= Av*Vi_min; // in V
15 Vo_max= Av*Vi_max; // in V
16 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  format('v',7);
3  clc;
4  clear;
5  close;
6  // Given data
7  Rf= 250; // in kohm
8  // Output voltage expression , Vo= -5*Va+3*Vb
9  // and we know that for a difference amplifier
   circuit ,
10 // Vo= -Rf/R1*Va + [R2/(R1+R2)]*[1+Rf/R1]*Vb
11 // Comparing both the expression , we get
12 // -Rf/R1*Va= -5*Va, or
13 R1= Rf/5; // in kohm
14 disp(R1,"The value of R1 in kohm")
15 // and
16 R2= 3*R1^2/(R1+Rf-3*R1)

```



```
17 disp(R2,"The value of R2 in kohm")
18
19 // Note : Answer in the book is wrong
```

Scilab code Exa 1.14 Output voltage

```
1 // Exa 1.14
2 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 Vi_1= 150; // in V
8 Vi_2= 140; // in V
9 Vd= Vi_1-Vi_2; // in V
10 Vd=Vd*10^-6; // in V
11 Vc= (Vi_1+Vi_2)/2; // in V
12 Vc=Vc*10^-6; // in V
13 // Vo= Ad*Vd*(1+Vc/(CMRR*Vd))
14
15 // (i) For Ad=4000 and CMRR= 100
16 Ad=4000;
17 CMRR= 100;
18 Vo= Ad*Vd*(1+Vc/(CMRR*Vd)); // in volt
19 Vo= Vo*10^3; // in mV
20 disp(Vo,"(i) Output voltage in mV")
21
22 // (ii) For Ad=4000 and CMRR= 10^5
23 Ad=4000;
24 CMRR= 10^5;
25 Vo= Ad*Vd*(1+Vc/(CMRR*Vd)); // in volt
26 Vo= Vo*10^3; // in mV
27 disp(Vo,"(ii) Output voltage in mV")
```

Scilab code Exa 1.15 Output voltage

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

Scilab code Exa 1.16 Output voltage

```
1 // Exa 1.16
2 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 R1= 33; // in k
8 R2= 10; // in k
9 R3= 330; // in k
```

```

10 V1= '50mV sin(1000 t)';
11 V2= '10mV sin(3000 t)';
12 Vo1= R3/R1*50*10^-3;
13 Vo2= R3/R2*10*10^-3;
14 // Vo= -Vo1-Vo2;
15 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 R1=10; // in kohm
8 R2=150; // in kohm
9 R3=10; // in kohm
10 R4=300; // in kohm
11 V1= 1; // in V
12 V2= 2; // in V
13 Vo= [(1+R4/R2)*(R3*V1/(R1+R3))-(R4/R2)*V2];
14 disp(Vo,"Output voltage in volts is : ")

```

Scilab code Exa 1.18 Output voltage

```

1 // Exa 1.18
2 format('v',6);
3 clc;
4 clear;
5 close;
6 // Given data

```

```

7 R1=12; // in kohm
8 Rf=360; // in kohm
9 V1= -0.3; // in V
10 Vo= (1+Rf/R1)*V1; // in V
11 disp(Vo,"Output voltage result in volts is : ")
12
13 // Part(b)
14 Vo= 2.4; // in V
15 // We know, Vo= (1+Rf/R1)*V1
16 V1= Vo/(1+Rf/R1);
17 V1= V1*10^3; // in mV
18 disp(V1,"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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 Rf=68; // in kohm
8 R1=33; // in kohm
9 R2=22; // in kohm
10 R3=12; // in kohm
11 V1= 0.2; // in V
12 V2=-0.5; // in V
13 V3= 0.8; // in V
14 Vo= -Rf/R1*V1 + (-Rf/R2)*V2 + (-Rf/R3)*V3; // in
volts
15 disp(Vo,"Output voltage in volts is : ")

```

Scilab code Exa 1.20 Output voltage

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

Scilab code Exa 1.22 Inverting op amp

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

```

19 R2= R2*10^-3; // in k
20 disp(Rf,"The value of Rf in k is : ")
21 disp(R1,"The value of R1 in k is : ")
22 disp(R2,"The value of R2 in k is : ")

```

Scilab code Exa 1.24 Output voltage

```

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

```

Scilab code Exa 1.25 Output voltage

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

Scilab code Exa 1.26 Gain

```
1 // Exa 1.26
2 format('v',7);
```

```

3  clc;
4  clear;
5  close;
6  // Given data
7  // omega_t= Ao*omega_b
8  // 2*%pi*f_t = Ao*2*%pi*f_b
9  // f_t= Ao*f_b
10 // Part (i)
11 Ao1= 10^5;
12 f_b1= 10^2; // in Hz
13 f_t1= Ao1*f_b1; // in Hz
14 // Part (ii)
15 Ao2= 10^6;
16 f_t2= 10^6; // in Hz
17 f_b2= f_t2/Ao2; // in Hz
18 // Part (iii)
19 f_b3= 10^3; // in Hz
20 f_t3= 10^8; // in Hz
21 Ao3= f_t3/f_b3;
22 // Part (iv)
23 f_b4= 10^-1; // in Hz
24 f_t4= 10^6; // in Hz
25 Ao4= f_t4/f_b4;
26 // Part (v)
27 Ao5= 2*10^5;
28 f_b5= 10; // in Hz
29 f_t5= Ao5*f_b5; // in Hz
30 disp(f_t1,"The value of f_t1 in Hz is : ")
31 disp(f_b2,"The value of f_b2 in Hz is : ")
32 disp(Ao3,"The value of Ao3 is : ")
33 disp(Ao4,"The value of Ao4 is : ")
34 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 Ao= 86;// in dB
8 A= 40;// in dB
9 f=100;// in kHz
10 f=f*10^3;// in Hz
11 // From  $20*\log(S) = 20*\log(Ao/A)$ , where S, stands
    for  $\sqrt{1+(f/fb)^2}$ 
12 S= 10^((Ao-A)/20);
13 // S=  $\sqrt{1+(f/fb)^2}$ 
14 fb= f/sqrt(S^2-1);// in Hz
15 Ao= 10^(Ao/20);
16 ft= Ao*fb;// in Hz
17 ft= round(ft*10^-6);// in MHz
18 disp(Ao,"The value of Ao is : ")
19 disp(fb,"The value of fb in Hz is : ")
20 disp(ft,"The value of ft in MHz is : ")

```

Scilab code Exa 1.28 3dB frequency and gain

```

1 // Exa 1.28
2 format('v',5);
3 clc;
4 clear;
5 close;
6 // Given data
7 Ao= 10^4;// in V/V
8 f_t= 10^6;// in Hz
9 R2byR1= 20;
10 omega_t= 2*pi*f_t;
11 omega_3dB= omega_t/(1+R2byR1);

```

```
12 f3dB= omega_3dB/(2*%pi); // in Hz
13 f3dB= f3dB*10^-3; // in kHz
14 disp(f3dB,"3-dB frequency of the closed loop
    amplifier in kHz is : ")
15 f3dB= 0.1*f3dB; // in Hz
16 voBYvi= -R2byR1/sqrt(1+(2*%pi*f3dB/omega_3dB)^2);
17 voBYvi= abs(voBYvi); // in v/v
18 disp(voBYvi,"Gain in v/v is : ")
```

Chapter 2

MOSFET

Scilab code Exa 2.1 Device operate region

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

```

20     disp("At V_D = 0.5 , the device is in saturation
        region");
21
22 end
23
24 // Part(b) V_D= 0.9;// in V
25 V_D= 0.9;// in V
26 V_DS= V_D-V_S;// in V
27 V_GS= V_G-V_S;// in V
28 if V_GS < Vt then
29     disp("At V_D = 0.9 , the device is in cut off
        region")
30 elseif V_DS<= (V_GS-Vt) then
31     disp("At V_D = 0.9 , the device is in triode
        region");
32 else
33     disp("At V_D = 0.9 , the device is in saturation
        region");
34
35 end
36
37 // Part(c) V_D= 3;// in V
38 V_D= 3;// in V
39 V_DS= V_D-V_S;// in V
40 V_GS= V_G-V_S;// in V
41 if V_GS < Vt then
42     disp("At V_D = 3 , the device is in cut off
        region")
43 elseif V_DS<= (V_GS-Vt) then
44     disp("At V_D = 3 , the device is in triode
        region");
45 else
46     disp("At V_D = 3 , the device is in saturation
        region");
47
48 end

```

Scilab code Exa 2.2 Drain current

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

```

29     I_D= unCox*W/L*[(V_GS-Vt)*V_DS-V_DS^2/2];
30     I_D= I_D*10^6; // in A
31     disp(I_D,"The device is in triode region. So the
           drain current in the triode region in A is
           : ")
32 else
33     I_D= unCox*W/(2*L)*(V_GS-Vt)^2
34     I_D= I_D*10^6; // in A
35     disp(I_D,"The device is in saturation region. So
           drain current in the saturation region in
           A is : ")
36 end

```

Scilab code Exa 2.3 Value of VDS

```

1 // Exa 2.3
2 format('v',6);
3 clc;
4 clear;
5 close;
6 // Given data
7 Vt= 0.7; // in V
8 I_D= 100; // in A
9 I_D=I_D*10^-6; // in A
10 // When
11 V_GS= 1.2; // in V
12 V_DS= V_GS; // in V
13 // At this condition , device is in saturation region
    , so     I_D= unCox*W/(2*L)*(V_GS-VT)^2
14 unCoxWby2L= I_D/(V_GS-Vt)^2;
15 // For
16 V_DS= 3; // in V
17 V_GS= 1.5; // in V
18 // In this condition , device is in saturation region
    , so

```

```

19 I_D= unCoxWby2L*(V_GS-Vt)^2; // in A
20 I_D= I_D*10^6; // in A
21 disp(I_D,"For V_DS= 3V and V_GS= 1.5 V, The value of
      I_D in A is : ")
22 // For
23 V_GS= 3.2; // in V
24 r_DS= 1/(2*unCoxWby2L*(V_GS-Vt)); // in
25 disp(r_DS,"For V_GS = 3.2 V, Drain to source
      resistance in is : ")

```

Scilab code Exa 2.4 Value of VGS RS and RD

```

1 // Exa 2.4
2 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 I_D= 0.4; // in mA
8 I_D=I_D*10^-3; // in A
9 Vt= 0.7; // in V
10 V_SS= -2.5; // in V
11 V_DD= 2.5; // in V
12 unCox= 100; // in A/V^2
13 unCox= unCox*10^-6; // in A/V^2
14 W= 32; // in m
15 L= 1; // 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 disp(V_GS,"The value of V_GS in volt is : ")
21 V_G= 0;
22 // Formula V_GS= V_G-V_S
23 V_S= V_G-V_GS; // in V

```

```

24 R_S= (V_S-V_SS)/I_D// in
25 R_S= R_S*10^-3;// in k
26 disp(R_S,"The value of R_S in k is : ")
27 V_D= 0.5;// in V
28 R_D= (V_DD-V_D)/I_D;//in
29 R_D= R_D*10^-3;// in k
30 disp(R_D,"The value of R_D in k is : ")

```

Scilab code Exa 2.5 Value of required of R

```

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

```

Scilab code Exa 2.6 Value of R and VD

```
1 // Exa 2.6
2 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 V_DD= 10; // in V
8 I_D= 0.4; // in mA
9 I_D=I_D*10^-3; // in A
10 Vt= 2; // in V
11 unCox= 20; // in A/V^2
12 unCox= unCox*10^-6; // in A/V^2
13 L= 10; //in m
14 L= L*10^-6; // in m
15 W=100; // in m
16 W=W*10^-6; // in m
17 V_S= 0; // in V as source is connected to ground
18 // I_D= unCox*W/(2*L)*(V_OV)^2
19 V_OV= sqrt(I_D/(unCox*W/(2*L))); // in V
20 V_GS= V_OV+Vt; // in V
21 V_D= V_GS; // in V
22 R= (V_DD-V_D)/I_D; // in
23 R= R*10^-3; // in k
24 disp(R,"The value of R in k is : ")
```

Scilab code Exa 2.7 Effective resistance between drain and source

```
1 // Exa 2.7
2 format('v',5);
```

```

3  clc;
4  clear;
5  close;
6  // Given data
7  KnWbyL= 1; // in mA
8  KnWbyL=KnWbyL*10^-3; // in A
9  Vt= 1; // in V
10 V_DS= 0.1; // in V
11 V_D= V_DS; // in V
12 V_GS= 5; // in V
13 V_DD= V_GS; // in V
14 // Formula I_D= K'nW/L*[(V_GS-Vt)*V_DS-V_DS^2/2]
15 I_D= KnWbyL*[(V_GS-Vt)*V_DS-V_DS^2/2]; // in A
16 R_D= (V_DD-V_D)/I_D; // in
17 R_D= R_D*10^-3; // in k
18 disp(R_D,"The required value of R_D in k is : ")

```

Scilab code Exa 2.8 Voltage at all nodes

