Scilab Textbook Companion for Basic Electronics by R. K. Garg, A. Dixit and P. Yadav[1]

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Book Description

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

Contents

List of Scilab Codes

Chapter 1

Semiconductor Materials And Junction Diode

Scilab code Exa 1.1 Drift velocity

```
// Exa 1.1
clc;
clear;
close;
format('v',6)
// Given data
miu = 0.2;// in m^2/V-s
V = 100;// in mV
V = V * 10^-3;// in V
d = 0.5;// in mm
d = d * 10^-3;// in m
// mobility , miu = Vd/E and
E = V/d;
// Drift velocity ,
Vd = miu*E;// in m/s
disp(Vd,"The electron drift velocity in m/s is");
// Time required ,
T = d/Vd;// in sec
T=T*10^6;// in s
```

```
disp(T,"The time required for an electron to move
    across the thickness in micro seconds is");
```

Scilab code Exa 1.2 Intrinsic Conductivity

```
// Exa 1.2
clc;
clear;
close;
format('v',6)
// Given data
q = 1.6*10^-19;// in C
n_i = 2.5*10^19;// in /m^3
miu_n = 0.38;// in m^2/V-s
miu_p = 0.18;// in m^2/V-s
// The intrinsic conductivity for germanium,
sigma_i = q*n_i*(miu_n+miu_p);// in (ohm-m)^-1
disp(sigma_i,"The intrinsic conductivity in (ohm-m)
    ^-1 is");
```

Scilab code Exa 1.3 Intrinsic carrier concentration

```
// Exa 1.3
clc;
clear;
close;
format('e',10)
// Given data
rho = 0.50;// in ohm-m
q = 1.6*10^-19;// in C
miu_n = 0.39;// in m^2/V-s
miu_p = 0.19;// in m^2/V-s
sigma = 1/rho;// in (ohm-m)^-1
```

```
//conductivity of a semiconductor, sigma = q*n_i*(
    miu_p+miu_n) or
n_i = sigma/(q*(miu_n+miu_p));// in /m^3
disp(n_i,"The intrinsic carrier concentration per m
    ^3 is");
```

Scilab code Exa 1.4 Conductivity of Si sample

```
// Exa 1.4
clc;
clear;
close;
format('v',6)
// Given data
N_D = 10^21;// in /m^3
N_A = 5*10^20;// in /m^3
NdasD = N_D-N_A;// in /m^3
n = NdasD;// in /m^3
miu_n = 0.18;// in m^2/V-s
q = 1.6*10^-19;// in C
// The conductivity of silicon ,
sigma = q*n*miu_n;// in (ohm-m)^-1
disp(sigma,"The conductivity of Si sample in (ohm-m)
    ^-1 is");
```

Scilab code Exa 1.5 Conductivity of the copper

```
// Exa 1.5
clc;
clear;
close;
format('e',8)
// Given data
```

```
At = 63.54;// atomic weight of copper
d = 8.9;// density in gm/cm^3
n = 6.023*10^23/At*d;// in electron/cm^3
q = 1.63*10^-19;// in C
miu = 34.8;// in m^2/V-s
// The conductivity of copper,
sigma = n*q*miu;// in mho/cm
disp(sigma,"The conductivity of copper in mho/cm is");
```

Scilab code Exa 1.6 Concentration of holes and electrons

```
// Exa 1.6
clc;
clear;
close;
format('e',9)
// Given data
sigma = 100;// in (ohm-m)^-1
n_i = 2.5*10^13;// in /cm^3
miu_n = 3800;// in cm^2/V-s
miu_p = 1800;// in cm^2/V-s
q = 1.6*10^-19;// in C
// Conductivity of a p-type germanium, sigma = q*p*miu_p or
p = sigma/(q*miu_p);// in /cm^3
disp(p,"Concentration of holes in a p-type Ge in /cm^3 is");
// The concentration of electrons in a p-type Ge
n = (n_i^2)/p;// in /cm^3
disp(n,"The concentration of electrons in a p-type Ge in /cm^3 is");
//Given for Si
sigma= 0.1;// in (ohm m)^-1
miu_n= 1300;// in cm^2/V-sec
```

```
n_i= 1.5*10^10;// in /cm^3
//sigma = q*n*miu_n;
n = sigma/(q*miu_n);// in /cm^3
disp(n,"The concentration of electrons in n-type Si
    in /cm^3 is");
// The concentration of holes in n-type Si
p = (n_i^2)/n;// in /cm^3
disp(p,"The concentration of holes in n-type Si in /
    cm^3 is");
```

Scilab code Exa 1.7 Resistivity of Ge sample

```
// Exa 1.7
clc;
clear;
close;
format('v',6)
// Given data
miu_n = 3800;// cm^2/V-s
miu_p = 1800;//  cm^2/V-s
n_i = 2.5*10^13;// in /cm^3
Nge = 4.41*10^22;// in /cm^3
q = 1.602*10^-19;// in C
impurity = 10^8;
// The number of donor atoms,
N_D = Nge/impurity;//in /cm^3
// The number of holes
p = (n_i^2)/N_D;// in /cm^3
// Conductivity of an N-type Ge,
sigma = q*N_D*miu_n;// in (ohm-cm)^-1
// The resistivity of the Ge
rho = 1/sigma;// in ohm-cm
disp(rho,"The resistivity of a dopped Ge in ohm-cm
    is");
```

Scilab code Exa 1.8 Resistivity of intrinsic Si

```
// Exa 1.8
clc;
clear;
close;
format('e',8)
// Given data
Nsi = 4.96*10^22;// in /cm^3
n_i = 1.52*10^10;// in /cm^2
q = 1.6*10^-19;// in C
miu_n = 0.135;// in  m^2/V-s
miu_n = miu_n * 10^4;// in  cm^2/V-s
miu_p = 0.048;// in  m^2/V-s
miu_p = miu_p * 10^4;// in  cm^2/V-s
// The conductivity of an intrinsic silicon,
sigma = q*n_i*(miu_n+miu_p);// in (ohm-cm)^-1
// The resistivity of intrinsic silicon
rho = 1/sigma;// in ohm-cm
disp(rho,"The resistivity of intrinsic silicon in
   ohm-cm is");
format('v',5)
impurity = 50*10^6;
// The number of donor atoms,
N_D = Nsi/impurity;// in /cm^3
// Total free electrons,
n = N_D;// in /cm^3
// Total holes in a doped Si,
p = (n_i^2)/n;// in /cm^3
// Conductivity of a doped Si,
sigma = q*n*miu_n;// in (ohm-m)^-1
// The resistivity of doped silicon
rho = 1/sigma;// in ohm-cm
disp(rho,"The resistivity of doped silicon in ohm-cm
```

```
is");
```

Scilab code Exa 1.9 Value of temperature

```
// Exa 1.9
clc;
clear;
close;
format('v',6)
// Given data
N_D= 5*10^28/(2*10^8);
// The Fermi level , E_F= E_C if ,
N_C= N_D;
// Formula N_C= 4.82*10^21*T^(3/2)
T= (N_C/(4.82*10^21))^(2/3);// in K
disp(T,"The value of temperature in K is : ")
```

Scilab code Exa 1.10 Minority carrier concentration

```
// Exa 1.10
clc;
clear;
close;
format('v',7)
// Given data
n_i = 1.5*10^16;//m^3
impurity = 10^20;
minority = (n_i^2)/impurity;// in atoms/m^3
q = 1.6*10^-19;// in C
rho = 2*10^3;// in ohm-m
// The miniority carrier concentration
miu_n = 1/(q*rho*n_i*2);//  in m^2/V-s
```

```
disp(miu_n,"The miniority carrier concentration in m^2/V-s is");
n = impurity;
// The conductivity ,
sigma = q*impurity*miu_n;// in (ohm-m)^-1
// The resistivity
rho = 1/sigma;// in  ohm-m
disp(rho,"The resistivity in ohm-m is");
kT = 0.026;// in eV
n_o = n;
// The position of Fermi level
E_FdividedEi = kT*log(n_o/n_i);// in eV
disp(E_FdividedEi,"The position of Fermi level in eV is : ");
format('e',8)
// Minority carrier concentration
M = ((n_i*2)^2)/n_o;// in atoms/cm^3
disp(M,"Minority carrier concentration in atoms/cm^3 is");
```

Scilab code Exa 1.11 Conductivity and resistivity of an intrinsic sample

```
// Exa 1.12
clc;
clear;
close;
format('v',5)
// Given data
d = 5.0*10^22;// in atoms/cm^3
impurity = 10^8;// in atoms
N_D = d/impurity;
n_i = 1.45*10^10;
n = N_D;
//Low of mass action ,  n*p = (n_i^2);
p = (n_i^2)/n;// in /cm^3
```

```
q = 1.6*10^-19;// in C
miu_n = 1300;// in cm/V-s
n_i = n;
//The Conductivity
sigma = q*miu_n*n_i;// in (ohm-cm)^-1
// The resistivity
rho = 1/sigma;// in ohm-cm
disp(rho,"The resistivity in ohm-cm is");
```

