Scilab Textbook Companion for Electronic Circuits by S. Sharma[1]

Created by
Ameer Azam Khan
Electronics Engineering
Electronics Engineering
Greenway Institute for management studies
College Teacher
None
Cross-Checked by
Bhavani Jalkrish

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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.

Contents

List of Scilab Codes

Chapter 1

Operational Amplifiers

Scilab code Exa 1.1 Value of Rf

```
// Exa 1.1
format('v',7);
clc;
clear;
close;
// Given data
G= -100;
R1= 2.2;// in kohm
R1=R1*10^3;// in ohm
// Formula G=-Rf/R1
Rf= -G*R1;
Rf= Rf*10^-3;// in kohm
disp(Rf,"The value of Rf in kohm is ")
```

Scilab code Exa 1.2 Output voltage

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

```
clc;
clear;
close;
// Given data
Rf= 200;// in kohm
R1= 2;// in kohm
vin=2.5;// in mV
vin=vin*10^-3;// in volt
G= -Rf/R1;
vo= G*vin;// in V
disp(vo,"The output voltage in volt is : ")
```

Scilab code Exa 1.3 Inverting amplifier

```
// Exa 1.3
format('v',7);
clc;
clear;
close;
// Given data
G=-10;
Ri= 100;// in kohm
R1= Ri;// in kohm
R1=R1*10^3;// in ohm
// Formula G=-R2/R1
R2= R1*abs(G);// ohm
R1= R1*10^-3;// in kohm
R2= R2*10^-6;// in Mohm
disp(R1,"Value of R1 in kohm is : ")
disp(R2,"and value of R2 in Mohm is : ")
```

Scilab code Exa 1.4 Inverting amplifier

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

Scilab code Exa 1.5 Output voltage

```
// Exa 1.5
format('v',7);
clc;
clear;
close;
// Given data
Rf= 1;// in Mohm
Rf=Rf*10^6;//in ohm

// Part(a)
V1=1;//in volt
V2=2;//in volt
V3=3;//in volt
R1= 500;// in kohm
R1=R1*10^3;//in ohm
R2= 1;// in Mohm
R2=R2*10^6;//in ohm
R3= 1;// in Mohm
R3=R3*10^6;//in ohm
Vo= -Rf*(V1/R1+V2/R2+V3/R3);// in volt
```

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

// Part(b)
V1=-2;//in volt
V2=3;//in volt
V3=1;//in volt
R1= 200;// in kohm
R1=R1*10^3;//in ohm
R2= 500;// in kohm
R2=R2*10^3;//in ohm
R3= 1;// in Mohm
R3=R3*10^6;//in ohm
Vo= -Rf*(V1/R1+V2/R2+V3/R3);// in volt
disp(Vo,"(b) Output voltage in volt is : ")
```

Scilab code Exa 1.6 Maximum and minimum closed loop gain

```
// Exa 1.6
format('v',7);
clc;
clear;
close;
// Given data
disp("Minimum closed loop voltage gain for R2=0 and
    R1= 2 kohm")
R2=0;
R1=2;// in kohm
R1=R1*10^3;// in ohm
Av_min= (1+R2/R1)
disp(Av_min)

disp("Maximum closed loop voltage gain for maximum
    value of R2=100 kohm and R1= 2 kohm")
R2=100;// in kohm
R1=2;// in kohm
```

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

Scilab code Exa 1.7 Output voltage

```
// Exa 1.7
format('v',7);
clc;
clear;
close;
// Given data
V1= 745;// in  V
V2= 740;// in  V
V1=V1*10^-6;// in volt
V2=V2*10^-6;// in volt
CMRR=80;// in dB
Av=5*10^5;
// (i)
// CMRR in dB= 20*log(Ad/Ac)
Ad=Av;
Ac= Ad/10^(CMRR/20);
// (ii)
Vo= Ad*(V1-V2)+Ac*(V1+V2)/2;
disp(Vo,"Output voltage in volt is : ")

// 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

```
// Exa 1.8
```

```
format('v',7);
clc;
clear;
close;
// Given data
R1= 1;// in Mohm
Ri=R1;// in Mohm
Rf=1;// in Mohm
A_VF= -Rf/R1;
disp(A_VF,"Voltage gain is : ")
```

Scilab code Exa 1.10 Output voltage

```
// Exa 1.10
format('v',7);
clc;
clear;
close;
// Given data
V1=2;// in V
V2=3;// in V
Rf=3;// in kohm
R1=1;// in kohm
disp("Output voltage when only 2V voltage source is
    acting in volt")
Vo1= (1+Rf/R1)*V1;
disp(Vo1);
disp("Output voltage due to 3V voltage source in
    volt")
Vo2= (1+Rf/R1)*V2;
disp(Vo2);
Vo= Vo1+Vo2;// in volts
disp(Vo,"Total output voltage in volts")
```

Scilab code Exa 1.11 Range of voltage gain

```
// Exa 1.11
format('v',7);
clc;
clear;
close;
// Given data
Rf=500;// in kohm
min_vvs= 0;// minimum value of variable resistor in
   ohm
max_vvs= 10;// maximum value of variable resistor in
    ohm
Ri_min= 10+min_vvs;// in kohm
Ri_max= 10+max_vvs;//in kohm
// Av= Vo/Vi= -Rf/Ri
disp("Closed loop voltage gain corresponding to Ri(
   min) is ")
Av=-Rf/Ri_min;
disp(Av)
disp("and closed loop voltage gain corresponding to
   Ri(max) is ")
Av=-Rf/Ri_max;
disp(Av)
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

```
// Exa 1.12
format('v',7);
```

```
clc;
clear;
close;
// Given data
Rf=200;// in kohm
R1= 20;// in kohm
// Av= Vo/Vi= -Rf/Ri
Av= -Rf/R1;
Vi_min= 0.1;// in V
Vi_max= 0.5;// in V
// Vo= Av*Vi
Vo_min= Av*Vi_min;// in V
Vo_max= Av*Vi_max;// in V
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

```
// Exa 1.13
format('v',7);
clc;
clear;
close;
// Given data
Rf= 250;// in kohm
// Output voltage expression , Vo= -5*Va+3*Vb
// and we know that for a difference amplifier
    circuit ,
// Vo= -Rf/R1*Va + [R2/(R1+R2)]*[1+Rf/R1]*Vb
// Comparing both the expression , we get
// -Rf/R1*Va= -5*Va, or
R1= Rf/5;// in kohm
disp(R1,"The value of R1 in kohm")
// and
R2= 3*R1^2/(R1+Rf-3*R1)
```

```
disp(R2,"The value of R2 in kohm")

// Note : Answer in the book is wrong
```

Scilab code Exa 1.14 Output voltage

```
// Exa 1.14
format('v',7);
clc;
clear;
close;
// Given data
Vi_1= 150;// in  V
Vi_2= 140;// in  V
Vd= Vi_1-Vi_2;// in  V
Vd=Vd*10^-6;// in V
Vc= (Vi_1+Vi_2)/2;// in  V
Vc=Vc*10^-6;// in V
// Vo= Ad*Vd*(1+Vc/(CMRR*Vd))

// (i) For Ad=4000 and CMRR= 100
Ad=4000;
CMRR= 100;
Vo= Ad*Vd*(1+Vc/(CMRR*Vd));// in volt
Vo= Vo*10^3;// in mV
disp(Vo,"(i) Output voltage in mV")

// (ii) For Ad=4000 and CMRR= 10^5
Ad=4000;
CMRR= 10^5;
Vo= Ad*Vd*(1+Vc/(CMRR*Vd));// in volt
Vo= Vo*10^3;// in mV
disp(Vo,"(ii) Output voltage in mV")
```

Scilab code Exa 1.15 Output voltage

```
// Exa 1.15
format('v',7);
clc;
clear;
close;
// Given data
Rf=470;// in kohm
R1=4.3;// in kohm
R2=33;// in kohm
R3=33;// in kohm
Vi= 80;// in  V
Vi=Vi*10^-6;// in volt
A1= 1+Rf/R1;
A2=-Rf/R2;
A3= -Rf/R3;
A=A1*A2*A3;
Vo= A*Vi;// in volt
disp(Vo,"Output voltage in volts is : ")
```

Scilab code Exa 1.16 Output voltage

```
// Exa 1.16
format('v',7);
clc;
clear;
close;
// Given data
R1= 33;// in  k
R2= 10;// in  k
R3= 330;// in  k
```

```
V1= '50mV sin(1000 t)';
V2= '10mV sin(3000 t)';
Vo1= R3/R1*50*10^-3;
Vo2= R3/R2*10*10^-3;
// Vo= -Vo1-Vo2;
disp("Output voltage is "+string(-Vo1)+" sin (1000 t
   )"+string(-Vo2)+" sin(3000 t)")
```

Scilab code Exa 1.17 Output voltage

```
// Exa 1.17
format('v',7);
clc;
clear;
close;
// Given data
R1=10;// in kohm
R2=150;// in kohm
R3=10;// in kohm
R4=300;// in kohm
V1= 1;// in V
V2= 2;// in V
Vo= [(1+R4/R2)*(R3*V1/(R1+R3))-(R4/R2)*V2];
disp(Vo,"Output voltage in volts is : ")
```

Scilab code Exa 1.18 Output voltage

```
// Exa 1.18
format('v',6);
clc;
clear;
close;
// Given data
```

```
R1=12;// in kohm
Rf=360;// in kohm
V1= -0.3;// in V
Vo= (1+Rf/R1)*V1;// in V
disp(Vo,"Output voltage result in volts is : ")

// Part(b)
Vo= 2.4;// in V
// We know, Vo= (1+Rf/R1)*V1
V1= Vo/(1+Rf/R1);
V1= V1*10^3;// in mV
disp(V1,"Input voltage in mV to result in an output
    of 2.4 Volt is")
```

Scilab code Exa 1.19 Output voltage

```
// Exa 1.19
format('v',7);
clc;
clear;
close;
// Given data
Rf=68;// in kohm
R1=33;// in kohm
R2=22;// in kohm
R3=12;// in kohm
V1= 0.2;// in V
V2=-0.5;// in V
V3= 0.8;// in V
Vo= -Rf/R1*V1 + (-Rf/R2)*V2 + (-Rf/R3)*V3;// in
    volts
disp(Vo,"Output voltage in volts is : ")
```

Scilab code Exa 1.20 Output voltage

```
// Exa 1.20
format('v',7);
clc;
clear;
close;
// Given data
Rf=100;// in kohm
R1=20;// in kohm
V1= 1.5;// in V
Vo1= V1;
Vo= -Rf/R1*Vo1;// in volts
disp(Vo,"Output voltage in volts is : ")
```

Scilab code Exa 1.22 Inverting op amp

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

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

Scilab code Exa 1.24 Output voltage

```
// Exa 1.24
format('v',7);
clc;
clear;
close;
// Given data
R1= 9;// in  k
R2= 1;// in  k
R3= 2;// in  k
R4= 3;// in  k
// The output voltage, vo1= (1+R1/R2)*va
vo1BYva= (1+R1/R2);//        (i)
// Voltage at node va= R4*v1/(R3+R4)
vaBYv1= R4/(R3+R4);//        (ii)
// From (i) and (ii)
vo1BYv1= vo1BYva*vaBYv1;//       (iii)
// The output voltage, vo2= (1+R1/R2)*va
vo2BYva= (1+R1/R2);//        (iv)
// Voltage at node va= R3*v2/(R3+R4)
vaBYv2= R3/(R3+R4);//        (v)
// From (i) and (ii)
vo2BYv2= vo2BYva*vaBYv2;//       (iii)
// Total output vo= vo1 + vo2
disp("Total voltage is "+string(vo1BYv1)+" v1 + "+string(vo2BYv2)+" v2")
```

Scilab code Exa 1.25 Output voltage

```
// Exa 1.25
format('v',7);
clc;
clear;
close;
// Given data
R1= 9;// in k
R2= 1;// in k
R3= 2;// in k
R4= 3;// in k
// The output voltage , vo1= (1+R1/R2)*va
vo1BYva= (1+R1/R2);//          (i)
// Voltage at node va= R4*v1/(R3+R4)
vaBYv1= R4/(R3+R4);//          (ii)
// From (i) and (ii)
vo1BYv1= vo1BYva*vaBYv1;//          (iii)
// The output voltage , vo2= (1+R1/R2)*va
vo2BYva= (1+R1/R2);//          (iv)
// Voltage at node va= R3*v2/(R3+R4)
vaBYv2= R3/(R3+R4);//          (v)
// From (i) and (ii)
vo2BYv2= vo2BYva*vaBYv2;//          (iii)
// The output voltage , vo3= (-R1/R2)*v3
vo3BYv3= (-R1/R2);//          (i)

// Total output vo= vo1 + vo2 + vo3
disp("Total voltage is "+string(vo1BYv1)+" v1 + "+
    string(vo2BYv2)+" v2 "+string(vo3BYv3)+" v3")
```

Scilab code Exa 1.26 Gain

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

```
clc;
clear;
close;
// Given data
// omega_t= Ao*omega_b
// 2*%pi*f_t = Ao*2*%pi*f_b
// f_t= Ao*f_b
// Part (i)
Ao1= 10^5;
f_b1= 10^2;// in Hz
f_t1= Ao1*f_b1;// in Hz
// Part (ii)
Ao2= 10^6;
f_t2= 10^6;// in Hz
f_b2= f_t2/Ao2;// in Hz
// Part (iii)
f_b3= 10^3;// in Hz
f_t3= 10^8;// in Hz
Ao3= f_t3/f_b3;
// Part (iv)
f_b4= 10^-1;// in Hz
f_t4= 10^6;// in Hz
Ao4= f_t4/f_b4;
// Part (v)
Ao5= 2*10^5;
f_b5= 10;// in Hz
f_t5= Ao5*f_b5;// in Hz
disp(f_t1,"The value of f_t1 in Hz is : ")
disp(f_b2,"The value of f_b2 in Hz is : ")
disp(Ao3,"The value of Ao3 is : ")
disp(Ao4,"The value of Ao4 is : ")
disp(f_t5,"The value of f_t5 in Hz is : ")
```