```

1  // Exa 2.8
2  format('v',7);
3  clc;
4  clear;
5  close;
6  // Given data
7  KnWbyL= 1; // in mA/V^2
8  KnWbyL=KnWbyL*10^-3; // in A/V^2
9  Vt= 1; // in V
10 V_DD= 10; // in V
11 R_D= 6; // in k
12 R_D= R_D*10^3; // in
13 R_S= 6; // in k
14 R_S= R_S*10^3; // in
15 R_G1= 10; // in M
16 R_G1= R_G1*10^6; // in

```

```

17 R_G2= 10; // in M
18 R_G2= R_G2*10^6; // in
19 V_G= V_DD*R_G2/(R_G1+R_G2); // in V
20 // V_S= R_S*I_D
21 // V_GS= V_G-V_S= V_G-R_S*I_D
22 // Formula I_D= K'nW/2*L*(V_GS-Vt)^2, Putting the
    value of V_GS, We get
23 // 18*I_D^2 -25*I_D +8= 0
24 // I_D= 0.89 mA or I_D= 0.5
25 I_D= 0.5; // in mA
26 I_D=I_D*10^-3; // in A
27 V_S= R_S*I_D; // in V
28 V_GS= V_G-V_S; // in V
29 V_D= V_DD-I_D*R_D; // in V
30 I_D= I_D*10^3; // in mA
31 disp(I_D,"The value of I_D in mA is : ")
32 disp(V_S,"The value of V_S in volt is : ")
33 disp(V_GS,"The value of V_GS in volt is : ")
34 disp(V_D,"The value of V_D in volt is : ")
35 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 R_D= 20; // in k
8 R_D= R_D*10^3; // in
9 R1= 30; // in k
10 R1= R1*10^3; // in
11 R2= 20; // in k

```

```

12 R2= R2*10^3; // in
13 V_DD= 5; // in V
14 Vtn= 1; // in V
15 Kn= 0.1; // in mA/V^2
16 Kn=Kn*10^-3; // in A/V^2
17 V_GS= R2*V_DD/(R1+R2); // in V
18 // I_D= 1/2* nCox*W/L*(V_GS-Vtm)^2
19 I_D = Kn*(V_GS-Vtn)^2 ; // in mA (As Kn= 1/2* nCox*
    W/L)
20 V_DS= V_DD-I_D*R_D; // in V
21 I_D= I_D*10^3; // in mA
22 disp(V_GS,"The value of V_GS in volt is : ")
23 disp(I_D,"The value of I_D in mA is : ")
24 disp(V_DS,"The value of V_DS in volt is : ")
25 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 Desing a bias circuit

```

1 // Exa 2.10
2 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 V_DD= 15; // in V
8 Vt= 1; // in V
9 V_D= 10; // in V
10 V_S= 5; // in V
11 KnWbyL= 1; // in mA/V^2
12 KnWbyL=KnWbyL*10^-3; // in A/V^2
13 R_G1= 8; // in M
14 R_G1= R_G1*10^6; // in
15 I_D= 0.5; // in mA

```

```

16 I_D=I_D*10^-3; // in A
17 R_D= (V_DD-V_D)/I_D; // in
18 R_S= V_S/I_D; // in
19 // Formul I_D= 1/2*KnWbyL*(V_OV)^2
20 V_OV= sqrt(2*I_D/KnWbyL); // in V
21 // Formula V_OV= V_GS-Vt
22 V_GS= V_OV+Vt; // in V
23 V_G= V_GS+V_S; // in V
24 // Formul V_G= R_G2*V_DD/(R_G1+R_G2)
25 R_G2= R_G1*V_G/(V_DD-V_G); // in
26 R_D= R_D*10^-3; // in k
27 R_S= R_S*10^-3; // in k
28 R_G2= R_G2*10^-6; // in M
29 disp(R_D,"The value of R_D in k is : ")
30 disp(R_S,"The value of R_S in k is : ")
31 disp(V_OV,"The value of V_OV in volts is : ")
32 disp(V_GS,"The value of V_GS in volts is : ")
33 disp(R_G2,"The value of R_G2 in M is : ")

```

Scilab code Exa 2.11 Bias point

```

1 // Exa 2.11
2 format('v',6);
3 clc;
4 clear;
5 close;
6 // Given data
7 V_DD= 15; // in V
8 KnWbyL= 0.25; // in mA/V^2
9 KnWbyL=KnWbyL*10^-3; // in A/V^2
10 Vt= 1.5; // in V
11 V_A= 50; // in V
12 R_D= 10; // in k
13 R_D= R_D*10^3; // in
14 R_L= 10; // in k

```

```

15 R_L= R_L*10^3; // in
16 R_G= 10; // in M
17 R_G= R_G*10^6; // in
18 // I_D= 1/2*KnWbyL*(V_D-Vt)^2 , (V_GS= V_D, as dc
    gate current is zero) (i)
19 // V_D= V_DD- I_D*R_D (ii)
20 I_D= 1.06; // in mA
21 I_D = I_D*10^-3; // in A
22 V_D= V_DD- I_D*R_D; // in V
23 V_GS=V_D; // in V
24 // The coordinates of operating point
25 V_GSQ= V_D; // in V
26 I_DQ= I_D*10^3; // in mA
27 disp("The coordinates of operating points are V_GSQ
    = "+string(V_GSQ)+" V and I_DQ= "+string(I_DQ)+"
    mA")
28 gm= KnWbyL*(V_GS-Vt); // in A/V
29 r_o= V_A/I_D; //in
30 // The gain is : Av= vo/vi = -gm*(R_D||R_L||r_o)
31 Av= -gm*[R_D*R_L*r_o/(R_D*R_L+R_D*r_o+R_L*r_o)]; //
    in V/V
32 // i_i= (vi-vo)/R_G
33 // i_i= vi/R_G*(1-vo/vi) and Rin= vi/i_i = R_G/(1-Av
    )
34 Rin= R_G/(1-Av); // in
35 Rin= Rin*10^-6; // in M
36 disp(Rin,"The input resistance in M is : ")
37 disp("The largest allowable input signal vi is
    determined by the need to keep the MOSFET in
    saturation at all times")
38 disp(" V_DS >= V_GS-
    vt")
39 disp("By enforcing this condition with equality at
    the point V_GS is maximum and V_DS is
    correspondingly minimum")
40 disp(" V_DSmin=
    V_GSmax -Vt")
41 disp(" V_DS-|Av| vi

```

```

    = V_GS + vi -Vt")
42 disp("                                4.4 - 3.3 vi
    = 4.4 + vi -1.5")
43 disp("which results in vi= 0.34V")

```

Scilab code Exa 2.12 Largest value of RD

```

1 // Exa 2.12
2 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 I_D= 0.5; // in mA
8 I_D= I_D*10^-3; // in mA
9 V_D= 3; // in V
10 Vt= -1; // in V
11 KpWbyL= 1; // in mA/V^2
12 KpWbyL=KpWbyL*10^-3; // in A/V^2
13 // Formul I_D= 1/2*KpWbyL*(V_OV)^2
14 V_OV= sqrt(2*I_D/KpWbyL); // in V
15 // For PMOS
16 V_OV= -V_OV; // in V
17 V_GS= V_OV+Vt; // in V
18 R_D= V_D/I_D; // in
19 V_Dmax= V_D+abs(Vt); // in V
20 R_D= V_Dmax/I_D; // in
21 R_D= R_D*10^-3; // in k
22 disp(R_D,"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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 V_GS1= 1.5; // in V
8 Vt= 1; // in V
9 r_DS1= 1; // in k
10 r_DS1= r_DS1*10^3; // in
11 r_DS2= 200; // in k
12 // r_DS1= 1/(KnWbyL*(V_GS1-Vt)) (i)
13 // r_DS2= 1/(KnWbyL*(V_GS2-Vt)) (i)
14 // dividing equation (i) by (ii)
15 V_GS2= (r_DS1/r_DS2)*(V_GS1-Vt)+Vt; // in V
16 disp(V_GS2,"To Obtain rDS= 200, The value of V_GS
    should be (in volt)")
17 // For V_GS= 1.5 ; // V
18 // W2= 2*W1;
19 // r_DS1/r_DS2= 2
20 r_DS2= r_DS1/2; // in
21 disp(r_DS2,"For V_GS= 1.5 V , the value of r_DS2 in
    is : ")
22 // For V_GS= 3.5 V
23 r_DS2= 200/2; // in
24 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 format('v',7);
3 clc;
4 clear;
5 close;

```



```

6 // Given data
7 I_D= 0.2; // in mA
8 I_D= I_D*10^-3; // in mA
9 Vt= 1; // in V
10 KpWbyL= 0.1; // in mA/V^2
11 KpWbyL=KpWbyL*10^-3; // in A/V^2
12 // Formul I_D= 1/2*KpWbyL*(V_GS-VT)^2
13 V_GS= sqrt(2*I_D/KpWbyL)+Vt; // in V
14 V_DSmin= V_GS-Vt; // in V
15 disp(V_GS,"Required V_GS in volts is : ")
16 disp(V_DSmin,"The minimum required V_DS in volts is
: ")
17 // For I_D= 0.8 mA
18 I_D = 0.8*10^-3; // in A
19 V_GS= sqrt(2*I_D/KpWbyL)+Vt; // in V
20 V_DSmin= V_GS-Vt; // in V
21 disp(V_GS,"Required V_GS in volts is : ")
22 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 V_SS= -5; // in V
8 unCox= 60; // in A/V^2
9 unCox= unCox*10^-6; // in A/V^2
10 Vt= 1; // in V
11 W= 100; // in m
12 L= 3; // in m
13 V_G=0; // in V

```

```

14 V_DD= 5; // in V
15 V_D=0; //in V
16 I_D= 1*10^-3; // in A
17 // I_D= (V_DD-V_D)/R_D
18 R_D= (V_DD-V_D)/I_D; // in
19 R_D= R_D*10^-3; // in k
20 disp(R_D,"The value of R_D in k is : ")
21 // Formul I_D= 1/2*unCox*W/L*(V_GS-Vt)^2
22 V_GS= sqrt(2*I_D*L/(unCox*W))+Vt; // in V
23 V_S= V_G-V_GS; // in V
24 R_S= (V_S-V_SS)/I_D; // in
25 R_S= R_S*10^-3; // in k
26 disp(R_S,"The resistance in k is ");

```

Scilab code Exa 2.17 Required value of R and W

```

1 // Exa 2.17
2 format('v',5);
3 clc;
4 clear;
5 close;
6 // Given data
7 V_D= 3.5; // in V
8 I_D= 115*10^-6; //in A
9 upCox= 60; // in A/V^2
10 upCox= upCox*10^-6; // in A/V^2
11 L= 0.8; //in m
12 V_GS= -1.5; // in V
13 Vt= 0.7; // in V
14 R= V_D/I_D; // in
15 R= R*10^-3; // in k
16 disp(R,"The value required for R in k is : ")
17 // Formul I_D= 1/2*upCox*W/L*(V_GS-Vt)^2
18 W= 2*I_D*L/(upCox*(V_GS-Vt)^2)
19 disp(W,"The value required for W in m is : ")

```

20

21 // 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 Vt= 1; // in V
8 unCox= 120; // in A/V^2
9 unCox= unCox*10^-6; // in A/V^2
10 L1=1; // in m
11 L2=L1; // in m
12 I_D= 120; //in A
13 I_D= I_D*10^-6; //in A
14 V_GS1= 1.5; //in V
15 V_G2= 3.5; // in V
16 V_S2= 1.5; // in V
17 V_DD= 5; // in V
18 V_D2= 3.5; // in V
19 // Formul  $I_D = 1/2 * unCox * W/L * (V_{GS1} - V_t)^2$ 
20 W1= 2*I_D*L1/(unCox*(V_GS1-Vt)^2); // in m
21 disp(W1,"The value of W1 in m is : ")
22 V_GS2= V_G2-V_S2; //in V
23 // Formul  $I_D = 1/2 * unCox * W/L * (V_{GS1} - V_t)^2$ 
24 W2= 2*I_D*L2/(unCox*(V_GS2-Vt)^2); // in m
25 disp(W2,"The value of W2 in m is : ")
26 R= (V_DD-V_D2)/I_D; // in
27 R= R*10^-3; // in k
28 disp(R,"Resistance in k ");
```

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

```
1 // Exa 2.19
2 format('v',5);
3 clc;
4 clear;
5 close;
6 // Given data
7 Vt= 2; // in V
8 K1WbyL= 1; // in mA/V^2
9 K1WbyL= K1WbyL*10^-3; //in mA/V^2
10 I_D= 10; //in A
11 I_D= I_D*10^-6; //in A
12 V_DD= 10; // in V
13 R_D= 4; // in k
14 R_D= R_D*10^3; // in
15
16 // Formul I_D= 1/2*K1WbyL*(V_GS-Vt)^2
17 V_GS= sqrt(2*I_D/K1WbyL)+Vt; // in V
18 V1= -V_GS; // in V
19 // Part (b)
20 I_D= 2; // in mA
21 I_D= I_D*10^-3; // in A
22 V2= V_DD-I_D*R_D; //in V
23 // Formul I_D= 1/2*K1WbyL*(V_GS-Vt)^2
24 V_GS= sqrt(2*I_D/K1WbyL)+Vt; // in V
25 V3= -V_GS; // in V
26 // Part (c)
27 I_D= 1; // in mA
28 I_D= I_D*10^-3; // in A
29 // Formul I_D= 1/2*K1WbyL*(V_GS-Vt)^2
30 V_GS= sqrt(2*I_D/K1WbyL)+Vt; // in V
31 V4= V_GS; // in V
32 // Part (d)
```