Scilab code Exa 1.12 Resistivity

```
// Exa 1.12
clc;
clear;
close;
format('v',5)
// Given data
d = 5.0*10^22;// in atoms/cm^3
impurity = 10^8;// in atoms
N_D = d/impurity;
n_i = 1.45*10^10;
n = N_D;
//Low of mass action ,  n*p = (n_i^2);
p = (n_i^2)/n;// in /cm^3
q = 1.6*10^-19;// in C
miu_n = 1300;// in cm/V-s
n_i = n;
//The Conductivity
sigma = q*miu_n*n_i;// in (ohm-cm)^-1
// The resistivity
rho = 1/sigma;// in ohm-cm
disp(rho,"The resistivity in ohm-cm is");
```

Scilab code Exa 1.14 Minority carrier concentration

```
// Exa 1.14
clc;
clear;
close;
format('v',6)
// Given data
n_i = 1.5*10^10;// in electrons/cm^3
N_D = 10^17;// in electrons/cm^3
n = N_D;// in electrons/cm^3
// The minority carrier concentration
p = (n_i^2)/n;// in holes/cm^3
disp(p,"The minority carrier concentration in holes/cm^3 is");
kT = 0.026;
// The location of Fermi level
E_FminusEi = kT*log(N_D/n_i);// in eV
disp(E_FminusEi,"The location of Fermi level in eV is");
```

Scilab code Exa 1.15 Doping level and drift velocity

```
// Exa 1.15
clc;
clear;
close;
format('e',9)
// Given data
V = 1;// in V
I = 8;// in mA
I = I * 10^-3;// in A
R = V/I;// in ohm
l = 2;// in mm
l = l * 10^-1;// in cm
```

```
b = 2;// in mm
b = b * 10^-1;// in cm
A = l*b;// in cm^2
L = 2;// in cm
// R = (rho*L)/A;
sigma = L/(R*A);// in (ohm-cm)^-1
// n = N_D;
miu_n = 1300;// in cm^2/V-s
q = 1.6 * 10^-19;// in C
// sigma = n*q*miu_n;
N_D = sigma/( miu_n*q );// in /cm^3
disp(N_D,"The doping level in /cm^3 is");
d = 2;
E = V/d;
// The drift velocity
Vd = miu_n * E;// in cm/s
disp(Vd,"The drift velocity in cm/sec is");
```

Scilab code Exa 1.17 Conductivity mobility and drift velocity

```
// Exa 1.17
clc;
clear;
close;
format('e',9)
// Given data
l = 1000;// in ft
l = l * 12*2.54;// in cm
R = 6.51;// in ohm
rho = R/l;// in ohm/cm
// The conductivity
sigma = 1/rho;// in mho/cm
sigma = sigma * 10^2;// in mho/m
D= 1.03*10^-3;// in m
A= %pi*D^2/4;// in m^2
```

```
disp(sigma,"The conductivity in mho/m is");
q = 1.6*10^-19;// in C
n = 8.4*10^28;// in electrons/m^3
// sigma = n*q*miu;
miu = sigma/(n*q);// in m^2/V-s
disp(miu,"The mobility in m^2/V-s is");
T = 2;
// The drift velocity
V = T/(n*q*A);// in m/s
disp(V,"The drift velocity in m/s is");
```

Scilab code Exa 1.18 Concentration of holes and electrons

```
// Exa 1.18
clc;
clear;
close;
format('e',8)
// Given data
N_D = 2*10^16;// in /cm^3
N_A = 5*10^15;// in /cm^3
// The concentration of holes
Pp = N_D-N_A;// in /cm^3
disp(Pp,"The concentration of holes in /cm^3 is");
n_i = 10^12;
// The concentartion of electrons
n_p = (n_i^2)/Pp;// in /cm^3
disp(n_p,"The concentartion of electrons in /cm^3 is
    ");
```

Scilab code Exa 1.19 Hall angle

```
// Exa 1.19
```

```
clc;
clear;
close;
format('v',6)
// Given data
rho = 0.005;// in ohm-m
Bz = 0.48;// in Wb/m^2
R_H = 3.55*10^-4;// in m^3/C
ExByJx= rho;
// R_H = Ey/(Bz*Jx);
EyByJx= R_H*Bz;
// The hall angle
theta_H = atand(EyByJx/ExByJx);// in
disp(theta_H,"The hall angle in degree is");
```

Scilab code Exa 1.20 Voltage between contact

```
// Exa 1.20
clc;
clear;
close;
format('v',9)
// Given data
R_H = 3.55 * 10^-4;// in m^3/C
Ix = 15;// in mA
Ix = Ix * 10^-3;// in A
A = 15*1;// in mm
A = A * 10^-6;// in m^2
Bz = 0.48;// in Wb/m^2
Jx = Ix/A;// in A/m^2
// R_H = Ey/(Bz*Jx);
Ey = R_H*Bz*Jx;// in V/m
// voltage between contacts
Voltage = Ey*Ix;// in V
disp(Voltage,"The voltage between contacts in V is")
```

```
;
```

Scilab code Exa 1.21 Concentration of donar atoms

```
// Exa 1.21
clc;
clear;
close;
format('e',8)
// Given data
A = 0.001;// in cm^2
l = 20;// in  m
l = l * 10^-4;// in cm
V = 20;// in V
I = 100;// in mA
I = I * 10^-3;// in A
R = V/I;// in ohm
// R = l/(sigma*A);
sigma = l/(R*A);// in (ohm-cm)^-1
miu_n = 1350;// in cm^2/V-s
q = 1.6*10^-19;// in C
// sigma = n*q*miu_n or
// The concentration of donor atoms
n = sigma/(q*miu_n);// in cm^-3
disp(n,"The concentration of donor atoms in cm^-3 is
   ");
```

Scilab code Exa 1.22 Dopping needed

```
// Exa 1.22
clc;
clear;
close;
```

```
format('e',8)
// Given data
R = 2;// in k ohm
R = R * 10^3;// in ohm
L = 200;// in  m
L = L * 10^-4;// in cm
A = 10^-6;// in cm^2
miu_n = 8000;// in cm^2/V-s
q = 1.6*10^-19;// in C
n = '0.9*N_D';
// R = (rho*l)/A= (1/(n*q*miu_n))*(l/A);
// rho = L/(R*q*miu_n*A);
n = L/(R*q*miu_n*A);// in /cm^-3
// The doping needed
Nd= n/0.9
disp(Nd,"The doping needed in cm^-3 is");
```

Scilab code Exa 1.23 Position of Fermi level

```
// Exa 1.23
clc;
clear;
close;
format('v',6)
// Given data
KT = 26*10^-3;
Nd = 10^15;
n_i = 1.5*10^10;
// The position of the Fermi level
E_FminusE_Fi = KT*log(abs( Nd/n_i ));// in eV
disp(E_FminusE_Fi,"The position of the Fermi level in eV is");
```

Scilab code Exa 1.24 Concentration of donar atoms added

```
// Exa 1.24
clc;
clear;
close;
format('e',9)
// Given data
Na = 5 * 10^15;// in cm^-3
Nc = 2.8 * 10^19;// in cm^-3
E_CminusE_F = 0.215;// in eV
KT = 26* 10^-3;// in eV
// The concentration of donors atoms
Nd = Na + Nc * (%e^( -E_CminusE_F/KT ));// in cm^-3
disp(Nd,"The concentration of donors atoms in cm^-3
   is");
```

Scilab code Exa 1.25 Dopping efficiency of sample

```
// Exa 1.25
clc;
clear;
close;
format('v',5)
// Given data
Nd = 10^18;
R = 10;// in ohm
A =10^-6;// in cm^2
L = 10;// in mm
L = L * 10^-4;// in cm
miu_n = 800;// in cm^2/V-s
q = 1.6*10^-19;// in C
//Formula used, n = L/(q*miu_n*A*R)
n = L/(q*miu_n*A*R);// in cm^-3
// The percentage doping efficiency
```

```
doping = (n/Nd)*100;// % doping efficiency in %
disp(doping,"The percentage doping efficiency in %
    is");
```

Scilab code Exa 1.26 Flowing current

```
// Exa 1.26
clc;
clear;
close;
format('v',6)
// Given data
Io = 2*10^-7;// in A
V = 0.1;// in V
// Current through the diode under forward bias,
I = Io*( (%e^(40*V))-1 );// in A
I = I * 10^6;// in  A
disp(I,"The current through the diode under forward
    bias in  A is");

// Note: Calculated value of I in the book is wrong.
```