Scilab code Exa 1.27 Value of Ao fb fr

```
// Exa 1.27
format('v',7);
clc;
clear;
close;
// Given data
Ao= 86;// in dB
A= 40;// in dB
f=100;// in kHz
f=f*10^3;// in Hz
// From  20*log(S) = 20*log(Ao/A), where S, stands
   for sqrt(1+(f/fb)^2)
S= 10^((Ao-A)/20);
// S= sqrt(1+(f/fb)^2)
fb= f/sqrt(S^2-1);// in Hz
Ao= 10^(Ao/20);
ft= Ao*fb;// in Hz
ft= round(ft*10^-6);// in MHz
disp(Ao,"The value of Ao is : ")
disp(fb,"The value of fb in Hz is : ")
disp(ft,"The value of ft in MHz is : ")
```

Scilab code Exa 1.28 3dB frequency and gain

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

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

Chapter 2

MOSFET

Scilab code Exa 2.1 Device operate region

```
// Exa 2.1
format('v',7);
clc;
clear;
close;
// Given data
V_S= 0;// As source is connected to ground
V_G= 1.5;// in V
V_D= 0.5;// in V
Vt= 0.7;// in V
// Part(a) V_D= 0.5;// in V
V_D= 0.5;// in V
V_DS= V_D-V_S;// in V
V_GS= V_G-V_S;// in V
if V_GS < Vt then
    disp("At V_D = 0.5 , the device is in cut off
        region")
elseif V_DS<= (V_GS-Vt) then
    disp("At V_D = 0.5 , the device is in triode
        region");
else
```

```
    disp("At V_D = 0.5 , the device is in saturation
        region");

end

// Part(b) V_D= 0.9;// in V
V_D= 0.9;// in V
V_DS= V_D-V_S;// in V
V_GS= V_G-V_S;// in V
if V_GS < Vt then
    disp("At V_D = 0.9 , the device is in cut off
        region")
elseif V_DS<= (V_GS-Vt) then
    disp("At V_D = 0.9 , the device is in triode
        region");
else
    disp("At V_D = 0.9 , the device is in saturation
        region");

end

// Part(c) V_D= 3;// in V
V_D= 3;// in V
V_DS= V_D-V_S;// in V
V_GS= V_G-V_S;// in V
if V_GS < Vt then
    disp("At V_D = 3 , the device is in cut off
        region")
elseif V_DS<= (V_GS-Vt) then
    disp("At V_D = 3 , the device is in triode
        region");
else
    disp("At V_D = 3 , the device is in saturation
        region");

end
```

Scilab code Exa 2.2 Drain current

```
// Exa 2.2
format('v',7);
clc;
clear;
close;
// Given data
unCox= 100;// in  A /V^2
unCox= unCox*10^-6;// in A/V^2
L= 1;//in  m
L= L*10^-6;// in m
W=10;// in  m
W=W*10^-6;// in m
V_GS= 1.5;// in V
Vt= 0.7;// in V
// For V_DS= 0.5 V
V_DS= 0.5;// in V
if V_DS<= (V_GS-Vt) then
    I_D= unCox*W/L*[(V_GS-Vt)*V_DS-V_DS^2/2];
    I_D= I_D*10^6;// in  A
    disp(I_D,"The device is in triode region. SO the drain current in the triode region in  A is : ")
else
    I_D= unCox*W/(2*L)*(V_GS-VT)^2;
    I_D= I_D*10^6;// in  A
    disp(I_D,"The device is in saturation region. SO the drain current in the saturation region in  A is : ")
end
// For V_DS= 0.9 V
V_DS= 0.9;// in V
if V_DS<= (V_GS-Vt) then
```

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

Scilab code Exa 2.3 Value of VDS

```
// Exa 2.3
format('v',6);
clc;
clear;
close;
// Given data
Vt= 0.7;// in V
I_D= 100;// in  A
I_D=I_D*10^-6;// in A
// When
V_GS= 1.2;// in V
V_DS= V_GS;// in V
// At this condition, device is in saturation region, so    I_D= unCox*W/(2*L)*(V_GS-VT)^2
unCoxWby2L= I_D/(V_GS-Vt)^2;
// For
V_DS= 3;// in V
V_GS= 1.5;// in V
// In this condition, device is in saturation region, so
```

```
I_D= unCoxWby2L*(V_GS-Vt)^2;// in A
I_D= I_D*10^6;// in  A
disp(I_D,"For V_DS= 3V and V_GS= 1.5 V, The value of I_D in  A is : ")
// For
V_GS= 3.2;// in V
r_DS= 1/(2*unCoxWby2L*(V_GS-Vt));// in
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

```
// Exa 2.4
format('v',7);
clc;
clear;
close;
// Given data
I_D= 0.4;// in mA
I_D=I_D*10^-3;// in A
Vt= 0.7;// in V
V_SS= -2.5;// in V
V_DD= 2.5;// in V
unCox= 100;// in  A /V^2
unCox= unCox*10^-6;// in A/V^2
W= 32;// in m
L= 1;// in m
// V_GS-Vt= V_OV
// I_D= unCox*W/(2*L)*(V_OV)^2
V_OV= sqrt(I_D/(unCox*W/(2*L)));// in V
V_GS= V_OV+Vt;// in V
disp(V_GS,"The value of V_GS in volt is : ")
V_G= 0;
// Formula V_GS= V_G-V_S
V_S= V_G-V_GS;// in V
```

```
R_S= (V_S-V_SS)/I_D// in
R_S= R_S*10^-3;// in k
disp(R_S,"The value of R_S in k  is : ")
V_D= 0.5;// in V
R_D= (V_DD-V_D)/I_D;//in
R_D= R_D*10^-3;// in k
disp(R_D,"The value of R_D in k  is : ")
```

Scilab code Exa 2.5 Value of required of R

```
// Exa 2.5
format('v',7);
clc;
clear;
close;
// Given data
V_DD= 3;// in V
I_D= 80;// in  A
I_D=I_D*10^-6;// in A
Vt= 0.6;// in V
unCox= 200;// in  A/V^2
unCox= unCox*10^-6;// in A/V^2
L= 0.8;//in  m
L= L*10^-6;// in m
W=4;// in  m
W=W*10^-6;// in m
// V_GS-Vt= V_OV
// I_D= unCox*W/(2*L)*(V_OV)^2
V_OV= sqrt(I_D/(unCox*W/(2*L)));// in V
V_GS= V_OV+Vt;// in V
V_D= 1;// in V
V_G= V_D;// in V
R= (V_DD-V_D)/I_D;// in
R= R*10^-3;// in k
disp(R,"The value of R in k  is : ")
```

Scilab code Exa 2.6 Value of R and VD

```
// Exa 2.6
format('v',7);
clc;
clear;
close;
// Given data
V_DD= 10;// in V
I_D= 0.4;// in mA
I_D=I_D*10^-3;// in A
Vt= 2;// in V
unCox= 20;// in  A /V^2
unCox= unCox*10^-6;// in A/V^2
L= 10;//in  m
L= L*10^-6;// in m
W=100;// in  m
W=W*10^-6;// in m
V_S= 0;// in V as source is connected to ground
// I_D= unCox*W/(2*L)*(V_OV)^2
V_OV= sqrt(I_D/(unCox*W/(2*L)));// in V
V_GS= V_OV+Vt;// in V
V_D= V_GS;// in V
R= (V_DD-V_D)/I_D;// in
R= R*10^-3;// in k
disp(R,"The value of R in k  is : ")
```

Scilab code Exa 2.7 Effective resistance between drain and source

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

```
clc;
clear;
close;
// Given data
KnWbyL= 1;// in mA
KnWbyL=KnWbyL*10^-3;// in A
Vt= 1;// in V
V_DS= 0.1;// in V
V_D= V_DS;// in V
V_GS= 5;// in V
V_DD= V_GS;// in V
// Formula I_D= K'nW/L*[(V_GS-Vt)*V_DS-V_DS^2/2]
I_D= KnWbyL*[(V_GS-Vt)*V_DS-V_DS^2/2];// in A
R_D= (V_DD-V_D)/I_D;//in
R_D= R_D*10^-3;// in k
disp(R_D,"The required value of R_D in k  is : ")
```

Scilab code Exa 2.8 Voltage at all nodes

```
// Exa 2.8
format('v',7);
clc;
clear;
close;
// Given data
KnWbyL= 1;// in mA/V^2
KnWbyL=KnWbyL*10^-3;// in A/V^2
Vt= 1;// in V
V_DD= 10;// in V
R_D= 6;// in k
R_D= R_D*10^3;// in
R_S= 6;// in k
R_S= R_S*10^3;// in
R_G1= 10;// in M
R_G1= R_G1*10^6;// in
```

```
R_G2= 10;// in M
R_G2= R_G2*10^6;// in
V_G= V_DD*R_G2/(R_G1+R_G2);// in V
// V_S= R_S*I_D
// V_GS= V_G-V_S= V_G-R_S*I_D
// Formula I_D= K'nW/2*L*(V_GS-Vt)^2, Putting the value of V_GS, We get
// 18*I_D^2 -25*I_D +8= 0
// I_D= 0.89 mA or I_D= 0.5
I_D= 0.5;// in mA
I_D=I_D*10^-3;// in A
V_S= R_S*I_D;// in V
V_GS= V_G-V_S;// in V
V_D= V_DD-I_D*R_D;// in V
I_D= I_D*10^3;// in mA
disp(I_D,"The value of I_D in mA is : ")
disp(V_S,"The value of V_S in volt is : ")
disp(V_GS,"The value of V_GS in volt is : ")
disp(V_D,"The value of V_D in volt is : ")
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

```
// Exa 2.9
format('v',7);
clc;
clear;
close;
// Given data
R_D= 20;// in k
R_D= R_D*10^3;// in
R1= 30;// in k
R1= R1*10^3;// in
R2= 20;// in k
```

```
R2= R2*10^3;// in
V_DD= 5;// in V
Vtn= 1;// in V
Kn= 0.1;// in mA/V^2
Kn=Kn*10^-3;// in A/V^2
V_GS= R2*V_DD/(R1+R2);// in V
// I_D= 1/2* nCox*W/L*(V_GS-Vtm)^2
I_D = Kn*(V_GS-Vtn)^2  ;// in mA (As Kn= 1/2* nCox*W/L)
V_DS= V_DD-I_D*R_D;// in V
I_D= I_D*10^3;// in mA
disp(V_GS,"The value of V_GS in volt is : ")
disp(I_D,"The value of I_D in mA is : ")
disp(V_DS,"The value of V_DS in volt is : ")
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

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

```
I_D=I_D*10^-3;//in A
R_D= (V_DD-V_D)/I_D;// in
R_S= V_S/I_D;// in
// Formul I_D= 1/2*KnWbyL*(V_OV)^2
V_OV= sqrt(2*I_D/KnWbyL);// in V
// Formula V_OV= V_GS-Vt
V_GS= V_OV+Vt;// in V
V_G= V_GS+V_S;// in V
// Formul V_G= R_G2*V_DD/(R_G1+R_G2)
R_G2= R_G1*V_G/(V_DD-V_G);//in
R_D= R_D*10^-3;// in k
R_S= R_S*10^-3;// in k
R_G2= R_G2*10^-6;// in M
disp(R_D,"The value of R_D in k  is : ")
disp(R_S,"The value of R_S in k  is : ")
disp(V_OV,"The value of V_OV in volts is : ")
disp(V_GS,"The value of V_GS  in volts is : ")
disp(R_G2,"The value of R_G2 in M  is : ")
```

Scilab code Exa 2.11 Bias point

```
// Exa 2.11
format('v',6);
clc;
clear;
close;
// Given data
V_DD= 15;// in V
KnWbyL= 0.25;// in mA/V^2
KnWbyL=KnWbyL*10^-3;// in A/V^2
Vt= 1.5;// in V
V_A= 50;// in V
R_D= 10;// in k
R_D= R_D*10^3;// in
R_L= 10;// in k
```

```
R_L= R_L*10^3;// in
R_G= 10;// in M
R_G= R_G*10^6;// in
// I_D= 1/2*KnWbyL*(V_D-Vt)^2 , (V_GS= V_D, as dc gate current is zero)   (i)
// V_D= V_DD- I_D*R_D              (ii)
I_D= 1.06;// in mA
I_D = I_D*10^-3;// in A
V_D= V_DD- I_D*R_D;// in V
V_GS=V_D;// in V
// The coordinates of operating point
V_GSQ= V_D;// in V
I_DQ= I_D*10^3;// in mA
disp("The coordinates of operating points are  V_GSQ = "+string(V_GSQ)+" V and I_DQ= "+string(I_DQ)+" mA")
gm= KnWbyL*(V_GS-Vt);// in A/V
r_o= V_A/I_D;//in
// The gain is : Av= vo/vi = -gm*(R_D||R_L||r_o)
Av= -gm*[R_D*R_L*r_o/(R_D*R_L+R_D*r_o+R_L*r_o)];// in V/V
// i_i= (vi-vo)/R_G
// i_i= vi/R_G*(1-vo/vi) and Rin= vi/i_i = R_G/(1-Av)
Rin= R_G/(1-Av);// in
Rin= Rin*10^-6;// in M
disp(Rin,"The input resistance in M  is : ")
disp("The largest allowable input signal vi is determined by the need to keep the MOSFET in saturation at all times")
disp("                                   V_DS >= V_GS-vt")
disp("By enforcing this condition with equality at the point V_GS is maximum and V_DS is correspondingly minimum")
disp("                                   V_DSmin= V_GSmax -Vt")
disp("                                   V_DS-|Av| vi
```