```

33 I_D= 2; // in mA
34 R_D= 2.5; // in k
35 R_D= R_D*10^3; // in
36 V_SS= 10; // in V
37 I_D= I_D*10^-3; // in A
38 V_GS= sqrt(2*I_D/K1WbyL)+Vt; // in V
39 V5= -V_SS+I_D*R_D; // in V
40 disp(V1,"The value of V1 in volts is : ")
41 disp(V2,"The value of V2 in volts is : ")
42 disp(V3,"The value of V3 in volts is : ")
43 disp(V4,"The value of V4 in volts is : ")
44 disp(V5,"The value of V5 in volts is : ")

```

Scilab code Exa 2.20 Labelled current and voltage

```

1 // Exa 2.20
2 format('v',4);
3 clc;
4 clear;
5 close;
6 // Given data
7 unCox= 20*10^-6; //in A/V^2
8 upCox= unCox/2.5; // in A/V^2
9 V_DD= 3; //in V
10 Vt= 1; // in V
11 W= 30; // in m
12 L= 10; // in m
13 // V_GS1= V_GS2
14 // Formula V_DD= V_GS1+V_GS2
15 V_GS1= V_DD/2; //in V
16 V_GS2= V_GS1; // in V
17 V2= V_GS1; // inV
18 I1= 1/2*unCox*W/L*(V_GS1-Vt)^2; // in A
19 // Both transistor have V_D = V_G and therefore they
    are operating in saturation

```

```

20 //1/2*unCox*W/L*(V4-Vt)^2 = 1/2*upCox*W/L*(V_DD-V4-
    Vt)
21 V4= (V_DD-Vt+sqrt(unCox/upCox))/(1+sqrt(unCox/upCox)
    );
22 I3= 1/2*unCox*W/L*(1.39-Vt)^2
23 disp(V2,"The value of V2 in volt is : ")
24 I1= I1*10^6; // in A
25 disp(I1,"The value of I1 in A is : ")
26 disp(V4,"The value of V4 in volt is : ")
27 I3= I3*10^6; // in A
28 disp(I3,"The value of I3 in A is : ")

```

Scilab code Exa 2.22 Voltage gain

```

1 // Exa 2.22
2 format('v',4);
3 clc;
4 clear;
5 close;
6 // Given data
7 Vt= 0.9; // in V
8 V_A= 50; // in V
9 V_D= 2; // in V
10 R_L= 10; // in M
11 R_L= R_L*10^3; // in
12 R_G= 10; // in M
13 R_G= R_G*10^6; // in
14 I_D= 500; // in A
15 I_D= I_D*10^-6; // in A
16 V_GS= V_D; // in V
17 ro= V_A/I_D; // in
18 gm= 2*I_D/(V_GS-Vt); // in A/V
19 // vo= -gm*vi*(ro || R_L)
20 vo_by_vi = -gm*(ro*R_L/(ro+R_L)); // in V/V
21 disp(vo_by_vi , "The voltage gain in V/V is : ")

```

```

22 // For I= 1 mA or twice the current
23 I_D1= I_D; // in A
24 I_D2= 2*I_D1; // in A
25 gm1= gm; // in A/V
26 // Effect on V_D
27 // I_D1/I_D2 = (V_GS1-Vt)^2/(V_GS2-Vt)^2
28 V_GS1= V_GS;
29 V_GS2= Vt+sqrt(2)*(V_GS1-Vt); // in V
30 disp(V_GS2,"The new value of V_GS in volts is : ")
31 // Effect on gm
32 // gm1/gm2= sqrt(I_D1/I_D2)
33 gm2= sqrt(I_D2/I_D1)*gm1; // in A/V
34 gm2= gm2*10^3; // in mA/V
35 disp(gm2,"The new value of gm2 in mA/V is : ")
36 // Effect on ro
37 // ro1/ro2= I_D2/I_D1
38 ro1= ro; // in
39 ro2= I_D1*ro1/I_D2; // in
40 ro2= ro2*10^-3; // in k
41 disp(ro2,"The new value of ro in k /V is : ")
42 ro2= ro2*10^3; // in
43 // Effect on gain
44 // Av= -gm*(ro2 || R_L)
45 Av= -gm*(ro2*R_L/(ro2+R_L)); // in V/V
46 disp(Av,"The new value of voltage gain in V/V is : ")
47
48 // Note: There is some difference between the new
49 // value of voltage gain in book and coding. The
50 // reason behind this is that ,
51 // the accurate value of new value of gm is
52 // 1.2856487 and in the book 1.3 has taken at place
53 // of 1.2856487.
54 // If we take this value of new value of gm 1.3 at
55 // place of 1.2856487 then our new voltage gain
56 // value will be same as in the book

```

Scilab code Exa 2.23 Value of CS

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

Scilab code Exa 2.24 Midband gain and upper 3dB frequency

```
1 // Exa 2.24
2 format('v',6);
3 clc;
4 clear;
5 close;
6 // Given data
```



```

7 Rsig= 100; // in k
8 Rsig= Rsig*10^3; // in
9 R_G= 4.7; // in M
10 R_G= R_G*10^6; // in
11 R_D= 15; // in k
12 R_D= R_D*10^3; // in
13 R_L= R_D; // in
14 gm= 1; //in mA/V
15 gm= gm*10^-3; //in A/V
16 ro=150; // in k
17 ro=ro*10^3; // in
18 Cgs= 1; // in pF
19 Cgs=Cgs*10^-12; //in F
20 Cgd= 0.4; // in pF
21 Cgd=Cgd*10^-12; //in F
22 vgsBYvsig= R_G/(Rsig+R_G);
23 Rdesh_L= R_D*R_L/(R_D+R_L); // in
24 voBYvgs= -gm*Rdesh_L;
25 Av= voBYvgs/vgsBYvsig; // in V/V
26 disp(Av,"The Mid-band gain in V/V is :")
27 CM= Cgd*(1+gm*Rdesh_L); // in F
28 // f_H= 1/(2*%pi*(Rsig || R_G)*(Cgs*CM))
29 f_H= 1/(2*%pi*(Rsig * R_G/(Rsig + R_G))*(Cgs+CM)); //
    in Hz
30 f_H= f_H*10^-3; // in kHz
31 disp(f_H,"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 format('v',5);
3 clc;
4 clear;
5 close;
6 // Given data
7 V_E= -0.7; // in V
8 Beta=50;
9 RC= 5; // in k
10 RE= 10; // in k
11 RE= RE*10^3; // in
12 RC= RC*10^3; // in
13 V_CC= 10; // in V
14 V_BE= -10; // in volt
15 I_E= (V_E-V_BE)/RE; // in A
16 disp(I_E*10^3,"Emitter current in mA is : ")
17 // I_E= I_B+I_C and I_C= Beta*I_B, so
18 I_B= I_E/(1+Beta); // in A
19 disp(I_B*10^6,"Base current in A is : ")
20 I_C= I_E-I_B; // in A
21 disp(I_C*10^3,"Collector current in mA is : ")
```

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

Scilab code Exa 3.3 Bias voltage

```

1 // Exa 3.3
2 format('v',6);
3 clc;
4 clear;
5 close;
6 // Given data
7 V_CC= 10; // in V
8 V_CE= 3.2; // in V
9 RC= 6.8; // in k
10 RC= RC*10^3; // in
11 I_S= 1*10^-15; // in A
12 V_T= 25*10^-3; // in V
13 I_C1= (V_CC-V_CE)/RC; // in A
14 // Formula I_C= I_S*%e^(V_BE1/V_T)
15 V_BE1= V_T*log(I_C1/I_S); // in volt
16 disp(I_C1*10^3,"Collector current in mA is : ")
17 disp(V_BE1,"Value of V_BE in volts is : ")
18
19 // Part (b)
20 v_in= 5*10^-3; // in V
21 Av= -(V_CC-V_CE)/V_T; // in V/V
22 disp(Av,"Voltage gain in V/V is : ")
23 v_o= abs(Av)*v_in; // in V
24 disp(v_o,"Change in output voltage in volts is : ")
25
26 // Part (c) for V_CE= 0.3 V
27 V_CE= 0.3; // in V
28 I_C2= (V_CC-V_CE)/RC; // in A
29 // I_C1= I_S*%e^(V_BE1/V_T) (i)
30 // I_C2= I_S*%e^(V_BE2/V_T) (ii)
31 // divide the equation (ii) by (i)
32 delta_V_BE= V_T*log(I_C2/I_C1); // in volt ( where
    delta_V_BE = V_BE2-V_BE1 )
33 disp(delta_V_BE*10^3,"The positive increment in
    V_BE in mV is : ")
34
35 // Part (d)
36 v_o= 0.99*V_CC; // in V

```

```

37 I_C3= (V_CC-v_o)/RC; // in A
38 delta_V_BE= V_T*log(I_C3/I_C1); // in V
39 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 V_CC= 10; // in V
8 V_CE= 5; // in V
9 V_BE= 0.7; // in V
10 I_C= 5*10^-3; // in mA
11 bita= 100;
12 R_C= (V_CC-V_CE)/I_C; // in
13 I_B= I_C/bita; // in A
14 R_B= (V_CC-V_BE)/I_B; // in
15 disp(R_C*10^-3, "The value of R_C in k is : ")
16 disp(I_B*10^6, "The value of I_B in A is : ")
17 disp(R_B*10^-3, "The value of R_B in k is : ")
18
19 // Note: The value of base current in the book is
    wrong

```

Scilab code Exa 3.5 Operating point

```

1 // Exa 3.5
2 format('v',7);
3 clc;

```

```

4 clear;
5 close;
6 // Given data
7 V_CC= 6; // in V
8 bita= 100;
9 R_C= 2; // in k
10 R_C= R_C*10^3; // in
11 R_B= 530; // in k
12 R_B= R_B*10^3; // in
13 // when I_C=0
14 I_C=0;
15 V_CE= V_CC-I_C*R_C; // in volt
16 V_CE= 0:0.1:6; // in Volt
17 I_C= (V_CC-V_CE)/R_C*1000; // in mA
18 plot(V_CE,I_C);
19 title("DC load line")
20 xlabel("V_CE in volts")
21 ylabel("I_C in mA")
22 disp("DC load line shown in figure")
23 // When V_CE= 0
24 I_C= V_CC/R_C; //in A
25 // Operating point for silicon transistor
26 V_BE= 0.7; // in V
27 I_B= (V_CC-V_BE)/R_B; //in A
28 I_CQ= bita*I_B; // in A
29 V_CEQ= V_CC-I_CQ*R_C; // in volt
30 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 format('v',7);
3 clc;
4 clear;

```

```

5 close;
6 // Given data
7 V_CC= 12; // in V
8 V_BE= 0.7; // in V
9 beta= 100;
10 R_C= 10; // in k
11 R_C= R_C*10^3; // in
12 R_B= 100; // in k
13 R_B= R_B*10^3; // in
14 I_BQ= (V_CC-V_BE)/((1+beta)*R_C+R_B); // in A
15 I_CQ= beta*I_BQ; // in A
16 V_CEQ= V_CC-(I_CQ+I_BQ)*R_C; // in volt
17 // For dc load line
18 // When
19 I_C=0;
20 V_CE= V_CC-(I_C+I_BQ)*R_C; // in volt
21 // When
22 V_CE= 0;
23 I_C= (V_CC-I_BQ*R_C)/R_C; // in A
24 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 format('v',6);
3 clc;
4 clear;
5 close;
6 // Given data
7 V_CC= 15; // in V
8 V_BE= 0.7; // in V
9 V_CE= 5; // in V
10 I_C= 5; // in mA
11 I_C=I_C*10^-3; // in A

```

```

12 bita= 100;
13 I_B= I_C/bita;// in A
14 disp(I_B*10^6,"Base current in A is : ")
15 //Apply KVL to collector circuit , V_CC= (I_C+I_B)*
    R_C+V_CE
16 R_C= (V_CC-V_CE)/(I_C+I_B);// in
17 disp(R_C*10^-3,"The value of R_C in k is : ")
18 //Apply KVL to base or input circuit , V_CC= (I_C+
    I_B)*R_C+V_CE + I_B*R_B
19 R_B= (V_CC-V_BE-(I_C+I_B)*R_C)/I_B;// in ohm
20 disp(R_B*10^-3,"The value of R_B in k is : ")

```

Scilab code Exa 3.8 Value of RB

```

1 // Exa 3.8
2 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 V_BE= 0.7;// in V
8 V_CE= 3;// in V
9 I_C= 1;// in mA
10 I_C=I_C*10^-3;// in A
11 bita= 100;
12 I_B= I_C/bita;// in A
13 // V_CE= V_BE+V_CB and V_CB= I_B*R_B
14 R_B= (V_CE-V_BE)/I_B;// in
15 disp(R_B*10^-3,"The value of R_B in k is : ")

```

Scilab code Exa 3.9 Operating point