Scilab code Exa 1.28 Dynamic resistance

```
// Exa 1.28
clc;
clear;
close;
format('v',6)
// Given data
T = 125;// in degree C
T = T + 273;// in K
V_T = T/11600;
```

```
Io = 30;// in  A
Io = Io * 10^-6;// in A
V = 0.2;// in V
// The dynamic resistance in forward direction ,
r_f = V_T/( Io * (%e^(V/V_T)) );// in ohm
disp(r_f,"The dynamic resistance in forward
   direction in ohm is");
r_f = V_T/( Io * (%e^(-V/V_T)) );// in ohm
// The dynamic resistance in reverse direction
r_f = r_f * 10^-6;// in Mohm
disp(r_f,"The dynamic resistance in reverse
   direction in Mohm is");
```

Scilab code Exa 1.29 Voltage

```
// Exa 1.29
clc;
clear;
close;
format('v',6)
// Given data
Eta = 1;
V_T = 0.026;
// I = Io*( (%e^(V/(Eta*V_T))) - 1 ) and  I = -Io;
// I = -0.9*Io;
// -0.9*Io = Io*( (%e^(V/(Eta*V_T))) - 1 );
V = Eta*V_T*log(0.1);// in V
V = V * 10^3;// in mV
disp(V,"The voltage in mV is");
V = 0.05;// in V
// The ratio of diode current with a forward bias to
    current with a reverse bias
If_by_Ir= ( (%e^(V/V_T))-1 )/( (%e^(-V/V_T))-1 );
disp(If_by_Ir,"The ratio of diode current with a
   forward bias to current with a reverse bias is");
```

```
Io = 10;// in  A
V = 0.1;// in V
// The value of I1
I1 = Io*( (%e^(V/V_T))-1 );// in  A
disp(I1,"The value of I1 in  A is");
V = 0.2;// in V
// The value of I2
I2 = Io*( (%e^(V/V_T))-1 );// in  A
I2 = I2 * 10^-3;// in mA
disp(I2,"The value of I2 in mA is");
V = 0.3;// in V
// The value of I3
I3 = Io*( (%e^(V/V_T))-1 );// in  A
I3 = I3 * 10^-6;// in A
disp(I3,"The value of I3 in A is");
```

Scilab code Exa 1.30 Factor

```
// Exa 1.30
clc;
clear;
close;
format('v',6)
// Given data
// Io150 = Io25 * 2^((150-25)/10);
//Io150 = 5800*Io25;
T = 150;// in degree C
T = T  + 273;// in K
V_T = 8.62*10^-5 * T;// in V
V = 0.4;// in V
Eta = 2;
Vt = 0.026;// in V
// The factor  by which current will get multiplied
I150byI25= 5800*%e^(V/(Eta*V_T))/%e^(V/(Eta*Vt));
disp(I150byI25,"The factor  by which current will
```

```
    get multiplied is");
```

Scilab code Exa 1.31 Operating Point

```
// Exa 1.31
clc;
clear;
close;
format('v',6)
// Given data
R = 1;// in ohm
V = 5;// in V
V1 = 0.5;// in V
R1 = 1;// in k ohm
R1 = R1 * 10^3;// in ohm
// V-(I_D*R1)-(I_D*R) - V1 = 0;
I_D = (V-V1)/(R1+R);// in A
I_D = I_D * 10^3;// in mA
V_D = (I_D*10^-3*R) + V1;// in V
disp("The operating point of the diode is : "+string
    (V_D)+" V, "+string(I_D)+" mA")
```

Scilab code Exa 1.32 VOlage drop across the forward bias diode

```
// Exa 1.32
clc;
clear;
close;
format('v',6)
// Given data
Eta = 1;
kT = 26;// in meV
// (%e^((e*V1)/kT)) = 2 or
```

```
//The voltage drop across the forward biased diode
V1 = log(2)*kT;// in mV
V1= V1*10^-3;// in V
disp(V1,"The voltage drop across the forward biased
    diode, in V is");
```

Scilab code Exa 1.33 Space charge capacitance of Ge diode

```
// Exa 1.33
clc;
clear;
close;
format('v',6)
// Given data
epsilon_Ge = 16/(36*%pi*10^11);// in F/cm
d = 2*10^-4;// in cm
A = 1;// in mm^2
A = A * 10^-2;// in cm^2
epsilon_o = epsilon_Ge;// in F/cm
// The space charge capacitance
C_T = (epsilon_o*A)/d;// in F
C_T = C_T * 10^12;// in pF
disp(C_T,"The space charge capacitance in pF is");
```

Scilab code Exa 1.34 Transition capacitance

```
// Exa 1.34
clc;
clear;
close;
format('v',6)
// Given data
D = 0.102;// in cm
```

```
A = (%pi*(D^2))/4;// in cm^2
sigma_p = 0.286;// in (ohm-cm)^-1
q = 1.6*10^-19;// in C
miu_p = 500;
// Formula used, sigma_p = q*miu_p*N_A;
N_A = sigma_p/(q*miu_p);// in atoms/cm^3
V1 = 5;// in V
V2 = 0.35;// in V
Vb = V1+V2;// in V
// The transition capacitance,
C_T = 2.92*10^-4*((N_A/Vb)^(1/2))*A;// in pF/cm^2
disp(C_T,"The value of C_T in pf/cm^2 is");
```

Scilab code Exa 1.35 Transition capacitance

```
// Exa 1.35
clc;
clear;
close;
format('v',6)
// Given data
C_T1 = 15;// in pF
Vb1 = 8;// in V
Vb2 = 12;// in V
// C_T1/C_T2 = (Vb2/Vb1)^(1/2);
C_T2 = C_T1 * ((Vb1/Vb2)^(1/2));// in pF
disp(C_T2,"The value of C_T for reverse bias in pF
   is");
```

Scilab code Exa 1.36 Voltage

```
// Exa 1.36
clc;
```

```
clear;
close;
format('v',6)
// Given data
V_T = 0.026;// in V
Eta = 1;
I = '-0.9*Io';
// T = Io*((%e^(V/(Eta*V_T)))-1 );
// I = Io*((%e^(V/(Eta*V_T)))-1 );
V = log(0.1)*V_T;// in V
V = V * 10^3;// in mV
disp(V,"The voltage in mV is");
```

Scilab code Exa 1.37 Drain current

```
// Exa 1.37
clc;
clear;
close;
format('v',6)
// Given data
Vin = 20;// in V
Vgamma = 0.7;// in V
R = 20;// in k ohm
R = R * 10^3;// in ohm
// Vin-(I_D*Vin) - Vgamma = 0 or
// The value of I_D,
I_D = (Vin-Vgamma)/R;// in A
I_D = I_D * 10^3;// in mA
disp(I_D,"Part (a) : The value of I_D for first
    circuit in mA is");

// Part (b)
Vin= 10;// in V
Vgamma = 0.7;// in V
```

```
R = 100;// in k ohm
// Drain current ,
I_D= Vin/R;// in mV
disp(I_D,"Part (b) : The value of I_D for second
    circuit in mA is ")
```

Scilab code Exa 1.38 Vo and ID

```
// Exa 1.38
clc;
clear;
close;
format('v',6)
// Given data
R1 = 1;// in k ohm
R1 = R1 * 10^3;// in ohm
R2 = 2;// in k ohm
R2 = R2 * 10^3;// in ohm
V = 10;// in V
V1 = 0.7;// in V
// V * (I_D*R1) - (R2*I_D) - V1 = 0;
I_D = (V-V1)/(R1+R2);// in A
I_D = I_D * 10^3;// in mA
disp(I_D,"The value of I_D in mA is");
// The output voltage ,
Vo = (I_D*10^-3 * R2) +V1;// in V
disp(Vo,"The value of Vo in V is");
```

Scilab code Exa 1.39 Current in each branch

```
// Exa 1.39
clc;
clear;
```

```
close;
format('v',6)
// Given data
V = 10;// in V
R = 10;// in ohm
// Current through resistance,
I = V/R;// in A
disp(I,"Part (a): The current through resistance in
   A is : ")
disp("Part (b) : Current through 10 ohm resistance
   will be Zero")
disp("Part (c): Current will be zero")
disp(I,"Part (d): The diode will be ON and current
   in A is : ")
```

Scilab code Exa 1.40 Operating Point

```
// Exa 1.40
clc;
clear;
close;
format('v',6)
// Given data
Vth= 0.5;// in V
R_F= 1*10^3;// in ohm
V= 5;// in V
// Applying KVL for loop, V-Vd-R_F*Ii= 0      (i)
// When Ii=0
Vd= V;// in V
// When Vd= 0
Ii= V/R_F;// in A
// From eq(i)
Ii= (V-Vth)/R_F;// in A
Vd= V-R_F*Ii;// in V
disp("The operating point is  : "+string(Vd)+" V, "+
```

```
string(Ii*10^3)+" mA")
```