```
    = V_GS + vi −Vt")
disp("                                    4.4 − 3.3 vi
    = 4.4 + vi −1.5")
disp("which results in vi= 0.34V")
```

Scilab code Exa 2.12 Largest value of RD

```
// Exa 2.12
format('v',7);
clc;
clear;
close;
// Given data
I_D= 0.5;// in mA
I_D= I_D*10^-3;// in mA
V_D= 3;// in V
Vt= -1;// in V
KpWbyL= 1;// in mA/V^2
KpWbyL=KpWbyL*10^-3;// in A/V^2
// Formul I_D= 1/2*KpWbyL*(V_OV)^2
V_OV= sqrt(2*I_D/KpWbyL);// in V
// For PMOS
V_OV= -V_OV;// in V
V_GS= V_OV+Vt;// in V
R_D= V_D/I_D;// in
V_Dmax= V_D+abs(Vt);// in V
R_D= V_Dmax/I_D;// in
R_D= R_D*10^-3;// in k
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

```
// Exa 2.14
format('v',7);
clc;
clear;
close;
// Given data
V_GS1= 1.5;// in V
Vt= 1;// in V
r_DS1= 1;// in k
r_DS1= r_DS1*10^3;// in
r_DS2= 200;// in k
//   r_DS1= 1/(KnWbyL*(V_GS1-Vt))              (i)
//   r_DS2= 1/(KnWbyL*(V_GS2-Vt))              (i)
// dividing equation (i) by (ii)
V_GS2= (r_DS1/r_DS2)*(V_GS1-Vt)+Vt;// in V
disp(V_GS2,"To Optain rDS= 200, The value of V_GS
    should be (in volt)")
// For  V_GS= 1.5 ;// V
// W2= 2*W1;
// r_DS1/r_DS2= 2
r_DS2= r_DS1/2;// in
disp(r_DS2,"For V_GS= 1.5 V , the value of r_DS2 in
      is : ")
// For V_GS= 3.5 V
r_DS2= 200/2;// in
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

```
// Exa 2.15
format('v',7);
clc;
clear;
close;
```

```
// Given data
I_D= 0.2;// in mA
I_D= I_D*10^-3;// in mA
Vt= 1;// in V
KpWbyL= 0.1;// in mA/V^2
KpWbyL=KpWbyL*10^-3;// in A/V^2
// Formul I_D= 1/2*KpWbyL*(V_GS-VT)^2
V_GS= sqrt(2*I_D/KpWbyL)+Vt;// in V
V_DSmin= V_GS-Vt;// in V
disp(V_GS,"Required V_GS in volts is : ")
disp(V_DSmin,"The minimum required V_DS in volts is : ")
// For I_D= 0.8 mA
I_D = 0.8*10^-3;// in A
V_GS= sqrt(2*I_D/KpWbyL)+Vt;// in V
V_DSmin= V_GS-Vt;// in V
disp(V_GS,"Required V_GS in volts is : ")
disp(V_DSmin,"The minimum required V_DS in volts is : ")
```

Scilab code Exa 2.16 Value of RD and RS

```
// Exa 2.16
format('v',7);
clc;
clear;
close;
// Given data
V_SS= -5;// in V
unCox= 60;// in   A /V^2
unCox= unCox*10^-6;// in A/V^2
Vt= 1;// in V
W= 100;// in   m
L= 3;// in   m
V_G=0;// in V
```

```
V_DD= 5;// in V
V_D=0;//in V
I_D= 1*10^-3;// in A
// I_D= (V_DD-V_D)/R_D
R_D= (V_DD-V_D)/I_D;// in
R_D= R_D*10^-3;// in k
disp(R_D,"The value of R_D in k  is : ")
// Formul I_D= 1/2*unCox*W/L*(V_GS-Vt)^2
V_GS= sqrt(2*I_D*L/(unCox*W))+Vt;// in V
V_S= V_G-V_GS;// in V
R_S= (V_S-V_SS)/I_D;// in
R_S= R_S*10^-3;// in k
disp(R_S,"The resistance in k  is ");
```

Scilab code Exa 2.17 Required value of R and W

```
// Exa 2.17
format('v',5);
clc;
clear;
close;
// Given data
V_D= 3.5;// in V
I_D= 115*10^-6;//in A
upCox= 60;// in  A/V^2
upCox= upCox*10^-6;// in A/V^2
L= 0.8;//in  m
V_GS= -1.5;// in V
Vt= 0.7;// in V
R= V_D/I_D;// in
R= R*10^-3;// in k
disp(R,"The value required for R in k  is : ")
// Formul I_D= 1/2*upCox*W/L*(V_GS-Vt)^2
W= 2*I_D*L/(upCox*(V_GS-Vt)^2)
disp(W,"The value required for W in  m is : ")
```

```

// 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

```
// Exa 2.18
format('v',7);
clc;
clear;
close;
// Given data
Vt= 1;// in V
unCox= 120;// in  A /V^2
unCox= unCox*10^-6;// in A/V^2
L1=1;// in  m
L2=L1;// in  m
I_D= 120;//in  A
I_D= I_D*10^-6;//in A
V_GS1= 1.5;//in V
V_G2= 3.5;// in V
V_S2= 1.5;// in V
V_DD= 5;// in V
V_D2= 3.5;// in V
// Formul I_D= 1/2*unCox*W/L*(V_GS1-Vt)^2
W1= 2*I_D*L1/(unCox*(V_GS1-Vt)^2);// in  m
disp(W1,"The value of W1 in  m is : ")
V_GS2= V_G2-V_S2;//in V
// Formul I_D= 1/2*unCox*W/L*(V_GS1-Vt)^2
W2= 2*I_D*L2/(unCox*(V_GS2-Vt)^2);// in  m
disp(W2,"The value of W2 in  m is : ")
R= (V_DD-V_D2)/I_D;// in
R= R*10^-3;// in k
disp(R,"Resistance in k ");
```

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

```
// Exa 2.19
format('v',5);
clc;
clear;
close;
// Given data
Vt= 2;// in V
K1WbyL= 1;// in mA/V^2
K1WbyL= K1WbyL*10^-3;//in mA/V^2
I_D= 10;//in  A
I_D= I_D*10^-6;//in A
V_DD= 10;// in V
R_D= 4;// in k
R_D= R_D*10^3;// in

// Formul I_D= 1/2*K1WbyL*(V_GS-Vt)^2
V_GS= sqrt(2*I_D/K1WbyL)+Vt;// in V
V1= -V_GS;// in V
// Part (b)
I_D= 2;// in mA
I_D= I_D*10^-3;// in A
V2= V_DD-I_D*R_D;//in V
// Formul I_D= 1/2*K1WbyL*(V_GS-Vt)^2
V_GS= sqrt(2*I_D/K1WbyL)+Vt;// in V
V3= -V_GS;// in V
// Part (c)
I_D= 1;// in mA
I_D= I_D*10^-3;// in A
// Formul I_D= 1/2*K1WbyL*(V_GS-Vt)^2
V_GS= sqrt(2*I_D/K1WbyL)+Vt;// in V
V4= V_GS;// in V
// Part (d)
```

```
I_D= 2;// in mA
R_D= 2.5;// in  k
R_D= R_D*10^3;// in
V_SS= 10;// in V
I_D= I_D*10^-3;// in A
V_GS= sqrt(2*I_D/K1WbyL)+Vt;// in V
V5= -V_SS+I_D*R_D;// in V
disp(V1,"The value of V1 in volts is : ")
disp(V2,"The value of V2 in volts is : ")
disp(V3,"The value of V3 in volts is : ")
disp(V4,"The value of V4 in volts is : ")
disp(V5,"The value of V5 in volts is : ")
```

Scilab code Exa 2.20 Labelled current and voltage

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

```
//1/2*unCox*W/L*(V4-Vt)^2 = 1/2*upCox*W/L*(V_DD-V4-Vt)
V4= (V_DD-Vt+sqrt(unCox/upCox))/(1+sqrt(unCox/upCox));
I3= 1/2*unCox*W/L*(1.39-Vt)^2
disp(V2,"The value of V2 in volt is : ")
I1= I1*10^6;// in  A
disp(I1,"The value of I1 in  A is : ")
disp(V4,"The value of V4 in volt is : ")
I3= I3*10^6;// in  A
disp(I3,"The value of I3 in  A is : ")
```

Scilab code Exa 2.22 Voltage gain

```
// Exa 2.22
format('v',4);
clc;
clear;
close;
// Given data
Vt= 0.9;// in V
V_A= 50;// in V
V_D= 2;// in V
R_L= 10;// in M
R_L= R_L*10^3;// in
R_G= 10;// in M
R_G= R_G*10^6;// in
I_D= 500;// in  A
I_D= I_D*10^-6;// in A
V_GS= V_D;// in V
ro= V_A/I_D;// in
gm= 2*I_D/(V_GS-Vt);// in A/V
// vo= -gm*vi*(ro || R_L)
vo_by_vi = -gm*(ro*R_L/(ro+R_L));// in V/V
disp(vo_by_vi ,"The voltage gain in V/V is : ")
```

```
// For I= 1 mA or twice the current
I_D1= I_D;// in A
I_D2= 2*I_D1;// in A
gm1= gm;// in A/V
// Effect on V_D
// I_D1/I_D2 = (V_GS1-Vt)^2/(V_GS2-Vt)^2
V_GS1= V_GS;
V_GS2= Vt+sqrt(2)*(V_GS1-Vt);// in V
disp(V_GS2,"The new value of V_GS in volts is : ")
// Effect on gm
// gm1/gm2= sqrt(I_D1/I_D2)
gm2= sqrt(I_D2/I_D1)*gm1;// in A/V
gm2= gm2*10^3;// in mA/V
disp(gm2,"The new value of gm2 in mA/V is : ")
// Effect on ro
// ro1/ro2= I_D2/I_D1
ro1= ro;// in
ro2= I_D1*ro1/I_D2;// in
ro2= ro2*10^-3;// in k
disp(ro2,"The new value of ro in k /V is : ")
ro2= ro2*10^3;// in
// Effect on gain
// Av= -gm*(ro2 || R_L)
Av= -gm*(ro2*R_L/(ro2+R_L));// in V/V
disp(Av,"The new value of voltage gain in V/V is : ")

// Note: There is some difference between the new value of voltage gain in book and coding. The reason behind this is that ,
// the accurate value of new value of gm is 1.2856487 and in the book 1.3 has taken at place of 1.2856487.
// 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

```
// Exa 2.23
format('v',5);
clc;
clear;
close;
// Given data
I_D= 1;// in mA
I_D= I_D*10^-3;// in A
gm= 1;//in mA/V
gm= gm*10^-3;//in A/V
f_L= 10;// in Hz
R_S= 6;// in  k
R_S= R_S*10^3;// in
R_D= 10;// in  k
R_D= R_D*10^3;// in
vo_by_vi= -gm*R_D/(1+gm*R_S);// in V/V
disp(vo_by_vi,"Mid band gain in V/V is : ");
// Formula f_L= 1/(2*%pi*(1/gm || R_S)) * CS
CS= 1/(2*%pi*(1/gm*R_S/(1/gm+R_S))*f_L) ;//in F
CS= CS*10^6;// in   F
disp(CS,"The value of Cs in   F is : ")
```

Scilab code Exa 2.24 Midband gain and upper 3dB frequency

```
// Exa 2.24
format('v',6);
clc;
clear;
close;
// Given data
```

```
Rsig= 100;// in  k
Rsig= Rsig*10^3;// in
R_G= 4.7;// in  M
R_G= R_G*10^6;// in
R_D= 15;// in  k
R_D= R_D*10^3;// in
R_L= R_D;// in
gm= 1;//in mA/V
gm= gm*10^-3;//in A/V
ro=150;// in  k
ro=ro*10^3;// in
Cgs= 1;// in pF
Cgs=Cgs*10^-12;//in F
Cgd= 0.4;// in pF
Cgd=Cgd*10^-12;//in F
vgsBYvsig= R_G/(Rsig+R_G);
Rdesh_L= R_D*R_L/(R_D+R_L);// in
voBYvgs= -gm*Rdesh_L;
Av= voBYvgs/vgsBYvsig;// in V/V
disp(Av,"The Mid-band gain in V/V is :")
CM= Cgd*(1+gm*Rdesh_L);// in F
// f_H= 1/(2*%pi*(Rsig || R_G)*(Cgs*CM))
f_H= 1/(2*%pi*(Rsig * R_G/(Rsig + R_G))*(Cgs+CM));// in Hz
f_H= f_H*10^-3;// in kHz
disp(f_H,"Frequency in kHz is : ")
```

Chapter 3

Bipolar Junction Transistors

Scilab code Exa 3.1 Value of IE IB IC and VC

```
// Exa 3.1
format('v',5);
clc;
clear;
close;
// Given data
V_E= -0.7;// in V
Bita=50;
RC= 5;// in  k
RE= 10;// in  k
RE= RE*10^3;// in
RC= RC*10^3;// in
V_CC= 10;// in V
V_BE= -10;// in volt
I_E= (V_E-V_BE)/RE;// in A
disp(I_E*10^3,"Emitter current in mA is : ")
// I_E= I_B+I_C and I_C= Bita*I_B , so
I_B= I_E/(1+Bita);// in A
disp(I_B*10^6,"Base current in   A is : ")
I_C= I_E-I_B;//in A
disp(I_C*10^3,"Collector current in mA is : ")
```

```
V_C= V_CC-I_C*RC;// in V
disp(V_C,"The value of V_C in volts is :")
```

Scilab code Exa 3.2 Value of alpha and bita