```

1 // Exa 3.9

```



```

2  format('v',7);
3  clc;
4  clear;
5  close;
6  // Given data
7  R1= 10;// in k
8  R1=R1*10^3;// in
9  R2= 5;// in k
10 R2=R2*10^3;// in
11 RC= 1;// in k
12 RC=RC*10^3;// in
13 RE= 2;// in k
14 RE=RE*10^3;// in
15 V_CC= 15;// in V
16 V_BE= 0.7;// in V
17 // When
18 I_C=0;
19 V_CE= V_CC-I_C*(RC+RE);// in V
20 // When V_CE= 0
21 I_C= V_CC/(RC+RE);// in A
22 V_B= V_CC*R2/(R1+R2);// in V
23 I_E= (V_B-V_BE)/RE;// in A
24 I_C= I_E;// in A (approx)
25 I_CQ= I_C;// in A
26 V_CE= V_CC-I_C*(RC+RE);// in V
27 V_CEQ= V_CE;// in V
28 V_CE= 0:0.1:15;// in Volt
29 I_C= (V_CC-V_CE)/(RC+RE)*1000;// in mA
30 plot(V_CE,I_C);
31 title("DC load line")
32 xlabel("V_CE in volts")
33 ylabel("I_C in mA")
34 disp("DC load line shown in figure")
35 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 V_CC= 10; // in V
8 V_BB= 3; // in V
9 V_BE= 0.7; // in V
10 V_T= 25*10^-3; // in V
11 bita=100;
12 RC= 3; // in k
13 RC=RC*10^3; // in
14 RB= 100; // in k
15 RB=RB*10^3; // in
16 I_B= (V_BB-V_BE)/RB; // in V
17 I_C= bita*I_B; // in A
18 V_C= V_CC-I_C*RC; // in V
19 gm= I_C/V_T; // in A/V
20 r_pi= bita/gm; // in
21 // v_be= r_pi/(RB+r_pi)*v_i
22 v_be_by_v_i= r_pi/(RB+r_pi);
23 // v_o= -gm*v_be*RC
24 v_o_by_v_i= -gm*v_be_by_v_i*RC; // in V/V
25 Av= v_o_by_v_i; // in V/V
26 disp(round(Av),"Voltage gain in V/V is : ")
```

Scilab code Exa 3.11 All node voltages and currents

```
1 // Exa 3.11
```

```

2  format('v',5);
3  clc;
4  clear;
5  close;
6  // Given data
7  V_B= 4;// in V
8  V_BE= 0.7;// in V
9  V_CC= 10;// in V
10 V_E= V_B-V_BE;// in V
11 R_E= 3.3;// in k
12 R_E=R_E*10^3;// in
13 RC= 4.7;// in k
14 RC=RC*10^3;// in
15 I_E= V_E/R_E;// in A
16 bita=100;
17 alpha= bita/(1+bita);
18 I_C= alpha*I_E;//in A
19 disp(I_C*10^3,"The value of I_C in mA is : ")
20 V_C= V_CC-I_C*RC;// in V
21 disp(V_C,"The value of V_C in volts is : ")
22 I_B= I_E/(1+bita);// in A
23 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  format('v',7);
3  clc;
4  clear;
5  close;
6  // Given data
7  V_B= 5;// in V
8  V_BE= 0.7;// in V
9  V_CC= 10;// in V
10 bita=100;

```

```

11 R_B= 100; // in k
12 R_C= 2; // in k
13 R_B=R_B*10^3; // in
14 R_C=R_C*10^3; // in
15 I_B= (V_B-V_BE)/R_B; // in A
16 I_C= beta*I_B; // in A
17 V_C= V_CC-I_C*R_C; // in V
18 I_E= I_C; // in A (approx)
19 disp(I_B*10^3,"The value of I_B in mA is : ")
20 disp(I_C*10^3,"The value of I_C in mA is : ")
21 disp(V_C,"The value of V_C in volts is : ")
22 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 format('v',5);
3 clc;
4 clear;
5 close;
6 // Given data
7 V_B= 0; // in V
8 V_EB= 0.7; // in V
9 beta=100;
10 V_EC= 0.2; // in V
11 V_E= V_EB+V_B; // in V
12 V_CC= 5; // in V
13 R_C= 1; // in k
14 R_C=R_C*10^3; // in
15 R_B= 10; // in k
16 R_B= R_B*10^3; // in
17 // V_E= V_B+V_EB (i)
18 // V_C= V_E-V_EC= V_B+V_EB-V_EC (ii)
19 // I_E= (V_CC-V_E)/R_C= (V_CC-V_B-V_EB)/R_C (iii)
)

```

```

20 // I_B= V_B/R_B (iv)
21 // I_C= (V_C+V_CC)/R_C= (V_B+V_EB-V_EC+V_CC)/R_B
    (v)
22 // By using relationship , I_E= I_B+I_C
23 V_B= (9*V_CC-11*V_EB+V_EC)/12; // in V
24 V_E= V_B+V_EB; // in V
25 V_C= V_B+V_EB-V_EC; // in V
26 I_E= (V_CC-V_B-V_EB)/R_C // in amp
27 I_C= (V_B+V_EB-V_EC+V_CC)/R_B; // in amp
28 I_B= V_B/R_B; // in amp
29 disp(V_B,"The value of V_B in volts is : ")
30 disp(V_E,"The value of V_E in volts is : ")
31 disp(V_C,"The value of V_C in volts is : ")
32 disp(I_E*10^3,"The value of I_E in mA is : ")
33 disp(I_C*10^3,"The value of I_C in mA is : ")
34 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 format('v',5);
3 clc;
4 clear;
5 close;
6 // Given data
7 bita=100;
8 hFE= 100;
9 VCEsat= 0.2; // in V
10 VBEsat= 0.8; // in V
11 VBEactive= 0.7; // in V
12 VBB= 5; // in V
13 VCC= 10; // in V
14 R_C= 3; // in k
15 R_C=R_C*10^3; // in
16 R_B= 50; // in k

```

```

17 R_B=R_B*10^3;// in
18 // Formula VCC= ICsat*R_C+VCEsat
19 ICsat= (VCC-VCEsat)/R_C;//A
20 disp(ICsat*10^3,"The value of IC(sat) in mA is : ")
21 IBmin= ICsat/bita;// in A
22 // Apply KVL to input circuit , VBB= IB*R_B+VBEsat
23 IB= (VBB-VBEsat)/R_B;// in A
24 disp(IB*10^6,"Actual base current in A is : ")

```

Scilab code Exa 3.16 Value of Bita

```

1 // Exa 3.16
2 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 // bita= alpha/(1-alpha)
8 // At alpha= 0.5
9 alpha= 0.5;
10 bita= alpha/(1-alpha);
11 disp(bita,"At alpha=0.5, the value of bita is : ")
12 // At alpha= 0.9
13 alpha= 0.9;
14 bita = alpha/(1-alpha);
15 disp(bita,"At alpha=0.9, the value of bita is : ")
16 // At alpha= 0.5
17 alpha= 0.999;
18 bita= alpha/(1-alpha);
19 disp(bita,"At alpha=0.999, the value of bita is : ")

```

Scilab code Exa 3.17 Value of Bita

```

1 // Exa 3.17
2 format('v',6);
3 clc;
4 clear;
5 close;
6 // Given data
7 // alpha= bita/(1-bit a)
8 // At bita= 1
9 bita=1;
10 alpha= bita/(1+bita);
11 disp(alpha,"At bita=1, the value of alpha is : ")
12 // At bita= 2
13 bita=2;
14 alpha= bita/(1+bita);
15 disp(alpha,"At bita=2, the value of alpha is : ")
16 // At bita= 100
17 bita=100;
18 alpha= bita/(1+bita);
19 disp(alpha,"At bita=100, the value of alpha is : ")
20 // At bita= 200
21 bita=200;
22 alpha= bita/(1+bita);
23 disp(alpha,"At bita=200, the value of alpha is : ")

```

Scilab code Exa 3.18 Value of I_s , I_c and V_{BE}

```

1 // Exa 3.18
2 format('v',9);
3 clc;
4 clear;
5 close;
6 // Given data
7 VBE= 0.76; // in V
8 VT= 0.025; // in V
9 I_C= 10*10^-3; // in A

```

```

10 // Formula  $I_C = I_S * e^{(V_{BE}/V_T)}$ 
11  $I_S = I_C / (e^{(V_{BE}/V_T)})$ ; // in A
12 disp(I_S, "The value of I_S in amp is : ")
13 // Part(a) for  $V_{BE} = 0.7$  V
14  $V_{BE} = 0.7$ ; // in V
15  $I_C = I_S * e^{(V_{BE}/V_T)}$ 
16 disp(I_C*103, "For  $V_{BE} = 0.7$  V , The value of I_C in
    mA is : ")
17
18 // Part (b) for  $I_C = 10$  A
19  $I_C = 10 * 10^{-6}$ ; // in A
20 // Formula  $I_C = I_S * e^{(V_{BE}/V_T)}$ 
21  $V_{BE} = V_T * \log(I_C / I_S)$ ;
22 disp(V_BE, "For  $I_C = 10$  A , The value of V_BE in V is
    : ")

```

Scilab code Exa 3.19 Transistor model

```

1 // Exa 3.19
2 format('v',9);
3 clc;
4 clear;
5 close;
6 // Given data
7  $V_{BE} = 0.7$ ; // in V
8  $V_T = 0.025$ ; // in V
9  $I_B = 100$ ; // in A
10  $I_B = I_B * 10^{-6}$ ; // in A
11  $I_C = 10 * 10^{-3}$ ; // in A
12 // Formula  $I_C = I_S * e^{(V_{BE}/V_T)}$ 
13  $I_S = I_C / (e^{(V_{BE}/V_T)})$ ; // in A
14  $\alpha = I_C / (I_C + I_B)$ ;
15  $\beta = I_C / I_B$ ;
16  $I_{S\_by\_alpha} = I_S / \alpha$ ; // in A
17  $I_{S\_by\_beta} = I_S / \beta$ ; // in A

```



```

18 disp(alpha,"The value of alpha is : ");
19 disp(bita,"The value of bita is : ");
20 disp(IS_by_alpha,"The value of Is/alpha in A is :");
21 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 VBE= 0.7; // in V
8 VCC= 10.7; // in V
9 R_C= 10; //in k
10 R_C=R_C*10^3; // in
11 R_B= 10; //in k
12 R_B=R_B*10^3; // in
13 I1= (VCC-VBE)/R_C; // in A
14 disp(I1*10^3,"The value of I1 in mA is : ")
15 // Part (b)
16 VC= -4; //in V
17 VB= -10; // in V
18 R_C= 5.6; //in k
19 R_C=R_C*10^3; // in
20 R_B= 2.4; //in k
21 R_B=R_B*10^3; // in
22 VCC=12; // V
23 I_C= (VC-VB)/R_B; // in A
24 V2= VCC- (R_C*I_C);
25 disp(V2,"The value of V2 in volt is : ");
26 // Part (c)
27 VCC= 0;
28 VCE= -10; // in V

```

```

29 R_C= 10; //in k
30 R_C=R_C*10^3; // in
31 I_C= (VCC-VCE)/R_C; // in A
32 V4= 1; // in V
33 I3= I_C; // in A (approx)
34 disp(V4,"The value of V4 in volt is : ");
35 disp(I3*10^3,"The value of I3 in mA is : ")
36 // Part (d)
37 VBE= -10; // in V
38 VCC= 10; // in V
39 R_B= 5; //in k
40 R_B=R_B*10^3; // in
41 R_C= 15; //in k
42 R_C=R_C*10^3; // in
43 // I5= I_C and
44 // I5= (V6-0.7-VBE)/R_B and I_C= (VCC-V6)/R_C
45 V6= (VCC*R_B+R_C*(0.7+VBE))/(R_C+R_B);
46 disp(V6,"The value of V6 in volt is : ")
47 I5= (V6-0.7-VBE)/R_B; // in A
48 disp(I5*10^3,"The value of I5 in mA is : ")

```

Scilab code Exa 3.21 Value of bita and labelled voltage

```

1 // Exa 3.21
2 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 // Part (a)
8 V_C= 2; // in V
9 R_C= 1; // in k
10 R_C=R_C*10^3; // in
11 V_B= 4.3; // in V
12 R_B= 200; // in k

```

```

13 R_B=R_B*10^3; // in
14 I_C= V_C/R_C; // in A
15 I_B= V_B/R_B; // in A
16 Beta= I_C/I_B;
17 disp("Part (a)")
18 disp(I_C*10^3,"Collector current in mA is : ")
19 disp(I_B*10^6,"Base current in A is : ")
20 disp(Beta,"The value of Beta is : ")
21
22 // Part (b)
23 V_C= 2.3; // in V
24 R_C= 230; // in k
25 R_C=R_C*10^3; // in
26 V_B= 4.3; // in V
27 R_B= 20; // in k
28 R_B=R_B*10^3; // in
29 I= V_C/R_C; // current through 230 resistro i.e.
    I_C + I_B in A
30 I_B= (V_B-V_C)/R_B; // in A
31 I_C= I-I_B; // in A
32 Beta= abs(I_C/I_B);
33 disp("Part (b)")
34 disp(I_C*10^3,"Collector current in mA is : ")
35 disp(I_B*10^3,"Base current in mA is : ")
36 disp(Beta,"The value of Beta is : ")
37
38 // Part (c)
39 V_E= 10; // in V
40 R_E= 1; // in k
41 R_E=R_E*10^3; // in
42 V_1= 7; // in V
43 R_C= 1; // in k
44 R_C=R_C*10^3; // in
45 V_B= 6.3; // in V
46 R_B= 100; // in k
47 R_B=R_B*10^3; // in
48 I_E= (V_E-V_1)/R_C; //in A
49 I_C=I_E; // in A (approx)

```