Scilab code Exa 1.43 Voltages

```
// Exa 1.43
clc;
clear;
close;
format('v',6)
// Given data
V_CC = 6;// in V
Vr = 0.6;// in V
V1= V_CC;//in V
V2 = V1-Vr;// in V
disp(V1,"The voltage at V1 in volts is : ")
disp(V2,"The voltage at V2 in volts is : ")
```

Scilab code Exa 1.44 I1 and I2

```
// Exa 1.44
clc;
clear;
close;
format('v',6)
// Given data
V_T = 0.7;// in V
V = 5;// in V
R = 2;// in k ohm
R = R * 10^3;// in ohm
Vs = 0.7;
Vx = Vs+V_T;// in V
// The value of I1
I1 = (V-Vx)/R;// in A
```

```
I1 = I1 * 10^3;// in mA
disp(I1,"The value of I1 in mA is");
// The value of I2
I2 = I1;// in mA
disp(I2,"The value of I2 in mA is");
```

Scilab code Exa 1.45 Output waveform

```
// Exa 1.45
clc;
clear;
close;
format('v',6)
// Given data
Rf = 300;// in ohm
V = 0.5;// in V
R = 600;// in ohm
Vi = 2;// in V
// The output voltage
Vo = (Vi-V)*( R/(R+Rf) );// in V
disp(Vo,"The value of Vo in V is");
```

Chapter 2

Diode Applications

Scilab code Exa 2.1 Average current and load voltage

```
// Exa 2.1
clc;
clear;
close;
format('v',6)
// Given data
N2 = 4;
N1 = 1;
R_L = 1*10^3;// in ohm
 Vm = 40;// in V
V_Lav = Vm/%pi;// in V
// The average load voltage
V_LDC = V_Lav;// in V
disp(V_LDC,"The average load voltage in V is");
Im = Vm/R_L;// in A
I_DC = Im/%pi;// in A
I_DC= I_DC*10^3;// in mA
disp(I_DC,"The average load current in mA is");
I_DC= I_DC*10^-3;// in A
// The RMS voltage
V_Lrms = Vm/2;// in V
```

```
disp(V_Lrms,"The RMS voltage in V is");
// The RMS current
Irms = V_Lrms/R_L;// in A
Irms= Irms*10^3;// in mA
disp(Irms,"The RMS current in mA is");
Irms= Irms*10^-3;// in A
//Eta = (P_ODC/P_iAC)*100;
I_Loc = I_DC;// in A
P_ODC = (I_Loc^2)*R_L;// in W
P_iAC = (Irms^2)*R_L;// in W
// The efficiency of rectification
Eta = (P_ODC/P_iAC)*100;// in %
disp(Eta,"The efficiency of rectification in % is");
V2rms = Vm/sqrt(2);
I2rms = Irms;// in A
// The value of TUF
TUF = ((P_ODC)/(V2rms*I2rms))*100;// in %
disp(TUF,"The value of TUF in % is");
// The ripple factor
Gamma = (sqrt((V_Lrms^2)-(V_LDC^2)))/V_LDC;
Gamma = round(Gamma * 100);// in % done by own
disp(Gamma,"The ripple factor in % is");
```

Scilab code Exa 2.2 Input AC power

```
// Exa 2.2
clc;
clear;
close;
format('v',6)
// Given data
Rf = 10;// in ohm
R_L = 1;// in k ohm
R_L = R_L * 10^3;// in ohm
Vi = 230;// in V
```

```
Vm = Vi*sqrt(2);
//I_DC = Im/%pi;
I_DC = Vm/((R_L+Rf)*%pi);// in A
Irms = Vm/((R_L+Rf)*2);// in A
// The input ac power
P_iAC = (Irms^2)*(Rf+R_L);// in W
disp(P_iAC,"The input ac power in W is");
// The output ac power
P_ODC = (I_DC^2)*R_L;// in W
disp(P_ODC,"The output ac power in W is");
// The efficiency
Eta = (P_ODC/P_iAC)*100;// in %
disp(Eta,"The efficiency in % is");
// The percentage regulation
R = (Rf/R_L)*100;// in %
disp(R,"The percentage regulation in % is");

// Note: The calculated value of input a.c. power in the book is wrong.
```

Scilab code Exa 2.3 Output DC voltage and current

```
// Exa 2.3
clc;
clear;
close;
format('v',6)
// Given data
V1 = 230;// in V
N2= 1;
N1 = 4;
R_L = 1;// in k ohm
R_L = R_L * 10^3;// in ohm
Vd = 0.7;// in V
// V_LDC = (Vm-Vd)/%pi;// in V
```

```
V2 = V1*(N2/N1);// in V
// Vm = sqrt(2)*Vrms;
Vm = sqrt(2)*V2;// in V
// The output dc voltage
V_LDC = (Vm-Vd)/%pi;// in V
disp(V_LDC,"The output dc voltage in V is");
// The current for a load resistance
I_LDC = V_LDC/R_L;// in A
I_LDC = I_LDC * 10^3;// in mA
disp(I_LDC,"The current for a load resistance in mA
    is");
```

Scilab code Exa 2.7 PIV rating

```
// Exa 2.7
clc;
clear;
close;
format('v',6)
// Given data
R1 = 2.2;// in k ohm
R2 = 2.2;// in  kohm
R3 = 4.7;// in k ohm
R = (R2*R3)/(R2+R3);// in k ohm
Vin = 200;
// Vo = (R/(R1+R))*Vin;
// The PIV rating for first diode
Vomax= round(R/(R1+R)*Vin);// in V
disp(Vomax,"The PIV rating for first diode in V is :
     ")
Rdas = (R1*R3)/(R1+R3);// in k ohm
// Vo = (Rdas/(R1+Rdas))*(-Vin);
// The PIV rating for second diode
Vomax=round(Rdas/(R1+Rdas)*Vin);// in V
disp(Vomax,"The PIV rating for second diode in V is
```

```
: ")
```

Scilab code Exa 2.9 PIV of diode

```
// Exa 2.9
clc;
clear;
close;
format('v',5)
// Given data
// Vi = 15*sind(314*t);
Vm = 15;// in V
R_L = 1;// in k ohm
R_L = R_L * 10^3;// in ohm
Im = Vm/R_L;// in A
Im = Im * 10^3;// in mA
Idc = Im/%pi;// in mA
// The average current
I_Dav = Idc;// in mA
disp(I_Dav,"The average current in mA is");
// The RMS current
I_Drms = Im/2;// in mA
disp(I_Drms,"The RMS current in mA is");
// The peak diode current
I_Dpeak = Im;// in mA
disp(I_Dpeak,"The peak diode current in mA is");
// The PIV of diode
PIV = 2*Vm;// in V
disp(PIV,"The PIV of diode in V is");
```

Scilab code Exa 2.10 Average load current and rectification efficiency

```
// Exa 2.10
```

```
clc;
clear;
close;
format('v',6)
// Given data
R_L = 1;// in k ohm
R_L = R_L * 10^3;// in ohm
Rf = 1;// in ohm
R2 = 2;// in ohm
N1 = 4;
N2 = 1;
V1rms = 240;// in V
V2rms = (N2/N1)*V1rms;// in V
Vm = sqrt(2)*V2rms;// in V
// The average load current
I_LDC = (2*Vm)/(%pi*(R2+Rf+R_L));// in A
I_LDC= I_LDC *10^3;// in mA
disp(I_LDC,"The average load current in mA is");
I_LDC= I_LDC *10^-3;// in A
// The average load voltage at no load
V_NL = (2*Vm)/%pi;// in V
disp(V_NL,"The average load voltage at no load in V
    is");
// The average load voltage at full load
V_LDC = I_LDC*R_L;// in V
disp(V_LDC,"The average load voltage at full load in
     V is");
// The percentage load regulation
Per_loadReg= (V_NL-V_LDC)/V_LDC*100;// in %
disp(Per_loadReg,"The percentage load regulation in
    % is : ")
Im = Vm/(R_L+R2+Rf);// in A
Irms = Im/2;// in A
P_iAC = (Vm^2)/(2*(R2+Rf+R_L));// in W
P_ODC = (I_LDC^2)*R_L;// in W
// The rectification efficiency
Eta = (P_ODC/P_iAC)*100;// in %
disp(Eta,"The rectification efficiency in % is");
```

Scilab code Exa 2.11 Output waveform

```
// Exa 2.11
clc;
clear;
close;
format('v',6)
// Given data
R1 = 2;// in k ohm
R2 = 2;// in k ohm
V_AB = 20;// in V
Vo = V_AB*(R1/(R1+R2));// in V
// The required PIV
V_AC = Vo;// in V
disp(V_AC,"The required PIV in V is");
```