```
// Exa 3.2
format('v',6);
clc;
clear;
close;
// Given data
V_E= 1.7;// in V
V_B= 1;// in V
RC= 5;// in k
RE= 5;// in k
RE= RE*10^3;// in
RC= RC*10^3;// in
RB= 100;//in k \
RB= RB*10^3;// in
V_CC= 10;// in V
V_BE= -10;// in volt
I_E= (V_CC-V_E)/RE;// in A
I_B= V_B/RB;// in V
// Formula I_B= (1-alpha)*I_E
alpha= 1-I_B/I_E;
disp(alpha,"Value of alpha is : ")
bita= alpha/(1-alpha);
disp(bita,"Value of bita is : ")
V_C= (I_E-I_B)*RC-V_CC;// in volt
disp(V_C,"Collector voltage in volts is : ")
```

Scilab code Exa 3.3 Bias voltage

```
// Exa 3.3
format('v',6);
clc;
clear;
close;
// Given data
V_CC= 10;// in V
V_CE= 3.2;// in V
RC= 6.8;// in  k
RC= RC*10^3;// in
I_S= 1*10^-15;// in A
V_T= 25*10^-3;// in V
I_C1= (V_CC-V_CE)/RC;// in A
// Formula I_C= I_S*%e^(V_BE1/V_T)
V_BE1= V_T*log(I_C1/I_S);// in volt
disp(I_C1*10^3,"Collector current in mA is : ")
disp(V_BE1,"Value of V_BE in volts is : ")

// Part (b)
v_in= 5*10^-3;// in V
Av= -(V_CC-V_CE)/V_T;// in V/V
disp(Av,"Voltage gain in V/V is : ")
v_o= abs(Av )*v_in;// in V
disp(v_o,"Change in output voltage in volts is : ")

// Part (c) for V_CE= 0.3 V
V_CE= 0.3;// in V
I_C2= (V_CC-V_CE)/RC;// in A
// I_C1= I_S*%e^(V_BE1/V_T)        (i)
// I_C2= I_S*%e^(V_BE2/V_T)        (ii)
// divide the equation (ii) by (i)
delta_V_BE= V_T*log(I_C2/I_C1);// in volt    ( where
    delta_V_BE = V_BE2-V_BE1 )
disp(delta_V_BE*10^3 ,"The positive increament in
   V_BE in mV is : ")

// Part (d)
v_o= 0.99*V_CC;// in V
```

```
I_C3= (V_CC-v_o)/RC;// in A
delta_V_BE= V_T*log(I_C3/I_C1);// in V
disp(delta_V_BE*10^3 ,"The negative increament in
    V_BE in mV is : ")
```

Scilab code Exa 3.4 Design a fixed bias circuit

```
// Exa 3.4
format('v',7);
clc;
clear;
close;
// Given data
V_CC= 10;// in V
V_CE= 5;// in V
V_BE= 0.7;// in V
I_C= 5*10^-3;// in mA
bita= 100;
R_C= (V_CC-V_CE)/I_C;// in
I_B= I_C/bita;// in A
R_B= (V_CC-V_BE)/I_B;// in
disp(R_C*10^-3,"The value of R_C in k  is : ")
disp(I_B*10^6,"The value of I_B in  A is : ")
disp(R_B*10^-3,"The value of R_B in k  is : ")

// Note: The value of base current in the book is
    wrong
```

Scilab code Exa 3.5 Operating point

```
// Exa 3.5
format('v',7);
clc;
```

```
clear;
close;
// Given data
V_CC= 6;// in V
bita= 100;
R_C= 2;// in k
R_C= R_C*10^3;// in
R_B= 530;// in k
R_B= R_B*10^3;// in
// when I_C=0
I_C=0;
V_CE= V_CC-I_C*R_C;// in volt
V_CE= 0:0.1:6;// in Volt
I_C= (V_CC-V_CE)/R_C*1000;// in mA
plot(V_CE,I_C);
title("DC load line")
xlabel("V_CE in volts")
ylabel("I_C in mA")
disp("DC load line shown in figure")
// When V_CE= 0
I_C= V_CC/R_C;//in A
// Operating point for silicon transistor
V_BE= 0.7;// in V
I_B= (V_CC-V_BE)/R_B;//in A
I_CQ= bita*I_B;// in A
V_CEQ= V_CC-I_CQ*R_C;// in volt
disp("Operating point is "+string(V_CEQ)+" V and "+
   string(I_CQ*10^3)+" mA")
```

Scilab code Exa 3.6 Q point values

```
// Exa 3.6
format('v',7);
clc;
clear;
```

```
close;
// Given data
V_CC= 12;// in V
V_BE= 0.7;// in V
bita= 100;
R_C= 10;// in k
R_C= R_C*10^3;// in
R_B= 100;// in k
R_B= R_B*10^3;// in
I_BQ= (V_CC-V_BE)/((1+bita)*R_C+R_B);// in A
I_CQ= bita*I_BQ;// in A
V_CEQ= V_CC-(I_CQ+I_BQ)*R_C;// in volt
// For dc load line
// When
I_C=0;
V_CE= V_CC-(I_C+I_BQ)*R_C;// in volt
// When
V_CE= 0;
I_C= (V_CC-I_BQ*R_C)/R_C;//in A
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

```
// Exa 3.7
format('v',6);
clc;
clear;
close;
// Given data
V_CC= 15;// in V
V_BE= 0.7;// in V
V_CE= 5;// in V
I_C= 5;// in mA
I_C=I_C*10^-3;// in A
```

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

Scilab code Exa 3.8 Value of RB

```
// Exa 3.8
format('v',7);
clc;
clear;
close;
// Given data
V_BE= 0.7;// in V
V_CE= 3;// in V
I_C= 1;// in mA
I_C=I_C*10^-3;// in A
bita= 100;
I_B= I_C/bita;// in A
// V_CE= V_BE+V_CB and V_CB= I_B*R_B
R_B= (V_CE-V_BE)/I_B;// in
disp(R_B*10^-3,"The value of R_B in k  is : ")
```

Scilab code Exa 3.9 Operating point

```
// Exa 3.9
```

```
format('v',7);
clc;
clear;
close;
// Given data
R1= 10;// in k
R1=R1*10^3;// in
R2= 5;// in k
R2=R2*10^3;// in
RC= 1;// in k
RC=RC*10^3;// in
RE= 2;// in k
RE=RE*10^3;// in
V_CC= 15;// in V
V_BE= 0.7;// in V
// When
I_C=0;
V_CE= V_CC-I_C*(RC+RE);// in V
// When V_CE= 0
I_C= V_CC/(RC+RE);// in A
V_B= V_CC*R2/(R1+R2);// in V
I_E= (V_B-V_BE)/RE;// in A
I_C= I_E;// in A (approx)
I_CQ= I_C;// in A
V_CE= V_CC-I_C*(RC+RE);// in V
V_CEQ= V_CE;// in V
V_CE= 0:0.1:15;// in Volt
I_C= (V_CC-V_CE)/(RC+RE)*1000;// in mA
plot(V_CE,I_C);
title("DC load line")
xlabel("V_CE in volts")
ylabel("I_C in mA")
disp("DC load line shown in figure")
disp("Operating point is "+string(V_CEQ)+" V and "+
   string(I_CQ*10^3)+" mA")
```

Scilab code Exa 3.10 Voltage gain

```
// Exa 3.10
format('v',7);
clc;
clear;
close;
// Given data
V_CC= 10;// in V
V_BB= 3;// in V
V_BE= 0.7;// in V
V_T= 25*10^-3;// in V
bita=100;
RC= 3;// in  k
RC=RC*10^3;// in
RB= 100;// in  k
RB=RB*10^3;// in
I_B= (V_BB-V_BE)/RB;// in V
I_C= bita*I_B;// in A
V_C= V_CC-I_C*RC;// in V
gm= I_C/V_T;// in A/V
r_pi= bita/gm;// in
// v_be= r_pi/(RB+r_pi)*v_i
v_be_by_v_i= r_pi/(RB+r_pi);
// v_o= -gm*v_be*RC
v_o_by_v_i= -gm*v_be_by_v_i*RC;// in V/V
Av= v_o_by_v_i;// in V/V
disp(round(Av),"Voltage gain in V/V is : ")
```

Scilab code Exa 3.11 All node voltages and currents

```
// Exa 3.11
```

```
format('v',5);
clc;
clear;
close;
// Given data
V_B= 4;// in V
V_BE= 0.7;// in V
V_CC= 10;// in V
V_E= V_B-V_BE;// in V
R_E= 3.3;// in k
R_E=R_E*10^3;// in
RC= 4.7;// in k
RC=RC*10^3;// in
I_E= V_E/R_E;// in A
bita=100;
alpha= bita/(1+bita);
I_C= alpha*I_E;//in A
disp(I_C*10^3,"The value of I_C in mA is : ")
V_C= V_CC-I_C*RC;// in V
disp(V_C,"The value of V_C in volts is : ")
I_B= I_E/(1+bita);// in A
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

```
// Exa 3.12
format('v',7);
clc;
clear;
close;
// Given data
V_B= 5;// in V
V_BE= 0.7;// in V
V_CC= 10;// in V
bita=100;
```

```
R_B= 100;// in k
R_C= 2;// in k
R_B=R_B*10^3;// in
R_C=R_C*10^3;// in
I_B= (V_B-V_BE)/R_B;// in A
I_C= bita*I_B;//in A
V_C= V_CC-I_C*R_C;// in V
I_E= I_C;// in A (approx)
disp(I_B*10^3,"The value of I_B in mA is : ")
disp(I_C*10^3,"The value of I_C in mA is : ")
disp(V_C,"The value of V_C in volts is : ")
disp(I_E*10^3,"The value of I_E in mAis : ")
```

Scilab code Exa 3.13 All node voltage and all branch current

```
// Exa 3.13
format('v',5);
clc;
clear;
close;
// Given data
V_B= 0;// in V
V_EB= 0.7;// in V
bita=100;
V_EC= 0.2;// in V
V_E= V_EB+V_B;// in V
V_CC= 5;// in V
R_C= 1;// in k
R_C=R_C*10^3;// in
R_B= 10;// in k
R_B= R_B*10^3;// in
// V_E= V_B+V_EB          (i)
// V_C= V_E-V_EC= V_B+V_EB-V_EC       (ii)
// I_E= (V_CC-V_E)/R_C= (V_CC-V_B-V_EB)/R_C        (iii
    )
```

```
// I_B= V_B/R_B                         (iv)
// I_C= (V_C+V_CC)/R_C= (V_B+V_EB-V_EC+V_CC)/R_B
      (v)
// By using relationship , I_E= I_B+I_C
V_B= (9*V_CC-11*V_EB+V_EC)/12;// in V
V_E= V_B+V_EB;// in V
V_C= V_B+V_EB-V_EC;// in V
I_E= (V_CC-V_B-V_EB)/R_C// in amp
I_C= (V_B+V_EB-V_EC+V_CC)/R_B;// in amp
I_B= V_B/R_B;// in amp
disp(V_B,"The value of V_B in volts is : ")
disp(V_E,"The value of V_E in volts is : ")
disp(V_C,"The value of V_C in volts is : ")
disp(I_E*10^3,"The value of I_E in mA is : ")
disp(I_C*10^3,"The value of I_C in mA is : ")
disp(I_B*10^3,"The value of I_B in mA is : ")
```

Scilab code Exa 3.14 Region in which Q point lie

```
// Exa 3.14
format('v',5);
clc;
clear;
close;
// Given data
bita=100;
hFE= 100;
VCEsat= 0.2;// in V
VBEsat= 0.8;// in V
VBEactive= 0.7;// in V
VBB= 5;// in V
VCC= 10;// in V
R_C= 3;// in k
R_C=R_C*10^3;// in
R_B= 50;// in k
```

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

Scilab code Exa 3.16 Value of Bita

```
// Exa 3.16
format('v',7);
clc;
clear;
close;
// Given data
// bita= alpha/(1-alpha)
// At alpha= 0.5
alpha= 0.5;
bita=  alpha/(1-alpha);
disp(bita,"At alpha=0.5, the value of bita is : ")
// At alpha= 0.9
alpha= 0.9;
bita = alpha/(1-alpha);
disp(bita,"At alpha=0.9, the value of bita is : ")
// At alpha= 0.5
alpha= 0.999;
bita= alpha/(1-alpha);
disp(bita,"At alpha=0.999, the value of bita is : ")
```

Scilab code Exa 3.17 Value of Bita

```
// Exa 3.17
format('v',6);
clc;
clear;
close;
// Given data
// alpha= bita/(1-bita)
// At bita= 1
bita=1;
 alpha= bita/(1+bita);
 disp(alpha,"At bita=1, the value of alpha is : ")
 // At bita= 2
bita=2;
 alpha= bita/(1+bita);
 disp(alpha,"At bita=2, the value of alpha is : ")
// At bita= 100
bita=100;
 alpha= bita/(1+bita);
 disp(alpha,"At bita=100, the value of alpha is : ")
// At bita= 200
bita=200;
 alpha= bita/(1+bita);
 disp(alpha,"At bita=200, the value of alpha is : ")
```

Scilab code Exa 3.18 Value of Is Ic and VBE

```
 // Exa 3.18
format('v',9);
clc;
clear;
close;
// Given data
VBE= 0.76;// in V
VT= 0.025;// in V
I_C= 10*10^-3;// in A
```

```
// Formula I_C= I_S*%e^(VBE/VT)
I_S= I_C/(%e^(VBE/VT));// in A
disp(I_S,"The value of I_S in amp is : ")
// Part(a) for VBE = 0.7 V
VBE= 0.7;// in V
I_C= I_S*%e^(VBE/VT)
disp(I_C*10^3,"For VBE = 0.7 V , The value of I_C in mA is : ")

// Part (b) for I_C= 10  A
I_C= 10*10^-6;// in A
// Formula I_C= I_S*%e^(VBE/VT)
VBE= VT*log(I_C/I_S);
disp(VBE,"For I_C = 10  A , The value of VBE in V is : ")
```

Scilab code Exa 3.19 Transistor model