```

50 V_C= I_C*R_C; // in V
51 I_B= (V_B-V_C)/R_B; // in A
52 Beta= I_E/I_B-1;
53 disp("Part (c)")
54 disp(I_E*10^3,"Emitter current in mA is : ")
55 disp(I_B*10^6,"Base current in A is : ")
56 disp(V_C,"Collector voltage in volts is : ")
57 disp(Beta,"The value of Beta is : ")
58
59 // Note : In the book the value of base current in
        the first part is wrong due to calculation error.
60 //           In the part (b) the values of collector
        current and Beta 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 format('v',6);
3 clc;
4 clear;
5 close;
6 // Given data
7 // Part (a)
8 bita= 30;
9 R_C= 2.2; // in k
10 R_C=R_C*10^3; // in
11 R_B= 2.2; // in k
12 R_B=R_B*10^3; // in
13 VCC= 3; // in V
14 VCE= -3; // in V
15 VBE= 0.7; // in V
16 V_B= 0; // in V
17 V_E= V_B-VBE; // in V
18 I_E= (V_E-VCE)/R_B; // in A

```

```

19 I_C= I_E; // in A
20 V_C= VCC-I_E*R_C; // in V
21 I_B= I_C/beta; // in A
22 disp("Part (a)")
23 disp(V_B,"The value of V_B in V is : ")
24 disp(V_E,"The value of V_E in V is : ")
25 disp(I_E*10^3,"The value of I_E in mA is : ")
26 disp(V_C,"The value of V_C in V is : ")
27 disp(I_B*10^3,"The value of I_B in mA is : ")
28 // Part (b)
29 R_C= 560; // in
30 R_B= 1.1; // in k
31 R_B=R_B*10^3; // in
32 VCC= 9; // in V
33 VCE= 3; // in V
34 V_B= 3; // in V
35 V_E= V_B+VBE; // in V
36 I_E= (VCC-V_E)/R_B; // in A
37 alpha= beta/(1+beta);
38 I_C= I_E*alpha; // in A
39 V_C= I_C*R_C; // in V
40 I_B= I_C/beta; // in A
41 disp("Part (b)")
42 disp(V_B,"The value of V_B in V is : ")
43 disp(V_E,"The value of V_E in V is : ")
44 disp(I_C*10^3,"The value of I_E in mA is : ")
45 disp(V_C,"The value of V_C in V is : ")
46 disp(I_B*10^3,"The value of I_B in mA is : ")

```

Scilab code Exa 3.23 Value of V_E V_C and α β

```

1 // Exa 3.23
2 format('v',5);
3 clc;
4 clear;

```

```

5 close;
6 // Given data
7 VBE= 0.7; // in V
8 VCC= 9; // in V
9 VCE= -9; // in V
10 V_B= -1.5; // in V
11 R_C= 10; // in k
12 R_C=R_C*10^3; // in
13 R_B= 10; // in k
14 R_B=R_B*10^3; // in
15 I_B= abs(V_B)/R_B; // in A
16 V_E= V_B-VBE; // in V
17 disp(V_E,"The value of V_E in volt is : ")
18 I_E= (V_E-VCE)/R_B; // in A
19 Beta= I_E/I_B-1;
20 alpha= Beta/(1+Beta);
21 disp(alpha,"The value of alpha in volt is : ")
22 disp(Beta,"The value of Beta in volt is : ")
23 V_C= VCC-I_E*alpha*R_C; // in V
24 disp(V_C,"The value of V_C in volt is : ")
25 // When Beta = infinite then
26 alpha= 1 ; // As infinite/(1+infinite) = 1
27 I_B= 0;
28 V_B=0;
29 V_C= VCC-I_E*R_C; // in volt
30 disp("When Beta = infinite then :-")
31 disp(V_B,"The value of V_B in volt is : ")
32 disp(V_E,"The value of V_E in volt is : ")
33 disp(V_C,"The value of V_C in volt is : ")

```

Scilab code Exa 3.24 Current flow

```

1 // Exa 3.24
2 format('v',5);
3 clc;

```

```

4 clear;
5 close;
6 // Given data
7 VBE_1= 0.7; // in V
8 VBE_2= 0.5; // in V
9 V_T= 0.025; // in V
10 I_C1= 10; // in mA
11 I_C1= I_C1*10^-3; // in A
12 // I_C1= I_S*%e^(VBE_1/V_T) (i)
13 // I_C2= I_S*%e^(VBE_2/V_T) (ii)
14 // Devide equation (ii) by (i)
15 I_C2= I_C1*%e^((VBE_2-VBE_1)/V_T); // in A
16 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 R1= 10; // in k
8 R1=R1*10^3; // in
9 R2= 10; // in k
10 R2=R2*10^3; // in
11 I_C=.5; // mA
12 V_T= 0.025; //in V
13 I_C= I_C*10^-3; // in A
14 V= 10; // in V
15 Vth= V*R1/(R1+R2); // in V
16 Rth= R1*R2/(R1+R2); //in
17 vo= I_C*Rth; // in V
18 vi=V_T; // in V
19 vo_by_vi= vo/vi; //in V/V

```

```
20 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 V_B= 2;// in V
8 V_CC=5;// in V
9 V_BE= 0.7;// in V
10 R_E= 1*10^3;// in
11 R_C= 1*10^3;// in
12 V_E= V_B-V_BE;// in V
13 I_E= V_E/R_E;// in A
14 I_C= I_E;// in A
15 V_C= V_CC-I_C*R_C;//in V
16 disp("At V_B= +2 V")
17 disp(V_E,"The value of V_E in volts is : ")
18 disp(V_C,"The value of V_C in volts is : ")
19
20 // Part (b)
21 V_B= 0;//in V
22 V_E= 0;// in V
23 I_E= 0;// in A
24 V_C= 5;// in V
25 disp("At V_B= 0 V")
26 disp(V_E,"The value of V_E in volts is : ")
27 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 V_B= 0; // in V
8 R_E=1*10^3; //in
9 R_C=1*10^3; //in
10 V_CC=5; // in V
11 V_BE= 0.7; // in V
12 V_E= V_B-V_BE; // in V
13 I_E= (1+V_E)/R_E; // in A
14 I_C= I_E; // (approx) in A
15 V_C= V_CC-I_C*R_C; //in V
16 disp("Part (i)")
17 disp(V_E,"The value of V_E in volt is : ");
18 disp(V_C,"The value of V_C in volt is : ");
19 // For saturation
20 V_CE=0.2 ; // V
21 V_CB= -0.5; // in V
22 // I_C= 5-V_C/R_C and V_C= V_E-VCE, So
23 // I_C= (5.2-V_E)/R_C
24 // I_E= (V_E+1)/R_E and at the edge of saturation
    I_C=I_E ,
25 V_E= 4.2/2; /// in V
26 V_B= V_E+0.7; // in V
27 V_C= V_E+0.2; // in V
28 disp("Part (ii) ")
29 disp(V_E,"The value of V_E in volts is : ");
30 disp(V_B,"The value of V_B in volts is : ");
31 disp(V_C,"The value of V_C in volts is : ");
32
33 // 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 V_CC=5; // in V
8 V_E= 1; // in V
9 V_BE= 0.7; // in V
10 R_E=5*10^3; //in
11 R_C=5*10^3; //in
12 R_B= 20*10^3; // in
13 I_E= (V_CC-V_E)/R_E; // in A
14 // For pnp transistor V_BE= V_E-V_B
15 V_B= V_E-V_BE; // in V
16 I_B= V_B/R_B; // in A
17 I_C= I_E-I_B; // in A
18 V_C= I_C*R_C-V_CC; // in V
19 bita= I_C/I_B;
20 alpha= I_C/I_E;
21 disp(V_B,"The value of V_B in volts is : ");
22 disp(I_B*10^3,"The value of I_B in mA is : ");
23 disp(I_E*10^3,"The value of I_E in mA is : ");
24 disp(I_C*10^3,"The value of I_C in mA is : ");
25 disp(V_C,"The value of V_C in volts is : ");
26 disp(bita,"The value of bita is : ");
27 disp(alpha,"The value of alpha is : ");
```

Scilab code Exa 3.30 DC voltage and value of gm

```

1 // Exa 3.30
2 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 V_CC=5; // in V
8 V_T= 0.025; // in V
9 R_C=7.5*10^3; //in
10 I_C= 0.5; // in mA
11 I_C= I_C*10^-3; // in A
12 I_E=I_C; // (approx) in A
13 V_C= V_CC-I_C*R_C; // in V
14 disp(V_C,"dc voltage at the collector in volt is : ")
15 )
16 gm= I_C/V_T; // in A/V
17 disp(gm*10^3,"The value of gm in mA/V is : ")
18 // v_be= -v_i
19 // v_c= -gm*v_be*R_C
20 vcbyvi= gm*R_C; // in V/V
21 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 V_T= 0.025; // in V
8 I_E= 0.5; // in mA
9 I_E= I_E*10^-3; // in mA
10 R_sig= 50; // in
11 R_C= 5*10^3; // in

```

```

12 re= V_T/I_E;// in ohm
13 Rin= Rsig+re;// in ohm
14 disp(Rin,"Input resistance in      is : ")
15 // Part(b)
16 // vo= -0.99*ie*R_C and ie= -v_sig/Rin
17 vo_by_v_sig= 0.99*R_C/Rin;// in V/V
18 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 format('v',4);
3 clc;
4 clear;
5 close;
6 // Given data
7 bita= 200;
8 alpha= bita/(1+bita);
9 R_C= 100;// in
10 R_B= 10;// in k
11 Rsig= 1;// in k
12 Rsig= Rsig*10^3;// in
13 R_B= R_B*10^3;// in
14 V_T= 25*10^-3;
15 V=1.5;// in V
16 I_E= 10;// in mA
17 I_E= I_E*10^-3;// in A
18 I_C= alpha*I_E;// in A
19 V_C= I_C*R_C;// in V
20 I_B= I_C/bita;// in A
21 V_B= V-(R_B*I_B)
22 gm= I_C/V_T;// in A/V
23 rpi= bita/gm;// in
24 Rib= rpi;// in

```

```

25 disp(Rib,"The value of Rib in      is : ")
26 Rin= R_B*rpi/(R_B+rpi); // in
27 disp(Rin,"The value of Rin in      is : ")
28 // vbe= v_sig*Rin/(Rsig+Rin);
29 vbe_by_vsig= Rin/(Rsig+Rin);
30 // vo= -gm*vbe*R_C and = -gm*v_sig*Rin/(Rsig+Rin)
31 vo_by_vsig= -gm*R_C*vbe_by_vsig; // in V/V
32 disp(vo_by_vsig,"Overall voltage gain in V/V is : ")
33 // if
34 vo= 0.4; //( ) in V
35 vs= vo/abs(vo_by_vsig); // in V
36 vbe= vbe_by_vsig*vs; // in V
37 disp(vs*10^3,"The value of v_sig in mV is : ")
38 disp(vbe*10^3,"The value of v_be in mV is : ")
39
40 // 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 V_T= 0.025; // in V
8 // Part(a)
9 disp("Part (a)")
10 V_BE= 690; // in mV
11 V_BE=V_BE*10^-3; // in V
12 I_C= 1; // in mA
13 I_B= 50; // in A
14 I_C=I_C*10^-3; // in A
15 I_B=I_B*10^-6; // in A

```

```

16 bita= I_C/I_B;
17 alpha= bita/(1+bita);
18 I_E= I_C/alpha; // in A
19 // I_C= I_S*%e^(V_BE/V_T)
20 I_S= I_C/(%e^(V_BE/V_T));
21 disp(bita,"The value of bita is : ")
22 disp(alpha,"The value of alpha is : ")
23 disp(I_E*10^3,"The value of I_E in mA is : ")
24 disp(I_S,"The value of I_S in amp is : ")
25
26 // Part(b)
27 disp("Part (b)")
28 V_BE= 690; // in mV
29 V_BE=V_BE*10^-3; // in V
30 I_C= 1; // in mA
31 I_C=I_C*10^-3; // in A
32 I_E= 1.070; // in mA
33 I_E=I_E*10^-3; // in A
34 bita= I_C/I_B;
35 alpha= I_C/I_E;
36 bita= alpha/(1-alpha);
37 I_B= I_C/bita; // in A
38 // I_C= I_S*%e^(V_BE/V_T)
39 I_S= I_C/(%e^(V_BE/V_T));
40 disp(bita,"The value of bita is : ")
41 disp(alpha,"The value of alpha is : ")
42 disp(I_B*10^6,"The value of I_B in A is : ")
43 disp(I_S,"The value of I_S in amp is : ")
44
45 // Part(c)
46 disp("Part (C)")
47 V_BE= 580; // in mV
48 V_BE=V_BE*10^-3; // in V
49 I_E= 0.137; // in mA
50 I_B= 7; // in A
51 I_E=I_E*10^-3; // in A
52 I_B=I_B*10^-6; // in A
53 // I_C= alpha*I_E = bita*I_B

```