Scilab code Exa 2.12 Idc and Irms

```
// Exa 2.12
clc;
clear;
close;
format('v',6)
// Given data
Vrms = 10;// in V
r_f = 0.3;// in ohm
R_L = 2;// in ohm
Vm = sqrt(2)*Vrms;// in V
Im = Vm/(R_L+r_f);// in A
// The value of Idc
Idc = Im/%pi;// in A
```

```
disp(Idc,"The value of Idc in A is");
// The RMS value of output current
Irms = Im/2;// in A
disp(Irms,"The RMS value of output current in A is")
    ;
```

Scilab code Exa 2.13 Ripple factor

```
// Exa 2.13
clc;
clear;
close;
format('v',6)
// Given data
Vdc = 50;// in V
Vrms = 5;// in V
// The ripple factor ,
Gamma = Vrms/Vdc;
disp(Gamma,"The ripple factor is");
```

Scilab code Exa 2.14 Mean and rms load current and output efficiency

```
// Exa 2.14
clc;
clear;
close;
format('v',6)
// Given data
Vrms = 50;// in V
r_f = 20;// in ohm
R_L = 980;// in ohm
Vm = sqrt(2)*Vrms;// in V
Im = (Vm)/(R_L+r_f);
```

```
// The mean load current
Idc = (2*Im)/%pi;// in A
Idc = round(Idc * 10^3);// in mA
disp(Idc,"The mean load current in mA is");
// The RMS load current
Irms = Im/sqrt(2);// in A
Irms = Irms*10^3;// in mA
disp(Irms,"The RMS load current in mA is");
a = 0.812;// assumed
// The output efficiency
Eta = a/(1+(r_f/R_L));
Eta = Eta * 100;// in %
disp(Eta,"The output efficiency in % is");
```

Scilab code Exa 2.15 Output voltage for a complete cycle

```
// Exa 2.15
clc;
clear;
close;
format('v',6)
// Given data
V = 10;// in V
V1 = 2.5;// in V
R = 1;// in Mohm
R = R * 10^6;// in ohm
i = (V-V1)/R;// in A
i = i * 10^6;// in  A
// The output voltage for a complete cycle
Vo1 = (i*10^-6*R)+V1;// in V
disp(Vo1,"The output voltage for a complete cycle in
    V is");
// The output voltage for half neagtive cycle
Vo2 = V1;// in V
disp(Vo2,"The output voltage for half negative cycle
```

```
in V is");
```

Scilab code Exa 2.17 DC output voltage PIV and rectification efficiency

```
// Exa 2.17
clc;
clear;
close;
format('v',5)
// Given data
V1 = 230;// iin V
N2 = 1;
N1 = 5;
R_L = 100;// in ohm
V2 = V1*N2/N1;// in V
Vrms = V2;// in V
Vs = V2/2;// in V
Vm = sqrt(2)*Vs;// in V
// The dc output voltage
Vdc = (2*Vm)/%pi;// in V
disp(Vdc,"The dc output voltage in V is");
// The PIV value
PIV = round(2*Vm);// in V
disp(PIV,"The PIV value in V is");
// The rectification efficiency
Eta = 0.812;
Eta = Eta*100;// in %
disp(Eta,"The rectification efficiency in % is");
```

Scilab code Exa 2.18 DC output voltage and output frequency

```
// Exa 2.18
clc;
```

```
clear;
close;
format('v',6)
// Given data
V1 = 220;// in V
N2 = 1;
N1 = 10;
R_L = 250;// in ohm
V2 = V1 * (N2/N1);// in V
Vm = sqrt(2)*V2;// in V
Im =Vm/R_L;// in A
Iav = (2*Im)/%pi;// in A
Idc = Iav;// in A
// The dc output volatge
Vdc = Idc* R_L;// in V
disp(Vdc,"The dc output volatge in V is");
Pdc = (Idc^2)*R_L;// in W
Irms = (Im)/sqrt(2);// in A
Pac = (Irms^2)*R_L;// in W
// The rectification efficiency
Eta = (Pdc/Pac)*100;// in %
disp(Eta,"The rectification efficiency in % is");
// The peak inverse volatge
PIV = Vm;// in V
disp(PIV,"The peak inverse volatge in V is");
f_in = 50;// in Hz
// The output frequency
f_out = 2*f_in;// in Hz
disp(f_out,"The output frequency in Hz is");

// Note: The answer of rectification efficiency in
   the book is not accurate.
```

Scilab code Exa 2.21 Filter capacitor

```
// Exa 2.21
clc;
clear;
close;
format('v',6)
// Given data
R_F = 0.01;
Vdc = 30;// in V
R_L = 1;// in  k ohm
R_L = R_L * 10^3;// in ohm
Idc = Vdc/R_L;// in A
Idc = Idc * 10^3;// in mA
// Vdc = Vm-( (5000*Idc)/C );
Gamma = 0.01;// ripple factor
//Gamma = 2900/(C*R_L);
C = 2900/(Gamma*R_L);// in F
Vm = Vdc + ((5000*Idc*10^-3)/C);// in V
// The input voltage required
V2 = (2*Vm)/sqrt(2);// in V
disp(V2,"The input voltage required in V is");

//Note: The value of Vm in the book is not accurate,
    So the answer in the book is wrong.
```

Scilab code Exa 2.22 Designing of a filter for full wave circuit

```
// Exa 2.22
clc;
clear;
close;
format('v',7)
// Given data
V_L = 25;// in V
I_L = 200;// in mA
I_L = I_L * 10^-3;// in A
```

```
R_L = V_L/I_L;// in ohm
Gamma = 3/100;
//Gamma = 1/(6*sqrt(2)*(omega^2)*L*C);
f = 50;// in Hz
omega = 2*%pi*f;// in rad/sec
//LC = 1/( 6*sqrt(2)*(omega^2)*Gamma )
L = R_L/(3*omega);// in H
disp(L,"The value of L in H is");
C = 1/( 6*sqrt(2)*(omega^2)*Gamma*L );// in F
C = C * 10^6;// in  F
disp(C,"The value of C in  F is");
```

Scilab code Exa 2.23 Output voltage current and ripple

```
// Exa 2.23
clc;
clear;
close;
format('v',6)
// Given data
Vm  = 15;// in V
// The output voltage
Vdc = (2*sqrt(2)*Vm)/%pi;// in V
disp(Vdc,"The output voltage in V is");
R_L = 5;// in ohm
Idc = Vdc/R_L;// in A
disp(Idc,"The current in A is");
L = 50;// in mH
L = L * 10^-3;// in H
C = 1000;// in  F
C = C * 10^-6;// in F
f = 50;// in Hz
omega = 2*%pi*f;// in rad/sec
// The ripple factor
Gamma = 1/( 6*sqrt(2)*(omega^2)*L*C );
```

```
disp(Gamma,"The ripple factor is");
// Im =Vm/X_L = (Vm*sqrt(2))/(2*%pi*f*L);
Im = (Vm*sqrt(2))/(2*%pi*f*L);// in A
I_Lmin = Im;// in A
// The maximum value of R_L
R_Lmax = Vdc/I_Lmin;// in ohm
disp(R_Lmax,"The maximum value of R_L in ohm is");
```

Scilab code Exa 2.24 Percentage ripple

```
// Exa 2.24
clc;
clear;
close;
format('v',6)
// Given data
f = 50;// in Hz
Vrms = 280;// in V
Vm = sqrt(2)*Vrms;// in V
V_Lmax = Vm;// in V
Idc = 100;// in mA
Idc =Idc * 10^-3;// in A
C2 = 10;// in   F
C2 = C2 * 10^-6;// in F
C1 = C2 ;// in F
R_L =V_Lmax/Idc;// in ohm
L = 104;// in H
omega = 2*%pi*f;// in rad/sec
// The percentage ripple
Gamma = sqrt(2)/( 8*omega^3*C1*C2*L*R_L)*100;// in %
disp(Gamma,"The percentage ripple in % is");

// Note: There is calculation error to find the
   value of gamma, So the answer in the book is
   wrong.
```

Scilab code Exa 2.25 Peak output voltage

```
// Exa 2.25
clc;
clear;
close;
format('v',6)
// Given data
Vin = 15;// in V
// Peak output voltage,
Vout = Vin;// in V
disp(Vout,"Peak output voltage in V is");
```

Scilab code Exa 2.26 Peak output voltage

```
// Exa 2.26
clc;
clear;
close;
format('v',6)
// Given data
R_L = 2;// in k ohm
R_L = R_L * 10^3;// in ohm
R = 2;// in k ohm
R = R * 10^3;// in ohm
Vin = 5;// in V
// The peak output voltage
Vout = (R_L/(R+R_L))*Vin;// in V
disp(Vout,"The peak output voltage in V is");
```