```
// Exa 3.19
format('v',9);
clc;
clear;
close;
// Given data
VBE= 0.7;// in V
VT= 0.025;// in V
I_B= 100;// in  A
I_B=I_B*10^-6;// in A
I_C= 10*10^-3;// in A
// Formula I_C= I_S*%e^(VBE/VT)
I_S= I_C/(%e^(VBE/VT));// in A
alpha= I_C/(I_C+I_B);
bita= I_C/I_B;
IS_by_alpha= I_S/alpha;// in A
IS_by_bita= I_S/bita;// in A
```

```
disp(alpha,"The value of alpha is : ");
disp(bita,"The value of bita is : ");
disp(IS_by_alpha,"The value of Is/alpha in A is :");
disp(IS_by_bita,"The value of Is/bita in A is : ");
```

Scilab code Exa 3.20 Labelled current and voltage

```
// Exa 3.20
format('v',7);
clc;
clear;
close;
// Given data
VBE= 0.7;// in V
VCC= 10.7;// in V
R_C= 10;//in k
R_C=R_C*10^3;// in
R_B= 10;//in k
R_B=R_B*10^3;// in
I1= (VCC-VBE)/R_C;// in A
disp(I1*10^3,"The value of I1 in mA is : ")
// Part (b)
VC= -4;//in V
VB= -10;// in V
R_C= 5.6;//in k
R_C=R_C*10^3;// in
R_B= 2.4;//in k
R_B=R_B*10^3;// in
VCC=12;// V
I_C= (VC-VB)/R_B;// in A
V2= VCC- (R_C*I_C);
disp(V2,"The value of V2 in volt is : ");
// Part (c)
VCC= 0;
VCE= -10;// in V
```

```
R_C= 10;//in  k
R_C=R_C*10^3;// in
I_C= (VCC-VCE)/R_C;// in A
V4= 1;// in V
I3= I_C;// in A (approx)
disp(V4,"The value of V4 in volt is : ");
disp(I3*10^3,"The value of I3 in mA is : ")
// Part (d)
VBE= -10;// in V
VCC= 10;// in V
R_B= 5;//in  k
R_B=R_B*10^3;// in
R_C= 15;//in  k
R_C=R_C*10^3;// in
// I5= I_C and
// I5= (V6-0.7-VBE)/R_B and I_C= (VCC-V6)/R_C
V6= (VCC*R_B+R_C*(0.7+VBE))/(R_C+R_B);
disp(V6,"The value of V6 in volt is : ")
I5= (V6-0.7-VBE)/R_B;// in A
disp(I5*10^3,"The value of I5 in mA is : ")
```

Scilab code Exa 3.21 Value of bita and labelled voltage

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

```
R_B=R_B*10^3;// in
I_C= V_C/R_C;// in A
I_B= V_B/R_B;// in A
Beta= I_C/I_B;
disp("Part (a)")
disp(I_C*10^3,"Collector current in mA is : ")
disp(I_B*10^6,"Base current in  A is : ")
disp(Beta,"The value of Beta is : ")

// Part (b)
V_C= 2.3;// in V
R_C= 230;// in k
R_C=R_C*10^3;// in
V_B= 4.3;// in V
R_B= 20;// in k
R_B=R_B*10^3;// in
I= V_C/R_C;// current through 230  resistro i.e. I_C + I_B in A
I_B= (V_B-V_C)/R_B;// in A
I_C= I-I_B;// in A
Beta= abs(I_C/I_B);
disp("Part (b)")
disp(I_C*10^3,"Collector current in mA is : ")
disp(I_B*10^3,"Base current in mA is : ")
disp(Beta,"The value of Beta is : ")

// Part (c)
V_E= 10;// in V
R_E= 1;// in k
R_E=R_E*10^3;// in
V_1= 7;// in V
R_C= 1;// in k
R_C=R_C*10^3;// in
V_B= 6.3;// in V
R_B= 100;// in k
R_B=R_B*10^3;// in
I_E= (V_E-V_1)/R_C;//in A
I_C=I_E;// in A (approx)
```

```
V_C= I_C*R_C;// in V
I_B= (V_B-V_C)/R_B;// in A
Beta= I_E/I_B-1;
disp("Part (c)")
disp(I_E*10^3,"Emitter current in mA is : ")
disp(I_B*10^6,"Base current in  A is : ")
disp(V_C,"Collector voltage in volts is : ")
disp(Beta,"The value of Beta is : ")

// Note : In the book the value of base current in the first part is wrong due to calculation error.
//            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

```
    // Exa 3.22
format('v',6);
clc;
clear;
close;
// Given data
// Part (a)
bita= 30;
R_C= 2.2;// in  k
R_C=R_C*10^3;// in
R_B= 2.2;// in  k
R_B=R_B*10^3;// in
VCC= 3;// in V
VCE= -3;// in V
VBE= 0.7;// in V
V_B= 0;// in V
V_E= V_B-VBE;// in V
I_E= (V_E-VCE)/R_B;// in A
```

```
I_C= I_E;// in A
V_C= VCC-I_E*R_C;// in V
I_B= I_C/bita;// in A
disp("Part (a)")
disp(V_B,"The value of V_B in V is : ")
disp(V_E,"The value of V_E in V is : ")
disp(I_E*10^3,"The value of I_E in mA is : ")
disp(V_C,"The value of V_C in V is : ")
disp(I_B*10^3,"The value of I_B in mA is : ")
// Part (b)
R_C= 560;// in
R_B= 1.1;// in k
R_B=R_B*10^3;// in
VCC= 9;// in V
VCE= 3;// in V
V_B= 3;// in V
V_E= V_B+VBE;// in V
I_E= (VCC-V_E)/R_B;// in A
alpha= bita/(1+bita);
I_C= I_E*alpha;// in A
V_C= I_C*R_C;// in V
I_B= I_C/bita;// in A
disp("Part (b)")
disp(V_B,"The value of V_B in V is : ")
disp(V_E,"The value of V_E in V is : ")
disp(I_C*10^3,"The value of I_E in mA is : ")
disp(V_C,"The value of V_C in V is : ")
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

```
// Exa 3.23
format('v',5);
clc;
clear;
```

```
close;
// Given data
VBE= 0.7;// in V
VCC= 9;// in V
VCE= -9;// in V
V_B= -1.5;// in V
R_C= 10;// in k
R_C=R_C*10^3;// in
R_B= 10;// in k
R_B=R_B*10^3;// in
I_B=  abs(V_B)/R_B;// in A
V_E= V_B-VBE;// in V
disp(V_E,"The value of V_E in volt is : ")
I_E= (V_E-VCE)/R_B;// in A
Beta= I_E/I_B-1;
alpha= Beta/(1+Beta);
disp(alpha,"The value of alpha in volt is : ")
disp(Beta,"The value of Beta in volt is : ")
V_C= VCC-I_E*alpha*R_C;// in V
disp(V_C,"The value of V_C in volt is : ")
// When Beta = infinite then
alpha= 1 ;// As infinite/(1+infinite) = 1
I_B= 0;
V_B=0;
V_C= VCC-I_E*R_C;// in volt
disp("When Beta =  infinite then :-")
disp(V_B,"The value of V_B in volt is : ")
disp(V_E,"The value of V_E in volt is : ")
disp(V_C,"The value of V_C in volt is : ")
```

Scilab code Exa 3.24 Current flow

```
// Exa 3.24
format('v',5);
clc;
```

```
clear;
close;
// Given data
VBE_1= 0.7;// in V
VBE_2= 0.5;// in V
V_T= 0.025;// in V
I_C1= 10;// in mV
I_C1= I_C1*10^-3;// in A
//  I_C1= I_S*%e^(VBE_1/V_T)          (i)
//  I_C2= I_S*%e^(VBE_2/V_T)          (ii)
// Devide equation (ii) by (i)
I_C2= I_C1*%e^((VBE_2-VBE_1)/V_T);// in A
disp(I_C2*10^6,"The value of I_C2 in  A is : ")
```

Scilab code Exa 3.25 Voltage gain

```
// Exa 3.25
format('v',7);
clc;
clear;
close;
// Given data
R1= 10;// in  k
R1=R1*10^3;// in
R2= 10;// in  k
R2=R2*10^3;// in
I_C=.5;// mA
V_T= 0.025;//in V
I_C= I_C*10^-3;// in A
V= 10;// in V
Vth= V*R1/(R1+R2);// in V
Rth=  R1*R2/(R1+R2);//in
vo= I_C*Rth;// in V
vi=V_T;// in V
vo_by_vi= vo/vi;//in V/V
```

```
disp(vo_by_vi,"The value of vo/vi in V/V is : ")
```

Scilab code Exa 3.27 Value of VB VC and VE

```
// Exa 3.27
format('v',7);
clc;
clear;
close;
// Given data
V_B= 2;// in V
V_CC=5;// in V
V_BE= 0.7;// in V
R_E= 1*10^3;// in
R_C= 1*10^3;// in
V_E= V_B-V_BE;// in V
I_E= V_E/R_E;// in A
I_C= I_E;// in A
V_C= V_CC-I_C*R_C;//in V
disp("At V_B= +2 V")
disp(V_E,"The value of V_E in volts is : ")
disp(V_C,"The value of V_C in volts is : ")

// Part (b)
V_B= 0;//in V
V_E= 0;// in V
I_E=  0;// in A
V_C= 5;// in V
disp("At V_B= 0 V")
disp(V_E,"The value of V_E in volts is : ")
disp(V_C,"The value of V_C in volts is : ")
```

Scilab code Exa 3.28 Value of VE and VC

```
// Exa 3.28
format('v',7);
clc;
clear;
close;
// Given data
V_B= 0;// in V
R_E=1*10^3;//in
R_C=1*10^3;//in
V_CC=5;// in V
V_BE= 0.7;// in V
V_E= V_B-V_BE;// in V
I_E= (1+V_E)/R_E;// in A
I_C= I_E;// (approx) in A
V_C= V_CC-I_C*R_C;//in V
disp("Part (i)")
disp(V_E,"The value of V_E in volt is : ");
disp(V_C,"The value of V_C in volt is : ");
// For saturation
V_CE=0.2 ;// V
V_CB= -0.5;// in V
// I_C= 5-V_C/R_C and V_C= V_E-VCE, So
// I_C= (5.2-V_E)/R_C
// I_E= (V_E+1)/R_E and at the edge of saturation I_C=I_E,
V_E= 4.2/2;/// in V
V_B= V_E+0.7;// in V
V_C= V_E+0.2;// in V
disp("Part (ii) ")
disp(V_E,"The value of V_E in volts is : ");
disp(V_B,"The value of V_B in volts is : ");
disp(V_C,"The value of V_C in volts is : ");

// 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

```
// Exa 3.29
format('v',7);
clc;
clear;
close;
// Given data
V_CC=5;// in V
V_E= 1;// in V
V_BE= 0.7;// in V
R_E=5*10^3;//in
R_C=5*10^3;//in
R_B= 20*10^3;// in
I_E= (V_CC-V_E)/R_E;//  in A
// For pnp transistor V_BE= V_E-V_B
V_B= V_E-V_BE;// in V
I_B= V_B/R_B;// in A
I_C= I_E-I_B;// in A
V_C= I_C*R_C-V_CC;// in V
bita= I_C/I_B;
alpha= I_C/I_E;
disp(V_B,"The value of V_B in volts is : ");
disp(I_B*10^3,"The value of I_B in mA is : ");
disp(I_E*10^3,"The value of I_E in mA is : ");
disp(I_C*10^3,"The value of I_C in mA is : ");
disp(V_C,"The value of V_C in volts is : ");
disp(bita,"The value of bita is : ");
disp(alpha,"The value of alpha is : ");
```

Scilab code Exa 3.30 DC voltage and value of gm

```
// Exa 3.30
format('v',7);
clc;
clear;
close;
// Given data
V_CC=5;// in V
V_T= 0.025;// in V
R_C=7.5*10^3;//in
I_C= 0.5;// in mA
I_C= I_C*10^-3;// in A
I_E=I_C;// (approx) in A
V_C= V_CC-I_C*R_C;// in V
disp(V_C,"dc voltage at the collector in volt is : ")
gm= I_C/V_T;// in A/V
disp(gm*10^3,"The value of gm in mA/V is : ")
// v_be= -v_i
// v_c= -gm*v_be*R_C
vcbyvi= gm*R_C;// in V/V
disp(vcbyvi,"The value of vc/vi in V/V is : ")
```

Scilab code Exa 3.31 Input resistance and overall voltage gain

```
// Exa 3.31
format('v',7);
clc;
clear;
close;
// Given data
V_T= 0.025;// in V
I_E= 0.5;// in mA
I_E= I_E*10^-3;// in mA
Rsig= 50;// in
R_C= 5*10^3;// in
```

```
re= V_T/I_E;// in ohm
Rin= Rsig+re;// in ohm
disp(Rin,"Input resistance in  is : ")
// Part(b)
// vo= -0.99*ie*R_C and ie= -v_sig/Rin
vo_by_v_sig= 0.99*R_C/Rin;// in V/V
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

```
// Exa 3.32
format('v',4);
clc;
clear;
close;
// Given data
bita= 200;
alpha= bita/(1+bita);
R_C= 100;// in
R_B= 10;// in k
Rsig= 1;// in k
Rsig= Rsig*10^3;// in
R_B= R_B*10^3;// in
V_T= 25*10^-3;
V=1.5;// in V
I_E= 10;// in mA
I_E= I_E*10^-3;// in A
I_C= alpha*I_E;// in A
V_C= I_C*R_C;// in V
I_B= I_C/bita;// in A
V_B= V-(R_B*I_B)
gm= I_C/V_T;// in A/V
rpi= bita/gm;// in
Rib= rpi;// in
```