```

54 bita= I_E/I_B-1;
55 alpha= bita/(1+bita);
56 I_C= bita*I_B; // in A
57 // I_C= I_S*%e^(V_BE/V_T)
58 I_S= I_C/(%e^(V_BE/V_T));
59 disp(bita,"The value of bita is : ")
60 disp(alpha,"The value of alpha is : ")
61 disp(I_C*10^3,"The value of I_C in mA is : ")
62 disp(I_S,"The value of I_S in amp is : ")
63
64 // Part(d)
65 disp("Part (d)")
66 V_BE= 780; // in mV
67 V_BE=V_BE*10^-3; // in V
68 I_C= 10.10; // in mA
69 I_B= 120; // in A
70 I_C=I_C*10^-3; // in A
71 I_B=I_B*10^-6; // in A
72 bita= I_C/I_B;
73 alpha= bita/(1+bita);
74 I_E= I_C/alpha; // in A
75 // I_C= I_S*%e^(V_BE/V_T)
76 I_S= I_C/(%e^(V_BE/V_T));
77 disp(bita,"The value of bita is : ")
78 disp(alpha,"The value of alpha is : ")
79 disp(I_E*10^3,"The value of I_E in mA is : ")
80 disp(I_S,"The value of I_S in amp is : ")
81
82 // Part(e)
83 disp("Part (e)")
84 V_BE= 820; // in mV
85 V_BE=V_BE*10^-3; // in V
86 I_E= 75; // in mA
87 I_B= 1050; // in A
88 I_E=I_E*10^-3; // in A
89 I_B=I_B*10^-6; // in A
90 // I_C= alpha*I_E = bita*I_B
91 bita= I_E/I_B-1;

```

```
92 alpha= bita/(1+bita);
93 I_C= bita*I_B;// in A
94 // I_C= I_S*%e^(V_BE/V_T)
95 I_S= I_C/(%e^(V_BE/V_T));
96 disp(bita,"The value of bita is : ")
97 disp(alpha,"The value of alpha is : ")
98 disp(I_C*10^3,"The value of I_C in mA is : ")
99 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_{C1}

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

```

22 V_CE1= V_C1-V_E;// in volt
23 disp(V_CE1,"For V_cm =0 , The alue of V_CE1 in volt
    is ")
24
25 // For V_cm= -5 volt
26 V_cm= -5;// in V
27 V_B= V_cm;// in V
28 // From V_BE= V_B-V_E
29 V_E= V_B-V_BE;// in volt
30 V_CE1= V_C1-V_E;// in volt
31 disp(V_CE1,"For V_cm =-5V , The alue of V_CE1 in
    volt is ")
32
33 // For V_cm= 5 volt
34 V_cm= 5;// in V
35 V_B= V_cm;// in V
36 V_E= V_B-V_BE;// in volt
37 V_CE1= V_C1-V_E;// in volt
38 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 format('v',5);
3 clc;
4 clear;
5 close;
6 // Given data
7 V_DD= 1.5;// in V
8 V_SS= V_DD;// in V
9 KnWL= 4;// in mA/V^2
10 KnWL=KnWL*10^-3;// in A/V^2
11 Vt= 0.5;// in V
12 I=0.4;// in mA

```

```

13 I=I*10^-3; // in A
14 R_D= 2.5; // in k
15 R_D= R_D*10^3; // in
16
17 // Part (a)
18 disp("Part (a)")
19 V_OV= sqrt(I/KnWL); // in V
20 V_GS= V_OV+Vt; // in V
21 disp(V_OV,"Value of V_OV in volt is : ")
22 disp(V_GS,"Value of V_GS in volt is : ")
23
24 // Part (b)
25 disp("Part (b)")
26 V_CM= 0; // in volt
27 V_S= -V_GS; // in volt
28 disp(V_S,"Value of V_S in volt is : ")
29 I=0.4; // in mA
30 i_D1= I/2; // in mA
31 disp(i_D1,"Value of i_D1 in mA is : ")
32 i_D1=i_D1*10^-3; // in A
33 V_D1= V_DD-i_D1*R_D; // in V
34 V_D2=V_D1; // in V
35 disp(V_D1,"Value of V_D1 in volt is ")
36 disp(V_D2,"Value of V_D2 in volt is ")
37
38
39 // Part (c)
40 disp("Part (c)")
41 V_CM=1; // in V
42 V_GS= 0.82; // in V
43 V_G= 1; // in V
44 V_S= V_G-V_GS; // in V
45 disp(V_S,"Value of V_S in volt is : ")
46 i_D1= I/2; // in mA
47 disp(i_D1,"Value of i_D1 in mA is : ")
48 i_D1=i_D1*10^-3; // in A
49 V_D1= V_DD-i_D1*R_D; // in V
50 V_D2=V_D1; // in V

```

```

51 disp(V_D1," Value of V_D1 in volt is ")
52 disp(V_D2," Value of V_D2 in volt is ")
53
54 // Part (d)
55 disp(" Part (d)")
56 V_CM_max= Vt+V_DD-i_D1*R_D
57 disp(V_CM_max," Highest value of V_CM in volt is :")
58
59 // Part (e)
60 V_S= 0.4; // in V
61 disp(" Part (e)")
62 V_CM_min= -V_SS+V_S+Vt+V_OV; // in V
63 disp(V_CM_min," Lowest value of V_CM in volt is")
64 V_Smin= V_CM_min-V_GS; // in volt
65 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 format('v',7);
3 clc;
4 clear;
5 close;
6 format('v',5)
7 // Given data
8 I= 0.4; // in mA
9 unCox= 0.2; // in mA/V^2
10 i_D= I/2; // in mA
11 V_OV1= 0.2; // in V
12 V_OV2= 0.3; // in V
13 V_OV3= 0.4; // in V
14 WbyL1= 2*i_D/(unCox*V_OV1^2);
15 gm1= I/V_OV1; // in mA/V
16 WbyL2= 2*i_D/(unCox*V_OV2^2);
17 gm2= I/V_OV2; // in mA/V

```

```

18 WbyL3= 2*i_D/(unCox*V_OV3^2);
19 gm3= I/V_OV3; // in mA/V
20 disp("Vov (in V) " + string(V_OV1) + "
      " + string(V_OV2) + " " + string(
      V_OV3))
21 disp("W/L " + string(WbyL1) + "
      " + string(WbyL2) + " " + string(
      WbyL3))
22 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 format('v',11)
8 V_A= 20; // in V
9 R_D= 5; // in k
10 R_D= R_D*10^3; // in
11 I= 0.8; // in mA
12 I=I*10^-3; // in A
13 i_D= I/2; // in A
14 unCox= 0.2; // mA/V^2
15 unCox= unCox*10^-3; // in A/V^2
16 WbyL= 100;
17 // Formula i_D= 1/2*unCox*WbyL*V_OV^2
18 V_OV= sqrt(2*i_D/(unCox*WbyL)); // in V
19 disp(V_OV,"The value of V_OV in volts is : ")
20 gm= I/V_OV; // in A/V;
21 disp(gm*10^3,"The value of gm in mA/V is : ")
22 r_o= V_A/i_D; // in

```

```

23 disp(r_o*10^-3,"The value of r_o in k is : ")
24 // Ad= v_o/v_id = gm*(R_D || r_o)
25 Ad= gm*(R_D*r_o/(R_D+r_o)) ;// in V/V
26 disp(Ad,"Differential gain in V/V is : ")

```

Scilab code Exa 4.5 Differential gain

```

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

```

```

        : ")
29
30
31 // Part (b)
32 disp("Part (b) when output is taken differentially")
33 Ad= gm*R_D;// in V/V
34 disp(Ad," Differential gain in V/V is : ")
35 Acn= 0;
36 disp(Acn,"Common mode gain in V/V is ")
37 // CMRRindB= 20*log10(Ad/Acn) = infinite ;// in dB
38 disp("Common mode rejection ratio in dB is : ")
39 disp("infinite");
40
41 // Part (c)
42 disp("Part (c) when output is taken differentially
        but the drain resistance have a 1% mismatch.")
43 Ad= gm*R_D;// in V/V
44 disp(Ad," Differential gain in V/V is : ")
45 // delta_R_D= 1% of R_D
46 delta_R_D= R_D*1/100;// in
47 Acn= R_D/(2*R_SS)*delta_R_D/R_D;// in V/V
48 disp(Acn,"Common mode gain in V/V is ")
49 CMRRindB= 20*log10(abs(Ad)/abs(Acn));// in dB
50 disp(CMRRindB,"Common mode rejection ratio in dB is
        : ")
51
52 // 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 format('v',7);

```

```

3  clc;
4  clear;
5  close;
6  // Given data (From Exa 4.4)
7  R_D= 5; // in k
8  R_D= R_D*10^3; // in
9  R_SS= 25; // in k
10 R_SS= R_SS*10^3; // in
11 I= 0.8; // in mA
12 I=I*10^-3; // in A
13 i_D= I/2; // in A
14 unCox= 0.2; // mA/V^2
15 unCox= unCox*10^-3; // in A/V^2
16 WbyL= 100;
17 // Formula i_D= 1/2*unCox*WbyL*V_OV^2
18 V_OV= sqrt(2*i_D/(unCox*WbyL)); // in V
19 gm= i_D/V_OV; // in A/V;
20 // gm mismatch have a negligible effect on Ad
21 Ad= gm*R_D; // in V/V(approx)
22 // delta_gm= 1% of gm
23 delta_gm = gm*1/100; // in A/V
24 Acm= R_D/(2*R_SS)*delta_gm/gm;
25 CMRRindB= 20*log10(Ad/Acm);
26 disp(CMRRindB,"CMRR in dB is : ")

```

Scilab code Exa 4.7 Value of VE VC1 and VC2

```

1  // Exa 4.7
2  format('v',7);
3  clc;
4  clear;
5  close;
6  // Given data
7  V_CM= 0;
8  V_BE= -0.7; // in volt

```



```

9 v_E= V_CM-V_BE;// in volt
10 disp(v_E," Value of v_E in volts is : ")
11
12 I_E= (5-0.7)/10^3;// in A
13 v_B1= 0.5;// in V
14 v_B2= 0;// in V
15 // Due to Q1 is off; therefore
16 v_C1= -5;// in V
17 v_C2= I_E*10^3-5;// in V
18 disp(v_C1," Value of v_C1 in volts is : ")
19 disp(v_C2," Value of v_C2 in volts is : ")

```

Scilab code Exa 4.8 Input differential signal

```

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

```

Scilab code Exa 4.9 Input differential resistance

```

1 // Exa 4.9
2 format('v',4);
3 clc;

```

```

4 clear;
5 close;
6 // Given data
7 Beta= 100;
8
9 // Part (a)
10 RE= 150; // in
11 VT= 25; // in mV
12 VT= VT*10^-3; // in V
13 IE= 0.5; // in mA
14 IE=IE*10^-3; // in A
15 re1= VT/IE; //in
16 R_id= 2*(Beta+1)*(re1+RE); // in
17 R_id= round(R_id*10^-3); // in k
18 disp(R_id,"The input differential resistance in k
    is :")
19
20 // Part (b)
21 RC=10; //in k
22 RC=RC*10^3; //in
23 Rsig= 5+5; // in k
24 VoltageGain1= R_id/(Rsig+R_id); //voltage gain from
    the signal source to the base of Q1 and Q2 in V/V
25 VoltageGain2= 2*RC/(2*(re1+RE)); // voltage gain from
    the bases to the output in V/V
26 Ad= VoltageGain1*VoltageGain2; //in V/V
27 disp(Ad,"The overall differential voltage gain in V/
    V is ");
28
29 // Part (c)
30 format('e',9)
31 delta_RC= 0.02*RC;
32 R_EE= 200; //in k
33 R_EE=R_EE*10^3; //in
34 Acm= RC/(2*R_EE)*delta_RC/RC; //in V/V
35 disp(Acm,"Common mode gain in V/V is :")
36
37 // Part (d)

```

```

38 format('v',4);
39 CMRRindB= 20*log10(Ad/Acm); // in dB
40 disp(CMRRindB,"CMRR in dB is : ")
41
42 // Part (e)
43 V_A= 100; // in V
44 r_o= V_A/(IE); // in
45 // Ricm= (Beta+1)*(R_EE || r_o/2)
46 Ricm= (Beta+1)*(R_EE*(r_o/2)/(R_EE+(r_o/2)));
47 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 format('v',4);
3 clc;
4 clear;
5 close;
6 // Given data
7 delta_RDbyRD= 2/100;
8 delta_WLbyWL= 2/100;
9 delta_Vt= 2; //in mV
10 delta_Vt= delta_Vt*10^-3; // in V
11 // (From Exa 4.4)
12 V_A= 20; // in V
13 R_D= 5; // in k
14 R_D= R_D*10^3; // in
15 I= 0.8; // in mA
16 I=I*10^-3; // in A
17 i_D= I/2; // in A
18 unCox= 0.2; // mA/V^2
19 unCox= unCox*10^-3; // in A/V^2
20 WbyL= 100;
21 // Formula i_D= 1/2*unCox*WbyL*V_OV^2