Scilab code Exa 2.27 IR and IRmax

```
// Exa 2.27
clc;
clear;
close;
format('v',6)
// Given data
Vi = 10;// in V
V1 = 6;// in V
R = 10;// in k ohm
R = R * 10^3;// in ohm
// The value of i_Rmax
i_Rmax = (Vi-V1)/R;// in A
i_Rmax = i_Rmax * 10^3;// in mA
Vi = -10;// in V
V1 = 8;// in V
// The value of i_R
i_R =(Vi+V1)/R;// in A
i_R  =i_R * 10^3;// in mA
disp(i_Rmax,"The value of i_Rmax in mA is : ")
disp(i_R,"The value of i_R in mA is : ")
```

Scilab code Exa 2.28 Output voltage and voltage across R

```
// Exa 2.28
clc;
clear;
close;
format('v',6)
// Given data
Vout = -0.7;// in V
V = -12;// in V
// The output voltage
V_R =V-Vout;// in V
```

```
disp(V_R,"The output voltage in V is");
```

Scilab code Exa 2.29 Output waveform

```
// Exa 2.29
clc;
clear;
close;
format('v',6)
// Given data
Vin = 10;// in V
V1 = 2;// in V
// Vin -V_C - V1 = 0;
V_C =Vin-V1;// in V
// During positive half cycle the output voltage
Vout = Vin-V_C;// in V
disp(Vout,"During positive half cycle the output
    voltage in V is : ")
Vin = -10;// in V
V1 = 8;// in V
// Vin-V1-Vout = 0;
// During negative half cycle the output voltage
Vout = Vin-V1;// in V
disp(Vout,"During negative half cycle the output
    voltage in V is : ")
```

Scilab code Exa 2.30 Output voltage

```
// Exa 2.30
clc;
clear;
close;
format('v',6)
```

```
// Given data
Vin = 10;// in V
V1 = 2;// in V
// Vin-V_C+V1 = 0;
V_C = Vin+V1;// in V
//During positive half cycle the output voltage
Vout = Vin-V_C;// in V
disp(Vout,"During positive half cycle the output
    voltage in V is");
Vin = -10;// iin V
V1 = 12;// in V
// Vin-V1-Vout = 0;
//During negative half cycle the output voltage
Vout = Vin-V1;// in V
disp(Vout,"During negative half cycle the output
    voltage in V is");
```

Scilab code Exa 2.31 Output voltage

```
// Exa 2.31
clc;
clear;
close;
format('v',6)
// Given data
Vi = 20;// in V
V1 = 5;// in V
Vc = Vi-V1;// in V
Vo = -5;// in V
// The value of Vo,
Vo = Vi+Vc;// in V
disp(Vo,"The value of Vo in V is");
```

Chapter 3

Zener Diode And LED

Scilab code Exa 3.1 Resistance of device

```
// Exa 3.1
clc;
clear;
close;
format('v',6)
// Given data
I1 = 30;// in mA
I2 = 20;// in mA
delI_Z = I1-I2;// in mA
delI_Z = delI_Z * 10^-3;// in A
V1 = 5.75;// in V
V2 = 5.6;// in V
delV_Z = V1-V2;// in V
// The resistance of the device
r_Z = delV_Z/delI_Z;// in ohm
disp(r_Z,"The resistance of the device in ohm is");
```

Scilab code Exa 3.2 Terminal voltage

```
// Exa 3.2
clc;
clear;
close;
format('v',6)
// Given data
V_Z = 4.7;// in V
r_Z = 15;// in ohm
I_Z = 20;// in mA
I_Z = I_Z * 10^-3;// in A
// The terminal voltage
VdasZ = V_Z + (I_Z*r_Z);// in V
disp(VdasZ,"The terminal voltage in V is");
```

Scilab code Exa 3.3 Value of IZM

```
// Exa 3.3
clc;
clear;
close;
format('v',5)
// Given data
P_ZM = 500;// in mW
P_ZM = P_ZM * 10^-3;// in W
V_Z = 6.8;// in V
// The value of I_ZM
I_ZM = P_ZM/V_Z;// in A
I_ZM = I_ZM * 10^3;// in mA
disp(I_ZM,"The value of I_ZM in mA is");
```

Scilab code Exa 3.4 Maximum power dissipation

```
// Exa 3.4
```

```
clc;
clear;
close;
format('v',8)
// Given data
P_ZM = 1500;// in mW
Deratingfactor = 3.33;// in mW
T1 = 85;// in degree C
T2 = 60;// in degree C
total = Deratingfactor*(T1-T2);// total derating
    factor in mW
// The maximum power dissipation
P_ZM = P_ZM - total;// in mW
disp(P_ZM,"The maximum power dissipation in mW is");
```

Scilab code Exa 3.5 Value of VL VR VZ and PZ

```
// Exa 3.5
clc;
clear;
close;
format('v',5)
// Given data
R_L = 1.2;// in k ohm
R_L = R_L * 10^3;// in ohm
Vi = 16;// in V
R = 1;// in k ohm
R = R * 10^3;// in ohm
// The value of V_L
V_L = (R_L*Vi)/(R+R_L);// in V
disp(V_L,"The value of V_L in V is");
V_Z = 10;// in V
// The value of V_R
V_R = Vi-V_L;// in V
disp(V_R,"The value of V_R in V is");
```

```
// The value of I_Z
I_Z = 0;// in A
disp(I_Z,"The value of I_Z in A is");
// The value of P_Z
P_Z =V_Z*I_Z;// in W
disp(P_Z,"The value of P_Z in W is");
```

Scilab code Exa 3.6 Range of value of Vi

```
// Exa 3.6
clc;
clear;
close;
format('v',6)
// Given data
R_L = 1.2;// in k ohm
R_L = R_L * 10^3;// in ohm
R = 220;// in ohm
V_Z = 20;// in V
// The minimum value of Vi
Vimin = ((R_L+R)/R_L)*V_Z;// in V
disp(Vimin,"The minimum value of Vi in V is");
I_L = V_Z/R_L;// in A
I_ZM = 60;// in mA
I_ZM = I_ZM * 10^-3;// in A
// I_ZM = I_R-I_L;
I_Rmax = I_ZM + I_L;
// The maximum value of Vi
Vimax = (I_Rmax*R)+V_Z;// in V
disp(Vimax,"The maximum value of Vi in V is");
```

Scilab code Exa 3.7 Whether zener diode operating in Breakdown region

```
// Exa 3.7
clc;
clear;
close;
format('v',5)
// Given data
R_L = 1;// in k ohm
R_L = R_L * 10^3;// in ohm
R = 270;// in ohm
V = 18;// in V
V_Z= 10;// in V
V_L = (R_L/(R_L+R))*V;// in V
if V_L > V_Z then
    disp("As the value of V_L ("+string(V_L)+" V) is
        greater than the value of V_Z ("+string(V_Z)
       +" V), So")
disp("The zener diode is operating in the breakdown
   region.");
end
```

Scilab code Exa 3.8 Zener current

```
// Exa 3.8
clc;
clear;
close;
format('v',6)
// Given data
V1 = 18;// in V
V2 = 10;// in V
R = 250;// in ohm
I_R = (V1-V2)/R;// in A
I_R = I_R * 10^3;// in mA
R_L = 1;// in k ohm
R_L = R_L * 10^3;// in ohm
```

```
I_L = V2/R_L;// in A
I_L =I_L * 10^3;// in mA
// I_R = I_L+I_Z;
// So, the value of zener current
I_Z = I_R - I_L;// in mA
disp(I_Z,"The value of zener current in mA is");
```

Scilab code Exa 3.9 Current flowing through resistance R

```
// Exa 3.9
clc;
clear;
close;
format('v',6)
// Given data
R = 10;// in k ohm
R = R * 10^3;// in ohm
Vi = 20;// in V
V_Z = 10;// in V
I_L = 1;// in mA
I_L = I_L * 10^-3;// in A
R_L = 10;// in k ohm
R_L = R_L * 10^3;// in ohm
V_L = (R_L/(R_L+R))*Vi;// in V
// The current flowing through the resistance
I = (Vi-V_Z)/R;// in A
I= I*10^3;// in mA
disp(I,"The current flowing through the resistance
   in mA is");
```