```
disp(Rib,"The value of Rib in    is : ")
Rin= R_B*rpi/(R_B+rpi);// in
disp(Rin,"The value of Rin in    is : ")
// vbe= v_sig*Rin/(Rsig+Rin);
vbe_by_vsig= Rin/(Rsig+Rin);
// vo= -gm*vbe*R_C and = -gm*v_sig*Rin/(Rsig+Rin)
vo_by_vsig= -gm*R_C*vbe_by_vsig;// in V/V
disp(vo_by_vsig,"Overall voltage gain in V/V is : ")
// if
vo= 0.4;//(  ) in V
vs= vo/abs(vo_by_vsig);// in V
vbe= vbe_by_vsig*vs;// in V
disp(vs*10^3,"The value of v_sig in mV is : ")
disp(vbe*10^3,"The value of v_be in mV is : ")

// 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

```
// Exa 3.33
format('v',7);
clc;
clear;
close;
// Given data
V_T= 0.025;// in V
// Part(a)
disp("Part (a)")
V_BE= 690;// in mV
V_BE=V_BE*10^-3;// in V
I_C= 1;// in mA
I_B= 50;// in   A
I_C=I_C*10^-3;// in A
I_B=I_B*10^-6;// in A
```

```
bita= I_C/I_B;
alpha= bita/(1+bita);
I_E= I_C/alpha;// in A
// I_C= I_S*%e^(V_BE/V_T)
I_S= I_C/(%e^(V_BE/V_T));
disp(bita,"The value of bita is : ")
disp(alpha,"The value of alpha is : ")
disp(I_E*10^3,"The value of I_E in mA is : ")
disp(I_S,"The value of I_S in amp is : ")

// Part(b)
disp("Part (b)")
V_BE= 690;// in mV
V_BE=V_BE*10^-3;// in V
I_C= 1;// in mA
I_C=I_C*10^-3;// in A
I_E= 1.070;// in mA
I_E=I_E*10^-3;// in A
bita= I_C/I_B;
alpha= I_C/I_E;
bita= alpha/(1-alpha);
I_B= I_C/bita;// in A
// I_C= I_S*%e^(V_BE/V_T)
I_S= I_C/(%e^(V_BE/V_T));
disp(bita,"The value of bita is : ")
disp(alpha,"The value of alpha is : ")
disp(I_B*10^6,"The value of I_B in  A is : ")
disp(I_S,"The value of I_S in amp is : ")

// Part(c)
disp("Part (C)")
V_BE= 580;// in mV
V_BE=V_BE*10^-3;// in V
I_E= 0.137;// in mA
I_B= 7;// in  A
I_E=I_E*10^-3;// in A
I_B=I_B*10^-6;// in A
//  I_C= alpha*I_E  = bita*I_B
```

```
bita= I_E/I_B-1;
alpha= bita/(1+bita);
I_C= bita*I_B;// in A
// I_C= I_S*%e^(V_BE/V_T)
I_S= I_C/(%e^(V_BE/V_T));
disp(bita,"The value of bita is : ")
disp(alpha,"The value of alpha is : ")
disp(I_C*10^3,"The value of I_C in mA is : ")
disp(I_S,"The value of I_S in amp is : ")

// Part(d)
disp("Part (d)")
V_BE= 780;// in mV
V_BE=V_BE*10^-3;// in V
I_C= 10.10;// in mA
I_B= 120;// in  A
I_C=I_C*10^-3;// in A
I_B=I_B*10^-6;// in A
bita= I_C/I_B;
alpha= bita/(1+bita);
I_E= I_C/alpha;// in A
// I_C= I_S*%e^(V_BE/V_T)
I_S= I_C/(%e^(V_BE/V_T));
disp(bita,"The value of bita is : ")
disp(alpha,"The value of alpha is : ")
disp(I_E*10^3,"The value of I_E in mA is : ")
disp(I_S,"The value of I_S in amp is : ")

// Part(e)
disp("Part (e)")
V_BE= 820;// in mV
V_BE=V_BE*10^-3;// in V
I_E= 75;// in mA
I_B= 1050;// in  A
I_E=I_E*10^-3;// in A
I_B=I_B*10^-6;// in A
//  I_C= alpha*I_E  = bita*I_B
bita= I_E/I_B-1;
```

```
alpha= bita/(1+bita);
I_C= bita*I_B;// in A
// I_C= I_S*%e^(V_BE/V_T)
I_S= I_C/(%e^(V_BE/V_T));
disp(bita,"The value of bita is : ")
disp(alpha,"The value of alpha is : ")
disp(I_C*10^3,"The value of I_C in mA is : ")
disp(I_S,"The value of I_S in amp is : ")
```

Chapter 4

Differential Amplifiers

Scilab code Exa 4.1 Value of ic1 and vce1

```
// Exa 4.1
format('v',7);
clc;
clear;
close;
// Given data
V_CC= 10;// in volt
V_EE= -10;// in volt
I= 1;// in mA
I=I*10^-3;// in A
R_C= 10;// in kohm
R_C=R_C*10^3;// in kohm
V_BE=0.7;// in volt

i_C1= I/2;// in A
i_C2= i_C1;// in A
disp(i_C1*10^3,"Value of i_C1 in mA is : ")

V_C1= V_CC-i_C1*R_C;// in V
// For V_cm=0 volt
V_E= -0.7;// in volt
```

```
V_CE1= V_C1-V_E;// in volt
disp(V_CE1,"For V_cm =0 , The alue of V_CE1 in volt is ")

// For V_cm= -5 volt
V_cm= -5;// in V
V_B= V_cm;// in V
// From V_BE= V_B-V_E
V_E= V_B-V_BE;// in volt
V_CE1= V_C1-V_E;// in volt
disp(V_CE1,"For V_cm =-5V , The alue of V_CE1 in volt is ")

// For V_cm= 5 volt
V_cm= 5;// in V
V_B= V_cm;// in V
V_E= V_B-V_BE;// in volt
V_CE1= V_C1-V_E;// in volt
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

```
// Exa 4.2
format('v',5);
clc;
clear;
close;
// Given data
V_DD= 1.5;// in V
V_SS= V_DD;// in V
KnWL= 4;// in mA/V^2
KnWL=KnWL*10^-3;// in A/V^2
Vt= 0.5;// in V
I=0.4;// in mA
```

```
I=I*10^-3;//in A
R_D= 2.5;// in  k
R_D= R_D*10^3;// in

// Part (a)
disp("Part (a)")
V_OV= sqrt(I/KnWL);// in V
V_GS= V_OV+Vt;// in V
disp(V_OV,"Value of V_OV in volt is : ")
disp(V_GS,"Value of V_GS in volt is : ")

// Part (b)
disp("Part (b)")
V_CM= 0;// in volt
V_S= -V_GS;// in volt
disp(V_S,"Value of V_S in volt is :")
I=0.4;// in mA
i_D1= I/2;// in mA
disp(i_D1,"Value of i_D1 in mA is :")
i_D1=i_D1*10^-3;// in A
V_D1= V_DD-i_D1*R_D;// in V
V_D2=V_D1;// in V
disp(V_D1,"Value of V_D1 in volt is ")
disp(V_D2,"Value of V_D2 in volt is ")


// Part (c)
disp("Part (c)")
V_CM=1;// in V
V_GS= 0.82;// in V
V_G= 1;// in V
V_S= V_G-V_GS;// in V
disp(V_S,"Value of V_S in volt is :")
i_D1= I/2;// in mA
disp(i_D1,"Value of i_D1 in mA is :")
i_D1=i_D1*10^-3;// in A
V_D1= V_DD-i_D1*R_D;// in V
V_D2=V_D1;// in V
```

```
disp(V_D1,"Value of V_D1 in volt is ")
disp(V_D2,"Value of V_D2 in volt is ")

// Part (d)
disp("Part (d)")
V_CM_max= Vt+V_DD-i_D1*R_D
disp(V_CM_max,"Highest value of V_CM in volt is :")

// Part (e)
V_S= 0.4;// in V
disp("Part (e)")
V_CM_min= -V_SS+V_S+Vt+V_OV;// in V
disp(V_CM_min,"Lowest value of V_CM in volt is")
V_Smin= V_CM_min-V_GS;// in volt
disp(V_Smin,"Lowest value of V_S in volt is")
```

Scilab code Exa 4.3 Required values of WbyL

```
// Exa 4.3
format('v',7);
clc;
clear;
close;
format('v',5)
// Given data
I= 0.4;// in mA
unCox= 0.2;// in mA/V^2
i_D= I/2;// in mA
V_OV1= 0.2;// in V
V_OV2= 0.3;// in V
V_OV3= 0.4;// in V
WbyL1= 2*i_D/(unCox*V_OV1^2);
gm1= I/V_OV1;// in mA/V
WbyL2= 2*i_D/(unCox*V_OV2^2);
gm2= I/V_OV2;// in mA/V
```

```
WbyL3= 2*i_D/(unCox*V_OV3^2);
gm3= I/V_OV3;// in mA/V
disp("Vov (in V)            "+string(V_OV1)+"            "+string(V_OV2)+"            "+string(V_OV3))
disp("W/L                   "+string(WbyL1)+"            "+string(WbyL2)+"            "+string(WbyL3))
disp("gm(in mA/V)           "+string(gm1)+"            "+string(gm2)+"            "+string(gm3))
```

Scilab code Exa 4.4 Value of VOV gm ro and Ad

```
// Exa 4.4
format('v',7);
clc;
clear;
close;
// Given data
format('v',11)
V_A= 20;// in V
R_D= 5;// in k
R_D= R_D*10^3;// in
I= 0.8;// in mA
I=I*10^-3;// in A
i_D= I/2;// in A
unCox= 0.2;// mA/V^2
unCox= unCox*10^-3;// in A/V^2
WbyL= 100;
// Formula i_D= 1/2*unCox*WbyL*V_OV^2
V_OV= sqrt(2*i_D/(unCox*WbyL));// in V
disp(V_OV,"The value of V_OV in volts is : ")
gm= I/V_OV;// in A/V;
disp(gm*10^3,"The value of gm in mA/V is : ")
r_o= V_A/i_D;// in
```

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

Scilab code Exa 4.5 Differential gain

```
// Exa 4.5
format('v',7);
clc;
clear;
close;
// Given data
R_D= 5;// in k
R_D= R_D*10^3;// in
R_SS= 25;// in k
R_SS= R_SS*10^3;// in
I= 0.8;// in mA
I=I*10^-3;// in A
i_D= I/2;// in A
unCox= 0.2;// mA/V^2
unCox= unCox*10^-3;// in A/V^2
WbyL= 100;
// Formula i_D= 1/2*unCox*WbyL*V_OV^2
V_OV= sqrt(2*i_D/(unCox*WbyL));// in V
gm= i_D/V_OV;// in A/V;

// Part (a)
Ad= 1/2*gm*R_D;// in V/V
disp(Ad," Differential gain in V/V is : ")
Acm= -R_D/(2*R_SS);// in V/V
disp(Acm,"Common mode gain in V/V is ")
CMRR= abs(Ad)/abs(Acm);
CMRRindB= round(20*log10(CMRR));// in dB
disp(CMRRindB,"Common mode rejection ratio in dB is
```

```
    : ")


// Part (b)
disp("Part (b) when output is taken differentially")
Ad= gm*R_D;// in V/V
disp(Ad,"Differential gain in V/V is : ")
Acm= 0;
disp(Acm,"Common mode gain in V/V is ")
// CMRRindB= 20*log10(Ad/Acm) = infinite ;// in dB
disp("Common mode rejection ratio in dB is : ")
disp("infinite");

// Part (c)
disp("Part (c) when output is taken differentially
    but the drain resistance have a 1% mismatch.")
Ad= gm*R_D;// in V/V
disp(Ad,"Differential gain in V/V is : ")
// delta_R_D= 1% of R_D
delta_R_D= R_D*1/100;// in
Acm= R_D/(2*R_SS)*delta_R_D/R_D;// in V/V
disp(Acm,"Common mode gain in V/V is ")
CMRRindB= 20*log10(abs(Ad)/abs(Acm));// in dB
disp(CMRRindB,"Common mode rejection ratio in dB is
    : ")

// 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

```
// Exa 4.6
format('v',7);
```

```
clc;
clear;
close;
// Given data (From Exa 4.4)
R_D= 5;// in k
R_D= R_D*10^3;// in
R_SS= 25;// in k
R_SS= R_SS*10^3;// in
I= 0.8;// in mA
I=I*10^-3;// in A
i_D= I/2;// in A
unCox= 0.2;// mA/V^2
unCox= unCox*10^-3;// in A/V^2
WbyL= 100;
// Formula i_D= 1/2*unCox*WbyL*V_OV^2
V_OV= sqrt(2*i_D/(unCox*WbyL));// in V
gm= i_D/V_OV;// in A/V;
// gm mismatch have a negligible effect on Ad
Ad= gm*R_D;// in V/V(approx)
// delta_gm= 1% of gm
delta_gm = gm*1/100;// in A/V
Acm= R_D/(2*R_SS)*delta_gm/gm;
CMRRindB= 20*log10(Ad/Acm);
disp(CMRRindB,"CMRR in dB is : ")
```

Scilab code Exa 4.7 Value of VE VC1 and VC2

```
// Exa 4.7
format('v',7);
clc;
clear;
close;
// Given data
V_CM= 0;
V_BE= -0.7;// in volt
```

```
v_E= V_CM-V_BE;// in volt
disp(v_E,"Value of v_E in volts is : ")

I_E= (5-0.7)/10^3;// in A
v_B1= 0.5;// in V
v_B2= 0;// in V
// Due to Q1 is off; therefore
v_C1= -5;// in V
v_C2= I_E*10^3-5;// in V
disp(v_C1,"Value of v_C1 in volts is : ")
disp(v_C2,"Value of v_C2 in volts is : ")
```