```

```

22 V_OV= sqrt(2*i_D/(unCox*WbyL)); // in V
23 V_OS1= V_OV/2*delta_RDbyRD; // in V
24
25 // V_OS due to W/L ratio
26 V_OS2= V_OV/2*delta_WLbyWL; // in V
27
28 // V_OS due to threshold voltage
29 V_OS3= delta_Vt; // in V
30 // Total offset voltage
31 V_OS= sqrt(V_OS1^2+V_OS2^2+V_OS3^2); // in V
32 V_OS= V_OS*10^3; // in mV
33 disp(V_OS,"Total offset voltage in mV is : ")

```

Scilab code Exa 4.11 Value of Gm Ro Ad Acn and CMRR

```

1 // Exa 4.11
2 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 WLn= 100;
8 WLp= 200;
9 unCox= 0.2; // mA/V^2
10 unCox=unCox*10^-3; //in A/V^2
11 RSS= 25; // in k
12 RSS= RSS*10^3; // in
13 I=0.8; // in mA
14 I=I*10^-3; //in A
15 V_A= 20; // in V
16 i_D= I/2; // in A
17 // Formula i_D= 1/2*unCox*WLn*V_OV^2
18 V_OV= sqrt(2*i_D/(unCox*WLn)); // in V
19 gm= I/V_OV; // in A/V
20 disp(gm*10^3,"Value of Gm in mA/V is : ")

```

```

21 ro2= V_A/(I/2); // in ohm
22 ro4= ro2; // in ohm
23 Ro= ro2*ro4/(ro2+ro4); // in ohm
24 disp(Ro*10^-3," Value of Ro in k is : ")
25 Ad= gm*Ro; // in V/V
26 disp(Ad," Value of Ad in V/V is :")
27 // Finding the value of gm3
28 upCox= 0.1; // mA/V^2
29 upCox=upCox*10^-3; //in A/V^2
30 // Formula i_D= 1/2*upCox*Wp*V_OV^2
31 V_OV= sqrt(2*i_D/(upCox*Wp)); // in V
32 gm3= I/V_OV; // in A/V
33 Acm= 1/(2*gm3*RSS); //in V/V
34 disp(abs(Acm)," Value of |Acm| in V/V is : ")
35 CMRRindB= 20*log10(abs(Ad)/abs(Acm)); //in dB
36 disp(round(CMRRindB),"CMRR in dB is :")

```

Scilab code Exa 4.12 Value of Gm Ro Ad and Rid

```

1 // Exa 4.12
2 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 I=0.8; // in mA
8 I=I*10^-3; //in A
9 V_A= 100; // in V
10 Beta=160;
11 VT=25; // in mV
12 VT= VT*10^-3; //in V
13 gm= (I/2)/VT; // in A/V
14 Gm= gm; // Short circuit trnsconductance in mA/V
15 disp(Gm*10^3,"The value of Gm in mA/V")
16 ro2= V_A/(I/2); // in ohm

```

```

17 ro4= ro2;// in ohm
18 Ro= ro2*ro4/(ro2+ro4);// in ohm
19 disp(Ro*10^-3,"The value of Ro in k is :")
20 Ad= Gm*Ro;// in V/V
21 disp(Ad," Value of Ad in V/V is :")
22 r_pi= Beta/gm;//in
23 Rid= 2*r_pi;// in
24 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 format('v',5);
3 clc;
4 clear;
5 close;
6 // Given data
7 Vtp= -0.8;// in V
8 KpWL= 3.5;// in mA/V^2
9 I=0.7;// in mA
10 I=I*10^-3;// in A
11 R_D= 2;// in k
12 R_D=R_D*10^3;// in
13 KpWL=KpWL*10^-3;//in A/V^2
14 v_G1= 0;// in V
15 v_G2=v_G1;// in V
16 VSS= 2.5;// in V
17 VDD=VSS;// in V
18 VCS= 0.5;// in V
19 // Part (a)
20 V_OV= -sqrt(I/KpWL);// in V
21 disp(V_OV,"The value of V_OV in volts is : ")
22 V_GS= V_OV+Vtp;// in V
23 disp(V_GS,"The value of V_GS in volts is : ")
24 V_G= 0;// as gate is connected ground

```

```

25 v_S1= V_G-V_GS;// in V
26 v_S2= v_S1;// in V
27 disp(v_S1,"The value of V_S in volts is : ")
28 v_D1= I/2*R_D-VDD;// in V
29 v_D2=v_D1;// in V
30 disp(v_D1,"The value of v_D1 in V is : ")
31 disp(v_D2,"The value of v_D2 in V is : ")
32
33 // Part (b)
34 V_CMmin= I*R_D/2-VDD+Vtp;// in V
35 V_CMmax= VSS-VCS+Vtp+V_OV;// in V
36 disp(V_CMmin,"The value of V_CMmin in volt is : ")
37 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 format('v',5);
3 clc;
4 clear;
5 close;
6 // Given data
7 V_OV= 0.2;// in V
8 gm=1;// in mA/V
9 gm=gm*10^-3;// in A/V
10 Vt=0.8;// in V
11 unCox= 90;// in A/V^2
12 unCox=unCox*10^-6;// in A/V^2
13 // gm= I/V_OV
14 I= gm*V_OV;// in A
15 disp(I*10^3,"Bias current in mA is : ")
16 I_D= I/2;// in A
17 // Formula I_D= 1/2*unCox*WLn*V_OV^2
18 WbyL= 2*I_D/(unCox*V_OV^2);
19 disp(WbyL,"W/L ratio is : ")

```

Scilab code Exa 4.15 Value of VOV gm ro and Ad

```
1 // Exa 4.15
2 format('v',5);
3 clc;
4 clear;
5 close;
6 // Given data
7 I=0.5; // in mA
8 I=I*10^-3; // in A
9 WbyL= 50;
10 unCox= 250; // in A/V^2
11 unCox=unCox*10^-6; // in A/V^2
12 V_A= 10; // in V
13 R_D= 4; //in k
14 R_D= R_D*10^3; //in
15 V_OV= sqrt(I/(WbyL*unCox)); //in V
16 disp(V_OV,"The value of V_OV in V is : ")
17 gm= I/V_OV; // in A/V
18 disp(gm*10^3,"The value of gm in mA/V is ")
19 I_D=I/2; // in A
20 ro= V_A/I_D; // in
21 disp(ro*10^-3,"The value of ro in k is : ")
22 Ad= gm*(R_D*ro/(R_D+ro)); // in V/V
23 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 format('v',7);
3 clc;
```



```

4 clear;
5 close;
6 // Given data
7 I=1; // in mA
8 I=I*10^-3; // in A
9 i_C=1; // in mA
10 i_C=i_C*10^-3; // in A
11 V_CC= 5; // in V
12 V_CM= -2; // in V
13 V_BE= 0.7; // in V
14 R_C= 3; // in k
15 R_C= R_C*10^3; // in
16 Alpha=1;
17 Beta=100;
18 V_B= 1; // in V
19 i_C1= Alpha*I; // in A
20 i_C2=0;
21 v_E= V_B-V_BE; // in V
22 disp(v_E,"Emitters voltage in volts is : ")
23 v_C1= V_CC-i_C1*R_C; // in V
24 v_C2= V_CC-i_C2*R_C; // in V
25 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 A= 800;// unit less
8 Af= 50;// unit less
9 // Formula Af= A/(1+Beta*A)
10 Beta= 1/Af-1/A;
11 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 format('v',7);
3 clc;
```

```

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

```

Scilab code Exa 5.3 Value of fL and fH

```

1 // Exa 5.3
2 format('v',5);
3 clc;
4 clear;
5 close;
6 // Given data
7 Bita= 5/100;
8 f_H= 50; // in kHz
9 f_H= f_H*10^3; // in Hz
10 f_L= 50; // in kHz
11 Amid= 1000;
12 f_LF= f_L/(1+Bita*Amid); // in Hz
13 f_HF= f_H*(1+Bita*Amid); // in Hz
14 disp(f_LF,"Value of f_LF in Hz is : ")
15 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 format('v',6);
3 clc;
4 clear;
5 close;
6 // Given data
7 dAf_by_Af= 0.2/100;
8 dA_by_A= 150/2000;
9 A=2000;
10 // Formula  $dAf\_by\_Af = 1/(1+Beta*A) * dA\_by\_A$ 
11 Beta= dA_by_A/(A*dAf_by_Af )-1/A;
12 Af= A/(1+Beta*A);
13 disp(Beta*100,"Value of Beta in percent is ")
14 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 Av= 140;
8 Avf= 17.5;
9 // Formula  $Avf= Av/(1+Av*Beta)$ 
10 Beta= 1/Avf-1/Av;
11 disp(Beta,"Fraction of the output is ")
```

Scilab code Exa 5.6 Fraction of the output voltage feedback

```
1 // Exa 5.6
2 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 Av= 100;
8 Avf= 50;
9 // Formula  $Avf = Av / (1 + Av * Beta)$ 
10 Beta= 1/Avf - 1/Av;
11 disp(Beta,"The vlaue of beta is ")
12
13 // Part(ii)
14 Avf= 75;
15 // Formula  $Avf = Av / (1 + Av * Beta)$ 
16 Av= Avf / (1 - Beta * Avf)
17 disp(Av,"Value of amplifier gain is : ")
```

Scilab code Exa 5.7 Percentage reduction in stage gain

```
1 // Exa 5.7
2 format('v',6);
3 clc;
4 clear;
5 close;
6 // Given data
7 Av= 50;
8 Avf= 25;
9 // Formula  $Avf = Av / (1 + Av * Beta)$ 
10 Beta= 1/Avf - 1/Av;
```

```

11 // Part(i)
12 Av=50;
13 Avf= 40;
14 Perc_reduction= (Av-Avf)/Av*100; // Percentage of
    reduction in stage gain in %
15 disp(Perc_reduction,"Without feedback , percentage of
    reduction in stage gain in % is : ")
16
17 // Part(ii)
18 Av= 40;
19 Avf= 25;
20 gain_with_neg_feed= Av/(1+Beta*Av);
21 Perc_reduction= (Avf-gain_with_neg_feed)/Avf*100; //
    in %
22 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 Ao= 10^4;
8 Afo= 50;
9 omega_H= 2*%pi*100; // in rad/s
10 // Formula Afo= Ao/(1+Ao*Beta)
11 Beta= 1/Afo-1/Ao;
12 omega_f_H= omega_H*(1+Ao*Beta);
13 disp("Closed loop bandwidth in rad/s is : ")
14 disp(string(omega_f_H)+" or 2*%pi*20*10^3");
15 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 A_v β A_{vf} R_i R_{if} R_o and R_{of}

```
1 // Exa 5.10
2 format('v',5);
3 clc;
4 clear;
5 close;
6 // Given data
7 gm=50;
8 R_E= 100;// in ohm
9 R_S= 1;// in kohm
10 R_S=R_S*10^3;// in ohm
11 r_pi= 1100;// in ohm
12 h_ie= r_pi;
13 // Formula  $A_v= V_o/V_s$ , But  $V_o= gm*v_{pi}*R_E$  and  $V_s= I_b$ 
    *( $R_i+r_{pi}$ ), so
14  $A_v= gm*R_E/(R_S+h_{ie})$ 
15 // As  $V_o=V_f$ , so
16  $\beta=1$ ;
17  $D= 1+\beta*A_v$ ;
18  $A_{vf}= A_v/D$ ;
19  $R_i= R_S+r_{pi}$ ;// in ohm
20  $R_i= R_i*10^{-3}$ ;// in kohm
21  $R_{if}= R_i*D$ ;// in kohm
22 //  $R_o= \infty$ , so
23 //  $R_{of}= \infty$ 
24 disp( $A_v$ ,"Value of  $A_v$  is : ")
25 disp( $\beta$ ,"Value of  $\beta$  is : ")
26 disp( $D$ ,"The value of  $D$  is : ")
27 disp( $A_{vf}$ ,"Value of  $A_{vf}$  is : ")
28 disp( $R_i$ ,"Value of  $R_i$  in kohm")
29 disp( $R_{if}$ ,"Value of  $R_{if}$  in kohm is : ")
30 disp("Value of  $R_o$  and  $R_{of}$  is : ")
31 disp("infinite")
```

Scilab code Exa 5.11 Value of Avf Rif Rof and bita