Scilab code Exa 3.10 Value of VL IL IR and IZ

```
// Exa 3.10
```

```
clc;
clear;
close;
format('v',6)
// Given data
R = 200;// in  ohm
Vi = 20;// in V
V_Z = 10;// in V
R_L = 300;// in ohm
P_Zmax = 400;// in mW
// The value of V_L
V_L = (R_L/(R_L+R))*Vi;// in V
disp(V_L,"The value of V_L in V is");
V_L = V_Z;// in V
// The value of I_L
I_L = V_L/R_L;// in A
I_L = I_L * 10^3;// in mA
disp(I_L,"The value of I_L in mA is");
// The value of I_R
I_R = (Vi-V_Z)/R;// in A
I_R = I_R * 10^3;// in mA
disp(I_R,"The value of I_R in mA is");
// The value of I_Z
I_Z = I_R-I_L;// in mA
disp(I_Z,"The value of I_Z in mA is");
// V_L >= V_Z and V_L= R_L*Vi/(R_L+R)
// So, the minimum value of R_L
R_L= R*V_Z/(Vi-V_Z);// in ohm
disp(R_L,"The minimum value of R_L in ohm is : ")
```

Scilab code Exa 3.11 Maximum value of Ri

```
// Exa 3.11
clc;
clear;
```

```
close;
format('v',6)
// Given data
I_Z = 0.2;// in A
R = 10;// in ohm
V_Z = 8 + (R*I_Z);// in V
I_Lmin = V_Z/R;// in A
I_Zmax = 0.2;//in A
Vimax = 15;// in V
// The minimum value of R
Rimin = (Vimax-V_Z)/(I_Zmax+I_Lmin);// in ohm
disp(Rimin,"The minimum value of R in ohm is");

// Note: The calculation in the book is not accurate
    , So the answer in the book is not accurate.
```

Scilab code Exa 3.12 Output voltage and current through the zener diode

```
// Exa 3.12
clc;
clear;
close;
format('v',6)
// Given data
R_L = 10;// in k ohm
R_S = 5;// in k ohm
V_S = 12;// in V
V_Z = 8;// in V
V_L = (R_L/(R_S+R_L))*V_S;// in V
//The output voltage
Vo = V_L;// in V
disp(Vo,"The output voltage in V is");
// The voltage drop across R_S
R_S = V_S-Vo;// in V
disp(R_S,"The voltage drop across R_S in V is");
```

```
// The current through the zener diode
I_Z = 0;// in A
disp(I_Z,"The current through the zener diode in A
   is");
```

Scilab code Exa 3.13 value of VZ IZ and PZ

```
// Exa 3.13
clc;
clear;
close;
format('v',5)
// Given data
R_S = 1;// in k ohm
R_L = 1.2;// in k ohm
V_Z = 10;// in V
V_S = 16;// in V
V_L = (R_L/(R_L+R_S))*V_S;// in V
//The value of I_Z
I_Z = 0;// in A
disp(I_Z,"The value of I_Z in A is");
// The value of P_Z
P_Z = 0;
disp(P_Z,"The value of P_Z is");
//The value of Vo
Vo = V_L;// in V
disp(Vo,"The value of Vo in V is");
```

Scilab code Exa 3.14 Value of VL IL IZ and IR

```
// Exa 3.14
clc;
clear;
```

```
close;
format('v',6)
// Given data
R_L = 200;// in ohm
Vin = 20;// in V
V_Z = 10;// in V
P_Zmaz = 400;// in mW
R_S = 220;// in ohm
//The value of V_L with 200 ohm
V_L =(R_L/(R_S+R_L))*Vin;// in V
disp(V_L,"The value of V_L with 200 ohm in V is");
// The value of I_Z with 200 ohm
I_Z = 0;// in A
disp(I_Z,"The value of I_Z with 200 ohm in A is");
// The value of I_L with 200 ohm
I_L = Vin/(R_S+R_L)*10^3;// in mA
disp(I_L,"The value of I_L with 200 ohm in mA is");
//The value of I_R with 200 ohm
I_R = I_L;// in mA
disp(I_R,"The value of I_R with 200 ohm in mA is");
R_L = 50;// in ohm
V_L = (R_L/(R_S+R_L))*Vin;// in V
//The value of I_L with 50 ohm
I_L = Vin/(R_S+R_L)*10^3;// in mA
disp(I_L,"The value of I_L with 50 ohm in mA is");
// The value of I_R with 50 ohm
I_R = I_L;// in mA
disp(I_R,"The value of I_R with 50 ohm in mA is");
// The value of I_Z with 50 ohm
I_Z = 0;// in A
disp(I_Z,"The value of I_Z with 50 ohm in A is");
disp(V_L,"The value of V_L with 50 ohm in V is");
```

Scilab code Exa 3.15 Value of RLmin

```
// Exa 3.15
clc;
clear;
close;
format('v',6)
// Given data
V_Z = 15;// in V
Vin = 24;// in V
R = 27;// in ohm
I = (Vin-V_Z)/R;// in A
// The minimum value of R_L
R_Lmin = V_Z/I;// in ohm
disp(R_Lmin,"The minimum value of R_L in ohm is");
```

Scilab code Exa 3.16 Minimum value of R

```
// Exa 3.16
clc;
clear;
close;
format('v',6)
// Given data
R = 50;// in ohm
Vin = 10;// in V
V_Z = 6;// in V
I = (Vin-V_Z)/R;// in A
I = I * 10^3;// in mA
I_Zmin = 5;// in mA
// I = I_Z+I_L;
I_Rmax = I-I_Zmin;// in mA
// The minimum value of R
R = V_Z/(I_Rmax*10^-3);// in ohm
disp(R,"The minimum value of R in ohm is");
```

Scilab code Exa 3.17 Power dissipation in zener diode

```
// Exa 3.17
clc;
clear;
close;
format('v',6)
// Given data
R = 150*10^3;// in ohm
R_L = 75;// in k ohm
R_L = R_L * 10^3;// in ohm
V_Z = 15;// in V
Vin = 50;// in V
R_Z = 0;
Rth = (R*R_L)/(R+R_L);// in ohm
Vth = Vin * ( R_L/(R_L+R) );// in V
I_Z = Vth/Rth;// in A
// The power dissipation in the zener diode
P_Z = V_Z*I_Z;// in W
P_Z= P_Z*10^3;//in mW
disp(P_Z,"The power dissipation in the zener diode
   in mW is");

// Note: The calculation in the last line is wrong
   as 15*0.333 = 5 mW not 0.5mW, So the answer in
   the book is wrong.
```

Scilab code Exa 3.18 Value of RL

```
// Exa 3.18
clc;
clear;
```

```
close;
format('v',4)
// Given data
R = 222;// in ohm
Vin = 20;// in V
V_Z = 10;// in V
P = 400;// in mW
P= P*10^-3;// in W
I_Zmax = P/V_Z;// in A
//I = I_Z+I_L;
I = (Vin-V_Z)/R;// in A
I_Lmin = I - I_Zmax;// in mA
// The value of R_L
R_L =V_Z/I_Lmin;// in ohm
R_L= R_L*10^-3;// in k ohm
disp(R_L,"The value of R_L in k ohm is");
```

Scilab code Exa 3.19 Range of possible load current

```
// Exa 3.19
clc;
clear;
close;
format('v',6)
// Given data
R = 12;// in k ohm
Vin = 6.3;// in V
V_Z = 4.8;// in V
I = (Vin-V_Z)/R*10^3;// in mA
I_Z = 5;// in mA
// Maximum value of load current,
I_Lmax = I - I_Z;// in mA
I_Z = 100;// in mA
// Minimum value of load current,
I_Lmin = I - I_Z;// in mA
```

```
disp("The range of possible load current is : "+
    string(I_Lmin)+" mA <= I_L <= "+string(I_Lmax)+"
    mA")
// Minimum value of load resistance ,
R_Lmin= I_Lmin*10^-3*V_Z;// in ohm
// Maximum value of load resistance ,
R_Lmax= I_Lmax*10^-3*V_Z;// in ohm
disp("The range of possible load resistance is : "+
    string(R_Lmin)+" ohm <= R_L <= "+string(R_Lmax)+"
     ohm")
// The power rating required for load resistance
P_Zmax = I_Lmax*10^-3*V_Z;// in W
P_Zmax= P_Zmax*10^3;// in mW
disp(P_Zmax,"The power rating required for load
    resistance in mW is");

// Note: The calculated value of P_Zmax is wrong as
    120*10^-3*4.8= 576 mW not 5.76 mW
```

Chapter 4

Bipolar Junction Transistor

Scilab code Exa 4.1 Base current

```
// Exa 4.1
clc;
clear;
close;
format('v',6)
// Given data
Alpha = 0.98;
Vo = 4.9;// in V
R_L = 5;// in k ohm
R_L = R_L * 10^3;// in ohm
I_C = Vo/R_L;// in A
I_C = I_C * 10^3;// in mA
// Alpha = I_C/I_E;
I_E = I_C/Alpha;// in mA
// The base current
I_B = I_E-I_C;// in mA
disp(I_B,"The base current in mA is");
```