Scilab code Exa 4.8 Input differential signal

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

Scilab code Exa 4.9 Input differential resistance

```
// Exa 4.9
format('v',4);
clc;
```

```
clear;
close;
// Given data
Beta= 100;

// Part (a)
RE= 150;// in
VT= 25;// in mV
VT= VT*10^-3;// in V
IE= 0.5;// in mA
IE=IE*10^-3;// in A
re1= VT/IE;//in
R_id= 2*(Beta+1)*(re1+RE);// in
R_id= round(R_id*10^-3);// in k
disp(R_id,"The input differential resistance in k
   is :")

// Part (b)
RC=10;//in k
RC=RC*10^3;//in
Rsig= 5+5;// in k
VoltageGain1= R_id/(Rsig+R_id);//voltage gain from
   the signal source to the base of Q1 and Q2 in V/V
VoltageGain2= 2*RC/(2*(re1+RE));// voltage gain from
    the bases to the output in V/V
Ad= VoltageGain1*VoltageGain2;//in V/V
disp(Ad,"The overall differential voltage gain in V/
   V is ");

// Part (c)
format('e',9)
delta_RC= 0.02*RC;
R_EE= 200;//in k
R_EE=R_EE*10^3;//in
Acm= RC/(2*R_EE)*delta_RC/RC;//in V/V
disp(Acm,"Common mode gain in V/V is :")

// Part (d)
```

```
format('v',4);
CMRRindB= 20*log10(Ad/Acm);// in dB
disp(CMRRindB,"CMRR in dB is : ")

// Part (e)
V_A= 100;// in V
r_o= V_A/(IE);// in
// Ricm= (Beta+1)*(R_EE || r_o/2)
Ricm= (Beta+1)*(R_EE*(r_o/2)/(R_EE+(r_o/2)));
disp(Ricm*10^-6,"Input common mode resistance in M is : ")
```

Scilab code Exa 4.10 Three components of input offset voltage

```
// Exa 4.10
format('v',4);
clc;
clear;
close;
// Given data
delta_RDbyRD= 2/100;
delta_WLbyWL= 2/100;
delta_Vt= 2;//in mV
delta_Vt= delta_Vt*10^-3;// in V
//(From Exa 4.4)
V_A= 20;// in V
R_D= 5;// in k
R_D= R_D*10^3;// in
I= 0.8;// in mA
I=I*10^-3;// in A
i_D= I/2;// in A
unCox= 0.2;// mA/V^2
unCox= unCox*10^-3;// in A/V^2
WbyL= 100;
// Formula i_D= 1/2*unCox*WbyL*V_OV^2
```

```
V_OV= sqrt(2*i_D/(unCox*WbyL));// in V
V_OS1= V_OV/2*delta_RDbyRD;// in V

// V_OS due to W/L ratio
V_OS2= V_OV/2*delta_WLbyWL;// in V

// V_OS due to threshold voltage
V_OS3= delta_Vt;// in V
// Total offset voltage
V_OS= sqrt(V_OS1^2+V_OS2^2+V_OS3^2);// in V
V_OS= V_OS*10^3;// in mV
disp(V_OS,"Total offset voltage in mV is : ")
```

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

```
// Exa 4.11
format('v',7);
clc;
clear;
close;
// Given data
WLn= 100;
WLp= 200;
unCox= 0.2;// mA/V^2
unCox=unCox*10^-3;//in A/V^2
RSS= 25;// in k
RSS= RSS*10^3;// in
I=0.8;// in mA
I=I*10^-3;//in A
V_A= 20;// in V
i_D= I/2;// in A
// Formula i_D= 1/2*unCox*WLn*V_OV^2
V_OV= sqrt(2*i_D/(unCox*WLn));// in V
gm= I/V_OV;// in A/V
disp(gm*10^3,"Value of Gm in mA/V is : ")
```

```
ro2= V_A/(I/2);// in ohm
ro4= ro2;// in ohm
Ro= ro2*ro4/(ro2+ro4);// in ohm
disp(Ro*10^-3,"Value of Ro in k   is : ")
Ad= gm*Ro;// in V/V
disp(Ad,"Value  of Ad in V/V is :")
// Finding the value of gm3
upCox= 0.1;// mA/V^2
upCox=upCox*10^-3;//in A/V^2
// Formula i_D= 1/2*upCox*WLp*V_OV^2
V_OV= sqrt(2*i_D/(upCox*WLp));// in V
gm3= I/V_OV;// in A/V
Acm= 1/(2*gm3*RSS);//in V/V
disp(abs(Acm),"Value of |Acm| in V/V is : ")
CMRRindB= 20*log10(abs(Ad)/abs(Acm));//in dB
disp(round(CMRRindB),"CMRR in dB is :")
```

Scilab code Exa 4.12 Value of Gm Ro Ad and Rid

```
// Exa 4.12
format('v',7);
clc;
clear;
close;
// Given data
I=0.8;// in mA
I=I*10^-3;//in A
V_A= 100;// in V
Bita=160;
VT=25;// in mV
VT= VT*10^-3;//in V
gm= (I/2)/VT;// in A/V
Gm= gm;// Short circuit trnsconductance in mA/V
disp(Gm*10^3,"The value of Gm in mA/V")
ro2= V_A/(I/2);// in ohm
```

```
ro4= ro2;// in ohm
Ro= ro2*ro4/(ro2+ro4);// in ohm
disp(Ro*10^-3,"The value of Ro in k  is :")
Ad= Gm*Ro;// in V/V
disp(Ad,"Value  of Ad in V/V is :")
r_pi= Bita/gm;//in
Rid= 2*r_pi;// in
disp(Rid*10^-3,"The value of Rid in k  is :")
```

Scilab code Exa 4.13 Value of VOV and VGS

```
// Exa 4.13
format('v',5);
clc;
clear;
close;
// Given data
Vtp= -0.8;// in V
KpWL= 3.5;// in mA/V^2
I=0.7;// in mA
I=I*10^-3;// in A
R_D= 2;// in k
R_D=R_D*10^3;// in
KpWL=KpWL*10^-3;//in A/V^2
v_G1= 0;// in V
v_G2=v_G1;// in V
VSS= 2.5;// in V
VDD=VSS;// in V
VCS= 0.5;// in V
// Part (a)
V_OV= -sqrt(I/KpWL);// in V
disp(V_OV,"The value of V_OV in volts is : ")
V_GS= V_OV+Vtp;// in V
disp(V_GS,"The value of V_GS in volts is : ")
V_G= 0;// as gate is connected ground
```

```
v_S1= V_G-V_GS;// in V
v_S2= v_S1;// in V
disp(v_S1,"The value of V_S in volts is : ")
v_D1= I/2*R_D-VDD;// in V
v_D2=v_D1;// in V
disp(v_D1,"The value of v_D1 in V is : ")
disp(v_D2,"The value of v_D2 in V is : ")

// Part (b)
V_CMmin= I*R_D/2-VDD+Vtp;// in V
V_CMmax= VSS-VCS+Vtp+V_OV;// in V
disp(V_CMmin,"The value of V_CMmin in volt is : ")
disp(V_CMmax,"The value of V_CMmax in volt is : ")
```

Scilab code Exa 4.14 Ratio of W and L

```
// Exa 4.14
format('v',5);
clc;
clear;
close;
// Given data
V_OV= 0.2;// in V
gm=1;// in mA/V
gm=gm*10^-3;// in A/V
Vt=0.8;// in V
unCox= 90;// in  A /V^2
unCox=unCox*10^-6;// in A/V^2
// gm= I/V_OV
I= gm*V_OV;// in A
disp(I*10^3,"Bias current in mA is : ")
I_D= I/2;// in A
// Formula I_D= 1/2*unCox*WLn*V_OV^2
WbyL= 2*I_D/(unCox*V_OV^2);
disp(WbyL,"W/L ratio is : ")
```

Scilab code Exa 4.15 Value of VOV gm ro and Ad

```
// Exa 4.15
format('v',5);
clc;
clear;
close;
// Given data
I=0.5;// in mA
I=I*10^-3;// in A
WbyL= 50;
unCox= 250;// in   A /V^2
unCox=unCox*10^-6;// in A/V^2
V_A= 10;// in V
R_D= 4;//in  k
R_D= R_D*10^3;//in
V_OV= sqrt(I/(WbyL*unCox));//in V
disp(V_OV,"The value of V_OV in V is : ")
gm= I/V_OV;// in A/V
disp(gm*10^3,"The value of gm in mA/V is ")
I_D=I/2;// in A
ro= V_A/I_D;// in
disp(ro*10^-3,"The value of ro in k   is : ")
Ad= gm*(R_D*ro/(R_D+ro));// in V/V
disp(Ad,"The value of Ad in V/V is : ")
```

Scilab code Exa 4.16 Voltage at emitter and outputs

```
// Exa 4.16
format('v',7);
clc;
```

```
clear;
close;
// Given data
I=1;// in mA
I=I*10^-3;// in A
i_C=1;// in mA
i_C=i_C*10^-3;// in A
V_CC= 5;// in V
V_CM= -2;// in V
V_BE= 0.7;// in V
R_C= 3;// in  k
R_C= R_C*10^3;// in
Alpha=1;
Bita=100;
V_B= 1;// in V
i_C1= Alpha*I;// in A
i_C2=0;
v_E= V_B-V_BE;// in V
disp(v_E,"Emitters voltage in volts is : ")
v_C1= V_CC-i_C1*R_C;// in V
v_C2= V_CC-i_C2*R_C;// in V
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

```
// Exa 5.1
format('v',7);
clc;
clear;
close;
// Given data
A= 800;// unit less
Af= 50;// unit less
// Formula Af= A/(1+Bita*A)
Bita= 1/Af-1/A;
disp(Bita*100,"Percentage of output which is
   feedback to the input in % is  ")
```

Scilab code Exa 5.2 Value of alpha and Bita

```
// Exa 5.2
format('v',7);
clc;
```

```
clear;
close;
// Given data
Af= 100;// unit less
Vi= 50;// in mV
Vi= Vi*10^-3;// in V
Vs= 0.5;// in V
// Formula Af= Vo/Vs
Vo= Af*Vs;// in V
A= Vo/Vi;
disp(A,"Value of A is : ")
// Formula Af= A/(1+B*A)
B= 1/Af-1/A;
B=B*100;// in %
disp(B,"Value of B is in percent : ")
```

Scilab code Exa 5.3 Value of fL and fH

```
// Exa 5.3
format('v',5);
clc;
clear;
close;
// Given data
Bita= 5/100;
f_H= 50;// in kHz
f_H= f_H*10^3;// in Hz
f_L= 50;// in kHz
Amid= 1000;
f_LF= f_L/(1+Bita*Amid);// in Hz
f_HF= f_H*(1+Bita*Amid);// in Hz
disp(f_LF,"Value of f_LF in Hz is : ")
disp(f_HF*10^-6,"Value of f_LF in MHz is : ")
```

Scilab code Exa 5.4 Value of bita and Af

```
// Exa 5.4
format('v',6);
clc;
clear;
close;
// Given data
dAf_by_Af= 0.2/100;
dA_by_A= 150/2000;
A=2000;
// Formula dAf_by_Af = 1/(1+Bita*A) * dA_by_A
Bita= dA_by_A/(A*dAf_by_Af )-1/A;
Af= A/(1+Bita*A);
disp(Bita*100,"Value of Bita in percent is ")
disp(Af,"Value of Af is : ")
```

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

```
// Exa 5.5
format('v',7);
clc;
clear;
close;
// Given data
Av= 140;
Avf= 17.5;
// Formula Avf= Av/(1+Av*Bita)
Bita= 1/Avf-1/Av;
disp(Bita,"Fraction of the output is ")
```

Scilab code Exa 5.6 Fraction of the output voltage feedback

```
// Exa 5.6
format('v',7);
clc;
clear;
close;
// Given data
Av= 100;
Avf= 50;
// Formula Avf= Av/(1+Av*Bita)
Bita= 1/Avf-1/Av;
disp(Bita,"The vlaue of bita is ")

// Part(ii)
Avf= 75;
// Formula Avf= Av/(1+Av*Bita)
Av= Avf/(1-Bita*Avf)
disp(Av,"Value of amplifier gain is : ")
```

Scilab code Exa 5.7 Percentage reduction in stage gain

```
// Exa 5.7
format('v',6);
clc;
clear;
close;
// Given data
Av= 50;
Avf= 25;
// Formula Avf= Av/(1+Av*Bita)
Bita= 1/Avf-1/Av;
```

```
// Part(i)
Av=50;
Avf= 40;
Perc_reduction= (Av-Avf)/Av*100;// Percentage of reduction in stage gain in %
disp(Perc_reduction,"Without feedback, percentage of reduction in stage gain in % is : ")

// Part(ii)
Av= 40;
Avf= 25;
gain_with_neg_feed= Av/(1+Bita*Av);
Perc_reduction= (Avf-gain_with_neg_feed)/Avf*100;// in %
disp(Perc_reduction,"With feedback, percentage reduction in stage gain in % is : ")
```

Scilab code Exa 5.8 Bandwidth of a feedback amplifiers