```
1 // Exa 5.11
2 format('v',5);
3 clc;
4 clear;
5 close;
6 // Given data
7 gm=2; // in mA/V
8 gm=gm*10^-3; // in A/V
9 r_d= 40; // in kohm
10 r_d= r_d*10^3; // in ohm
11 Rs= 3; // in kohm
12 Rs= Rs*10^3; // in ohm
13 miu= gm*r_d;
14 Bita=1;
15 Av= miu*Rs/(r_d+Rs);
16 D= 1+Bita*Av;
17 Avf= Av/D;
18 // Ri=infinite , so R_if = Ri*D = infinite
19 Rof= r_d/D; // in ohm
20 disp(Av,"Value of Av is : ")
21 disp(D,"Value of D is ")
22 disp(Avf,"Value of Avf is : ")
23 disp("Value of R_if is ")
24 disp("infinite")
25 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  format('v',7);
3  clc;
4  clear;
5  close;
6  // Given data
7  gm=75; // in A/V
8  Rs= 1; // in kohm
9  Rs= Rs*10^3; // in ohm
10 R_E= 1; // in kohm
11 R_E= R_E*10^3; // in ohm
12 rpi= 1; // in kohm
13 rpi= rpi*10^3; // in ohm
14 hie=rpi;
15
16 Io= -gm;
17 Vi= Rs+R_E+rpi;
18 Gm= Io/Vi;
19 disp(Gm,"Value of Gm is : ")
20 Bita=-R_E;
21 disp(Bita,"Value of Bita is : ")
22 D= 1+Bita*Gm;
23 disp(D,"Value of D is : ")
24 Gmf= Gm/D;
25 disp(Gmf,"Value of Gmf is : ")
26 Ri= Rs+R_E+hie; // in ohm
27 Rif= Ri*D; // in ohm
28 Rif=Rif*10^-3; // in kohm
29 disp(Rif,"Value of Rif in kohm is : ")
30 // Ro=infinite , so R_of = Ro*D = infinite
31 disp("Value of R_of is ")
32 disp("infinite")

```

Scilab code Exa 5.19 Percentage change in Af

```

1 // Exa 5.19

```

```

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

```

Scilab code Exa 5.20 Percentage gain reduction

```

1  // Exa 5.20
2  format('v',5);
3  clc;
4  clear;
5  close;
6  // Given data
7  A= 100;
8  Vs=1; // in volt
9  Beta=1; // as in the voltage follower , the output
    voltage is same as input
10 Af= A/(1+Beta*A);
11 CLG= 1+A*Beta; // closed loop gain
12 disp(CLG,"Closed loop gain is : ")
13 CLG_dB= 20*log10(CLG);

```

```

14 disp(CLG_dB,"Closed loop gain in dB is : ")
15 Vo= Af*Vs;// in V
16 disp(Vo,"Value of Vo in volt is : ")
17 Vi= Vs-Vo;// in V
18 disp(round(Vi*10^3),"Value of Vi in mV is : ")
19 // If A decrease 10%,i.e.
20 A=90;
21 Af_desh= A/(1+Beta*A);
22 Per_gain_reduction= (Af_desh-Af)/Af*100;// in %
23 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 // Part (a)
8 PerError= 1;// in %
9 A= 10^5;// (Assumed value)
10 ABeta= 1/PerError*100;
11 Beta= 1/(PerError*A);
12 disp("% error          A          A
          1+ A ")
13 disp(string(PerError)+"          "+string(
    A)+"          "+string(ABeta)+"
          "+string(1+ABeta))

14 // Part (b)
15 PerError= 5;// in %
16 ABeta= 1/PerError*100;
17 Beta= 1/(PerError*A);
18 disp(string(PerError)+"          "+string(

```

```

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

```

Scilab code Exa 5.22 Value of AB

```

1 // Exa 5.22
2 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 S= -20;// sensitivity of closed to open loop gain in
    dB
8 // sensitivity of closed to open loop gain = 1/(1+AB
    ) = S
9 // or (1+AB) = -S
10 AB= 10^(-S/20) - 1;
11 disp(AB,”The loop gain AB for which the sensitivity
    of closed loop gain to open loop gain is -20 dB,
    is : ”)
12
13 // Part (b) when
14 S= 1/2;// sensitivity of closed to open loop gain in
    dB
15 //S= 1/(1+AB)
16 AB= 1/S-1;
17 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 format('v',5);
3 clc;
4 clear;
5 close;
6 // Given data
7 A=10^5;
8 Af= 10^3;
9 // Af= A/(1+A*Beta)
10 Beta= 1/Af-1/A;
11 GDF= 1+A*Beta;// gain density factor
12 disp(GDF,"Gain density factor is : ")
13 // Part (a) when A drops 10 %
14 A_desh= A-A*10/100;
15 Af_desh= A_desh/(1+A_desh*Beta);
16 CorresPer= (Af-Af_desh)/Af*100;// corresponding
    percentage in %
17 disp(CorresPer,"When A drops by 10 % then
    corresponding percentage is ")
18 // Part (b) when A drops 30 %
19 A_desh= A-A*30/100;
20 Af_desh= A_desh/(1+A_desh*Beta);
21 CorresPer= (Af-Af_desh)/Af*100;// corresponding
    percentage in %
22 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 A=100;
8 Af= 10;
9 f_L= 100;// in Hz
10 f_H= 10;// in kHz
11 // Af= A/(1+A*Beta)
12 Beta= 1/Af-1/A;
13 f_desh_L= f_L/(1+A*Beta);// in Hz
14 f_desh_H= f_H/(1+A*Beta);// in kHz
15 disp(f_desh_L,"Low frequency in Hz is : ")
16 disp(f_desh_H,"High frequency in kHz is : ")
17
18 // 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 beta

```

1 // Exa 5.25
2 format('v',7); 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 Is= 100;// in A
8 Is= Is*10^-6;// in A
9 If= 95;// in A
10 If= If*10^-6;// in A
11 Io= 10;// in mA
12 Io= Io*10^-3;// in A
13 A= Io/(Is-If);// n A/A
14 Bita= If/Io;// A/A
15 disp(A,"Value of A in A/A is : ")
16 disp(Bita,"Value of Bita in A/A is : ")
17
18 // 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 format('v',6);
3 clc;
4 clear;
5 close;
6 // Given data
7 A=2000;//V/V
8 Bita= 0.1;// inV/V
9 Ri= 1;// in kohm
10 Ri= Ri*10^3;// in ohm
11 Ro= 1;// in kohm
12 Ro= Ro*10^3;// in ohm
13 Af= A/(1+A*Bita);
14 disp(Af,"The gain Af in volt is : ")
15 Rif= Ri*(1+A*Bita);// in ohm
16 disp(Rif*10^-3,"The input resistance in kohm is : ")
17 Rof= Ro/(1+A*Bita);// in ohm
18 disp(Rof*10^-3,"The output resistance in kohm is : "
    )
19
20
21 // 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)
22 //          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 format('v',7);
3 clc;

```



```
4 clear;
5 close;
6 // Given data
7
8 // Part (b)
9 Af= 10;
10 A= 10^4;
11 // Af= A/(1+A*Beta);
12 Beta= 1/Af-1/A;
13 // Beta= R1/(R1+R2)
14 R2_by_R1= 1/Beta-1;
15 disp(R2_by_R1,"Value of R2/R1 is : ")
16
17 // Part (c)
18 Vs= 1; // in V
19 Vo= (1+R2_by_R1)*Vs;
20 disp(Vo,"Value of Vo in volt is : ")
21 Vf= Vo/(1+R2_by_R1)
22 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 Vf= 0.0125;// in volt
8 Vo= 0.5;// in volt
9 Bita= Vf/Vo;
10 // For oscillator A*Bita= 1
11 A= 1/Bita;
12 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 format('v',6);
```

```

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

```

Scilab code Exa 6.3 Wein Bridge oscillator

```

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

```

```
17 R3= 2*R4; // in ohm
18 disp(C," Value of C in nF is : ")
19 disp(R3*10^-3," Value of R3 in kohm is : ")
20 disp(R4*10^-3," Value of R4 in kohm is : ")
```

Scilab code Exa 6.4 Frequency of oscillations

```
1 // Exa 6.4
2 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 R1= 200; // in kohm
8 R1=R1*10^3; // in ohm
9 R2=R1; // in ohm
10 C1= 200; // in pF
11 C1= C1*10^-12; // in F
12 C2=C1; // in F
13 f= 1/(2*pi*R1*C1); // in Hz
14 disp(f*10^-3," Frequency of oscilltions in kHz is : "
    )
15
16 // 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 format('v',7);
3 clc;
4 clear;
5 close;
```

```

6 // Given data
7 L= 100;// in H
8 L= L*10^-6;// in H
9 C1= .001;// in F
10 C1= C1*10^-6;// in F
11 C2= .01;// in F
12 C2= C2*10^-6;// in F
13 C= C1*C2/(C1+C2);// in F
14 // (i)
15 f= 1/(2*%pi*sqrt(L*C));// in Hz
16 disp(round(f*10^-3),"Operating frequency in kHz is :
      ")
17 // (ii)
18 Bita= C1/C2;
19 disp(Bita,"Feedback fraction is : ")
20 // (iii)
21 // A*Bita >=1, so Amin*Bita= 1
22 Amin= 1/Bita;
23 disp(Amin,"Minimum gain to substain oscillations is
      : ")

```

Scilab code Exa 6.6 Operating frequency

```

1 // Exa 6.6
2 format('v',6);
3 clc;
4 clear;
5 close;
6 // Given data
7 L= 15;// in H
8 L= L*10^-6;// in H
9 C1= .004;// in F
10 C1= C1*10^-6;// in F
11 C2= .04;// in F
12 C2= C2*10^-6;// in F

```

```

13 C= C1*C2/(C1+C2); // in F
14 f= 1/(2*pi*sqrt(L*C)); // in Hz
15 disp(f*10^-3,"Frequency of oscillations in kHz is :
    ")

```

Scilab code Exa 6.7 Frequency of oscillator

```

1 // Exa 6.7
2 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 L= 0.01; // in H
8 C= 10; // in pF
9 C= C*10^-12; // in F
10 f= 1/(2*pi*sqrt(L*C)); // in Hz
11 disp(f*10^-3,"Frequency of oscillations in kHz is :
    ")
12
13 // 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 format('v',5);
3 clc;
4 clear;
5 close;
6 // Given data
7 L= 0.8; // in H
8

```

```

 9 C= .08; // in pF
10 C= C*10^-12; // in F
11 C_M= 1.9; // in pF
12 C_M= C_M*10^-12; // in F
13 C_T= C*C_M/(C+C_M); // in F
14 R=5; // in kohm
15 f_s= 1/(2*%pi*sqrt(L*C)); // in Hz
16 disp(f_s*10^-3,"Series resonant frequency in kHz is
      : ")
17 // (ii)
18 f_p= 1/(2*%pi*sqrt(L*C_T)); // in Hz
19 disp(f_p*10^-3,"parallel resonant frequency in kHz
      is : ")
20
21 // 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 format('v',8);
3 clc;
4 clear;
5 close;
6 // Given data
7 R1= 220; // in kohm
8 R1=R1*10^3; // in ohm
9 R2=R1; // in ohm
10 C1= 250; // in pF
11 C1= C1*10^-12; // in F
12 C2=C1; // in F
13 f= 1/(2*%pi*R1*C1);
14 disp(f,"Frequency of oscilltions in Hz is : ")

```

Scilab code Exa 6.11 Value of C

```
1 // Exa 6.11
2 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
7 R= 10;// in kohm
8 R=R*10^3;// in ohm
9 f=1000;
10 fie= 60;// in
11 // The impedance of given circuit , Z= R+j*1/(omega*
    C)
12 // the phase shift , tan(fie)= imaginary part/ Real
    part
13 // tand(fie) = 1/(omega*R*C)
14 C= 1/(2*%pi*R*tand(fie));
15 disp(C*10^12,"The value of C in pF is : ")
16
17 // 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 format('v',7);
3 clc;
4 clear;
5 close;
6 // Given data
```



```

7 L= 50; // in H
8 L= L*10^-6; // in H
9 C1= 300; // in pF
10 C1= C1*10^-12; // in F
11 C2= 100; // in pF
12 C2= C2*10^-12; // in F
13 C_eq= C1*C2/(C1+C2); // in F
14 f= 1/(2*%pi*sqrt(L*C_eq)); // in Hz
15 disp(f*10^-6,"Frequency of oscillations in MHz is :
    ")
16 Bita= C2/C1;
17 // (iii)
18 // A*Bita >=1, so A*Bita= 1 (for sustained
    oscillations)
19 Amin= 1/Bita;
20 disp(Amin,"Minimum gain to substain oscillations is
    : ")

```

Scilab code Exa 6.14 The range of capacitance

```

1 // Exa 6.14
2 format('v',4);
3 clc;
4 clear;
5 close;
6 // Given data
7 L1= 2; // in mH
8 L1= L1*10^-3; // in H
9 L2= 1.5; // in mH
10 L2= L2*10^-3; // in H
11 // Formula f= 1/(2*%pi*sqrt((L1+L2)*C))
12 // For f= 1000 kHz, C will be maximum
13 f=1000; // in kHz
14 f=f*10^3; // in Hz
15 Cmax= 1/((2*%pi*f)^2*(L1+L2)); // in F

```

```
16 // For f= 2000 kHz, C will be maximum
17 f=2000;// in kHz
18 f=f*10^3;// in Hz
19 Cmin= 1/((2*pi*f)^2*(L1+L2));// in F
20 disp(Cmin*10^12,"Minimum Capacitance in pF is : ")
21 disp(Cmax*10^12,"Maximum Capacitance in pF is : ")
```