```
// Exa 5.8
format('v',7);
clc;
clear;
close;
// Given data
Ao= 10^4;
Afo= 50;
omega_H= 2*%pi*100;// in rad/s
// Formula Afo= Ao/(1+Ao*Bita)
Bita= 1/Afo-1/Ao;
omega_f_H= omega_H*(1+Ao*Bita);
disp("Closed loop bandwidth in rad/s is :  ")
disp(string(omega_f_H)+" or 2*%pi*20*10^3");
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 and Rof

```
// Exa 5.10
format('v',5);
clc;
clear;
close;
// Given data
gm=50;
R_E= 100;// in ohm
R_S= 1;// in kohm
R_S=R_S*10^3;// in ohm
r_pi= 1100;// in ohm
h_ie= r_pi;
// Formula Av= Vo/Vs, But Vo= gm*vpi*R_E and Vs= Ib *(Ri+rpi), so
Av= gm*R_E/(R_S+h_ie)
// As Vo=Vf, so
Bita=1;
D= 1+Bita*Av;
Avf= Av/D;
Ri= R_S+r_pi;// in ohm
Ri= Ri*10^-3;// in kohm
R_if= Ri*D;// in kohm
// Ro= infinite , so
// Rof= infinite
disp(Av,"Value of Av is : ")
disp(Bita,"Value of Bita is : ")
disp(D,"The value of D is : ")
disp(Avf,"Value of Avf is : ")
disp(Ri,"Value of Ri in kohm")
disp(R_if,"Value of R_if in kohm is : ")
disp("Value of Ro and Rof is : ")
disp("infinite")
```

Scilab code Exa 5.11 Value of Avf Rif Rof and bita

```
// Exa 5.11
format('v',5);
clc;
clear;
close;
// Given data
gm=2;// in mA/V
gm=gm*10^-3;// in A/V
r_d= 40;// in kohm
r_d= r_d*10^3;// in ohm
Rs= 3;// in kohm
Rs= Rs*10^3;// in ohm
miu= gm*r_d;
Bita=1;
Av= miu*Rs/(r_d+Rs);
D= 1+Bita*Av;
Avf= Av/D;
// Ri=infinite , so R_if = Ri*D = infinite
Rof= r_d/D;// in ohm
disp(Av,"Value of Av is : ")
disp(D,"Value of D is ")
disp(Avf,"Value of Avf is : ")
disp("Value of R_if is ")
disp("infinite")
disp(Rof,"Value of Rof in ohm is : ")
```

Scilab code Exa 5.12 Value of D Gmf Rif and Rof

```
// Exa 5.12
```

```
format('v',7);
clc;
clear;
close;
// Given data
gm=75;// in A/V
Rs= 1;// in kohm
Rs= Rs*10^3;// in ohm
R_E= 1;// in kohm
R_E= R_E*10^3;// in ohm
rpi= 1;// in kohm
rpi= rpi*10^3;// in ohm
hie=rpi;

Io= -gm;
Vi= Rs+R_E+rpi;
Gm= Io/Vi;
disp(Gm,"Value of Gm is : ")
Bita=-R_E;
disp(Bita,"Value of Bita is : ")
D= 1+Bita*Gm;
disp(D,"Value of D is : ")
Gmf= Gm/D;
disp(Gmf,"Value of Gmf is : ")
Ri= Rs+R_E+hie;// in ohm
Rif= Ri*D;// in ohm
Rif=Rif*10^-3;// in kohm
disp(Rif,"Value of Rif in kohm is : ")
// Ro=infinite , so R_of = Ro*D = infinite
disp("Value of R_of is ")
disp("infinite")
```

Scilab code Exa 5.19 Percentage change in Af

```
// Exa 5.19
```

```
format('v',4);
clc;
clear;
close;
// Given data
A= 10^5;
Af= 100;
// Formula Af= A/(1+A*Bita)
Bita= 1/Af-1/A;

//when A= 10^3
A=10^3;
Af_desh= A/(1+A*Bita);

delta_Af= Af_desh-Af;
Perc_Change_inAf= delta_Af/Af*100;// in %
disp(Perc_Change_inAf,"Percentage change in Af is :
    ")
```

Scilab code Exa 5.20 Percentage gain reduction

```
// Exa 5.20
format('v',5);
clc;
clear;
close;
// Given data
A= 100;
Vs=1;// in volt
Bita=1;// as in the voltage follower, the output
    voltage is same as input
Af= A/(1+Bita*A);
CLG= 1+A*Bita;// closed loop gain
disp(CLG,"Closed loop gain is : ")
CLG_dB= 20*log10(CLG);
```

```
disp(CLG_dB,"Closed loop gain in dB is : ")
Vo= Af*Vs;// in V
disp(Vo,"Value of Vo in volt is : ")
Vi= Vs-Vo;// in V
disp(round(Vi*10^3),"Value of Vi in mV is : ")
// If A decrease 10%,i.e.
A=90;
Af_desh= A/(1+Bita*A);
Per_gain_reduction= (Af_desh-Af)/Af*100;// in %
disp(Per_gain_reduction,"Percentage of gain
    reduction in %")
```

Scilab code Exa 5.21 Open loop gain and loop gain

```
// Exa 5.21
format('v',7);
clc;
clear;
close;
// Given data
// Part (a)
PerError= 1;// in %
A= 10^5;// (Assumed value)
ABita= 1/PerError*100;
Bita= 1/(PerError*A);
disp("% error                A                    A
                   1+ A  ")
disp(string(PerError)+"                    "+string(
    A)+"              "+string(ABita)+"
                    "+string(1+ABita))
// Part (b)
PerError= 5;// in %
ABita= 1/PerError*100;
Bita= 1/(PerError*A);
disp(string(PerError)+"                    "+string(
```

```
    A)+"                    "+string(ABita)+"
                              "+string(1+ABita))
// Part (c)
PerError= 50;// in %
ABita= 1/PerError*100;
Bita= 1/(PerError*A);
disp(string(PerError)+"                    "+string(A)
    +"                    "+string(ABita)+"
                              "+string(1+ABita))
```

Scilab code Exa 5.22 Value of AB

```
// Exa 5.22
format('v',7);
clc;
clear;
close;
// Given data
S= -20;// sensitivity of closed to open loop gain in
     dB
// sensitivity of closed to open loop gain = 1/(1+AB
    ) = S
// or (1+AB) = -S
AB= 10^(-S/20) - 1;
disp(AB,"The loop gain AB for which the sensitivity
    of closed loop gain to open loop gain is -20 dB,
    is : ")

// Part (b) when
S= 1/2;// sensitivity of closed to open loop gain in
     dB
//S= 1/(1+AB)
AB= 1/S-1;
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 densitivity factor

```
// Exa 5.23
format('v',5);
clc;
clear;
close;
// Given data
A=10^5;
Af= 10^3;
// Af= A/(1+A*Bita)
Bita= 1/Af-1/A;
GDF= 1+A*Bita;// gain densitivity factor
disp(GDF,"Gain densitivity factor is : ")
// Part (a) when A drops 10 %
A_desh= A-A*10/100;
Af_desh= A_desh/(1+A_desh*Bita);
CorresPer= (Af-Af_desh)/Af*100;// corresponding percentage in %
disp(CorresPer,"When A drops by 10 % then corresponding percentage is ")
// Part (b) when A drops 30 %
A_desh= A-A*30/100;
Af_desh= A_desh/(1+A_desh*Bita);
CorresPer= (Af-Af_desh)/Af*100;// corresponding percentage in %
disp(CorresPer,"When A drops by 30 % then corresponding percentage is ")
```

Scilab code Exa 5.24 Upper and lower 3dB frequency

```
// Exa 5.24
format('v',7);
clc;
clear;
close;
// Given data
A=100;
Af= 10;
f_L= 100;// in Hz
f_H= 10;// in kHz
// Af= A/(1+A*Bita)
Bita= 1/Af-1/A;
f_desh_L= f_L/(1+A*Bita);// in Hz
f_desh_H= f_H/(1+A*Bita);// in kHz
disp(f_desh_L,"Low frequency in Hz is : ")
disp(f_desh_H,"High frequency in kHz is : ")

// 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

```
// Exa 5.25
format('v',7);clc;
clear;
close;
// Given data
Vs= 100;// in mV
Vf= 95;// in mV
Vs= Vs*10^-3;// in V
Vf= Vf*10^-3;// in V
Vo=10;// in V
Vi= Vs-Vf;// in V
Av= Vo/Vi;// in V/V
```

```
disp(Av,"Value of A in V/V is : ")
Bita= Vf/Vo;// in V/V
disp(Bita,"Value of Bita in V/V is : ")

// 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

```
// Exa 5.26
format('v',7);
clc;
clear;
close;
// Given data
Is= 100;// in  A
Is= Is*10^-6;// in A
If= 95;// in  A
If= If*10^-6;// in A
Io= 10;// in mA
Io= Io*10^-3;// in A
A= Io/(Is-If);// n A/A
Bita= If/Io;// A/A
disp(A,"Value of A in A/A is : ")
disp(Bita,"Value of Bita in A/A is : ")

// 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

```
// Exa 5.28
format('v',6);
clc;
clear;
close;
// Given data
A=2000;//V/V
Bita= 0.1;// inV/V
Ri= 1;// in kohm
Ri= Ri*10^3;// in ohm
Ro= 1;// in kohm
Ro= Ro*10^3;// in ohm
Af= A/(1+A*Bita);
disp(Af,"The gain Af in volt is : ")
Rif= Ri*(1+A*Bita);// in ohm
disp(Rif*10^-3,"The input resistance in kohm is : ")
Rof= Ro/(1+A*Bita);// in ohm
disp(Rof*10^-3,"The output resistance in kohm is : "
    )


// 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)
//          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

```
// Exa 5.29
format('v',7);
clc;
```

```
clear;
close;
// Given data

// Part (b)
Af= 10;
A= 10^4;
// Af= A/(1+A*Bita);
Bita= 1/Af-1/A;
// Bita= R1/(R1+R2)
R2_by_R1= 1/Bita-1;
disp(R2_by_R1,"Value of R2/R1 is : ")

// Part (c)
Vs= 1;// in V
Vo= (1+R2_by_R1)*Vs;
disp(Vo,"Value of Vo in volt is : ")
Vf= Vo/(1+R2_by_R1)
disp(Vf,"Value of Vf in volt is : ")
```

Chapter 6

Oscillators

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

```
// Exa 6.1
format('v',7);
clc;
clear;
close;
// Given data
Vf= 0.0125;// in volt
Vo= 0.5;// in volt
Bita= Vf/Vo;
// For oscillator A*Bita= 1
A= 1/Bita;
disp("Amplifier Should have a minimum gain of "+string(A)+" to provide oscillation")
```

Scilab code Exa 6.2 The frequency of oscillation

```
// Exa 6.2
format('v',6);
```

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

Scilab code Exa 6.3 Wein Bridge oscillator

```
// Exa 6.3
format('v',5);
clc;
clear;
close;
// Given data
f=2;// in kHz
f=f*10^3;// in Hz
// Let
R= 10;// in kohm   (As R should be greater than 1
   kohm)
R=R*10^3;// in ohm
// Formula f= 1/(2*%pi*R*C)
C= 1/(2*%pi*f*R);// in F
C= C*10^9;// in nF
// For Bita to be 1/3, Choose
R4= R;// in ohm
```

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

Scilab code Exa 6.4 Frequency of oscillations

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

// 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

```
// Exa 6.5
format('v',7);
clc;
clear;
close;
```

```
// Given data
L= 100;// in  H
L= L*10^-6;// in H
C1= .001;// in  F
C1= C1*10^-6;// in F
C2= .01;// in  F
C2= C2*10^-6;// in F
C= C1*C2/(C1+C2);// in F
// (i)
f= 1/(2*%pi*sqrt(L*C));// in Hz
disp(round(f*10^-3),"Operating frequency in kHz is :
    ")
// (ii)
Bita= C1/C2;
disp(Bita,"Feedback fraction is : ")
// (iii)
// A*Bita >=1, so Amin*Bita= 1
Amin= 1/Bita;
disp(Amin,"Minimum gain to substain oscillations is
    : ")
```

Scilab code Exa 6.6 Operating frequency

```
// Exa 6.6
format('v',6);
clc;
clear;
close;
// Given data
L= 15;// in  H
L= L*10^-6;// in H
C1= .004;// in  F
C1= C1*10^-6;// in F
C2= .04;// in  F
C2= C2*10^-6;// in F
```

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

Scilab code Exa 6.7 Frequency of oscillator

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

// 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

```
// Exa 6.8
format('v',5);
clc;
clear;
close;
// Given data
L= 0.8;// in H

```

```
C= .08;// in pF
C= C*10^-12;// in F
C_M= 1.9;// in pF
C_M= C_M*10^-12;// in F
C_T= C*C_M/(C+C_M);// in F
R=5;// in kohm
f_s= 1/(2*%pi*sqrt(L*C));// in Hz
disp(f_s*10^-3,"Series resonant frequency in kHz is : ")
// (ii)
f_p= 1/(2*%pi*sqrt(L*C_T));// in Hz
disp(f_p*10^-3,"parallel resonant frequency in kHz is : ")

// 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

```
// Exa 6.10
format('v',8);
clc;
clear;
close;
// Given data
R1= 220;// in kohm
R1=R1*10^3;// in ohm
R2=R1;// in ohm
C1= 250;// in pF
C1= C1*10^-12;// in F
C2=C1;// in F
f= 1/(2*%pi*R1*C1);
disp(f,"Frequency of oscilltions in Hz is : ")
```

Scilab code Exa 6.11 Value of C

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

// 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 oscillatoin and minimum gain

```
// Exa 6.12
format('v',7);
clc;
clear;
close;
// Given data
```

```
L= 50;// in   H
L= L*10^-6;// in H
C1= 300;// in pF
C1= C1*10^-12;// in F
C2= 100;// in pF
C2= C2*10^-12;// in F
C_eq= C1*C2/(C1+C2);// in F
f= 1/(2*%pi*sqrt(L*C_eq));// in Hz
disp(f*10^-6,"Frequency of oscillations in MHz is :
   ")
Bita= C2/C1;
// (iii)
// A*Bita >=1, so A*Bita= 1  (for sustained
   oscillations)
Amin= 1/Bita;
disp(Amin,"Minimum gain to substain oscillations is
   : ")
```

Scilab code Exa 6.14 The range of capacitance

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

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