Scilab code Exa 4.2 Collector and base current

```
// Exa 4.2
clc;
clear;
close;
format('v',6)
// Given data
Alpha = 0.95;
I_CBO = 5* 10^-3;// in mA
I_E = 3;// in mA
// The collector current
I_C = (Alpha*I_E)+I_CBO;// in mA
disp(I_C,"The collector current in mA is");
// The base current
I_B = I_E-I_C;// in mA
disp(I_B,"The base current in mA is");
```

Scilab code Exa 4.3 value of Bita

```
// Exa 4.3
clc;
clear;
close;
format('v',6)
// Given data
Alpha = 0.9;
// For alpha = 0.9, the value of Beta
Beta = Alpha/(1-Alpha);
disp(Beta,"For alpha = 0.9, the value of Beta is");
Alpha = 0.99;
// For alpha = 0.99, the value of Beta
Beta = Alpha/(1-Alpha);
disp(Beta,"For alpha = 0.99, the value of Beta is");
Alpha = 0.98;
// For alpha = 0.98, the value of Beta
Beta = Alpha/(1-Alpha);
```

```
disp(Beta,"For alpha = 0.98, the value of Beta is");
```

Scilab code Exa 4.4 Base current

```
// Exa 4.4
clc;
clear;
close;
format('v',6)
// Given data
R_C = 2;// in k ohm
R_C = R_C * 10^3;// in ohm
V = 2;// in V
// The collector current
I_C = V/R_C;// in A
Beta = 50;
// The base current
I_B = I_C/Beta;// in A
I_B= I_B*10^6;// in  A
disp(I_B,"The base current in  A is");
```

Scilab code Exa 4.5 Value of IC using alpha and bita

```
// Exa 4.5
clc;
clear;
close;
format('v',6)
// Given data
Beta = 49;
I_E = 12;// in mA
I_B = 240;// in  A
I_B = I_B * 10^-3;// in mA
```

```
Alpha = Beta/(1+Beta);
//Using alpha rating , the value of collector current
    ,
I_C = Alpha*I_E;// in mA
disp(Alpha,"The value of alpha is : ")
disp(I_C,"Using alpha rating , the value of I_C in mA
    is");
//Using beta rating , the value of collector current ,
I_C = Beta*I_B;// in mA
disp(I_C,"Using bita rating , the value of I_C in mA
    is");
```

Scilab code Exa 4.6 Value of alpha and bita

```
// Exa 4.6
clc;
clear;
close;
format('v',6)
// Given data
Alpha = 0.975;
Beta = Alpha/(1-Alpha);
// The value of beta ,
disp(Beta,"The value of Beta is");
Beta = 200;
// The value of alpha ,
Alpha = Beta/(1+Beta);
disp(Alpha,"The value of Alpha is");
```

Scilab code Exa 4.7 Collector and emitter current

```
// Exa 4.7
clc;
```

```
clear;
close;
format('v',6)
// Given data
Alpha = 0.98;
I_CO = 5;// in  A
I_CO = I_CO * 10^-3;// in mA
I_B = 100;// in  A
I_B = I_B * 10^-3;// in mA
Beta = Alpha/(1-Alpha);
// The collector current
I_C = Beta*I_B + (1+Beta)*I_CO;// in mA
disp(I_C,"The collector current in mA is");
// The emitter current
I_E = I_C+I_B;// in mA
disp(I_E,"The emitter current in mA is");
```

Scilab code Exa 4.8 Collector current

```
// Exa 4.8
clc;
clear;
close;
format('v',7)
// Given data
I_CBO = 10;// in  A
I_CBO = I_CBO * 10^-6;// in A
Beta = 50;
h_FE = Beta;
I_B = 0.25;// in mA
I_B = I_B * 10^-3;// in A
// The collector current
I_C = (Beta*I_B) + ((1+Beta)*I_CBO);//in A
I_C = I_C * 10^3;// in mA
disp(I_C,"The collector current in mA is");
```

```
T2 = 50;// in degree C
T1 = 25;// in degree C
I_CB0at25 = 10;// in  A
I_CB0at50 = I_CB0at25 * (2^((T2-T1)/10));// in  A
I_CB0at50 = I_CB0at50 * 10^-6;// in A
//The new collector current
I_C = (Beta*I_B) + ((1+Beta)*I_CB0at50);// in A
I_C = I_C * 10^3;// in mA
disp(I_C,"The new collector current in mA is");
```

Scilab code Exa 4.9 Value of IC and VCE

```
// Exa 4.9
clc;
clear;
close;
format('v',6)
// Given data
V_BE = 0.6;// in V
V_CC = 10;// in V
Beta = 60;
R_B = 20;// in  k ohm
R_B = R_B * 10^3;// in ohm
R_C = 300;// in ohm
// V_CC - (I_B*R_B)-V_BE = 0;
I_B = (V_CC-V_BE)/R_B;// in A
// The collector current
I_C = Beta*I_B;// in A
I_C= I_C*10^3;// in mA
disp(I_C,"The collector current in mA is");
// V_CC - (I_C*R_C) -V_CE = 0;
// The collector emitter voltage
V_CE = V_CC - (I_C*10^-3*R_C);// in V
disp(V_CE,"The collector emitter voltage in V is");
```

Scilab code Exa 4.10 DC laod line

```
// Exa 4.10
clc;
clear;
close;
format('v',6)
// Given data
V_BE = 0.6;// in V
V_CE = 0;// in V
R_C = 2;// in k ohm
R_C = R_C * 10^3;// in ohm
V_CC = 9;// in V
Beta= 2;
R_B = 8;// in k ohm
R_B = R_B * 10^3;// in ohm
// V_CC - (I_C*R_C) - V_CE = 0;
I_C = V_CC/R_C;// in A
I_C= I_C*10^3;// in mA
V_CE = V_CC;// in V
plot([V_CE,0],[0,I_C]);
xlabel("V_CE in volts");
ylabel("I_C in mA");
title("DC load line")
I_C= I_C*10^-3;// in A
I_B = (V_CC-V_BE)/R_B;// in A
//Collector emitter voltage , V_CE = V_CC - (I_C*R_C)
    = V_CC - (Beta*10^-3*I_B*R_C);
V_CE = V_CC - (Beta*I_B*R_C);// in V
// Collector current ,
I_C =Beta*I_B;// in A
I_C= I_C*10^3;// in mA
disp("The operating point is : "+string(V_CE)+" V, "
   +string(I_C)+" mA")
```

Scilab code Exa 4.11 Emitter current and collector voltage

```
// Exa 4.11
clc;
clear;
close;
format('v',5)
// Given data
V_CC = 12;// in V
Beta = 100;
R = 600;// in k ohm
R = R * 10^3;// in ohm
R1 = 600;// in ohm
//Applying KVL to input side, V_CC -(I_E*R1) - (I_B*
    R) - V_BE = 0
I_B = V_CC/(R+(Beta*R1));// in A
I_C = Beta*I_B;// in A
I_E = I_C+I_B;// in A
// Applying KVL to output side
V_CE = V_CC - (I_E*R1);// in V
I_E= I_E*10^3;// in mA
disp(I_E,"The emitter current in mA is");
disp(V_CE,"The collector voltage in V is");
```

Scilab code Exa 4.12 Value of RB

```
// Exa 4.12
clc;
clear;
close;
format('v',5)
// Given data
```

```
I_C = 6.4;// in mA
I_C = I_C * 10^-3;// in A
V_CE = 8.4;// in V
Beta = 80;
V_CC= 10;// in V
R = 250;// in ohm
R_E = 500;// in ohm
I_B = I_C/Beta;// in A
//Applying KVL to the input side, V_CC - (I_B*R_B) -
    V_BE - (I_E*R1) = 0 or
R_B = (V_CC-(Beta+1)*R_E*I_B)/I_B
R_B = R_B * 10^-3;// in k ohm
disp(R_B,"The value of R_B in k ohm is");
```

Scilab code Exa 4.13 Q point and stability factor

```
// Exa 4.13
clc;
clear;
close;
format('v',5)
// Given data
Beta = 44;
R_L = 1.51 * 10^3;// in ohm
R_E = 270;// in ohm
V_CC = 4.5;// in V
R2 = 2.7 * 10^3;// in ohm
R1 = 27 * 10^3;// in ohm
R_C = 1.5 * 10^3;// in ohm
Vth = V_CC * (R2/(R1+R2));// in V
Rth = (R1*R2)/(R1+R2);// in ohm
// Applying KVL to input circuit, Vth - (I_B*Rth) -
    V_BE - (I_E*R_E) = 0 or
I_C = (Vth*Beta)/(Rth + (Beta*R_E));// in A      (On
    putting I_C= Beta*I_B and V_BE=0)
```

```
//Applying KVL to output side, V_CC - (I_C*R_C) -
    V_CE - (I_E*R_E) = 0;
V_CE = V_CC - (I_C*(R_C+R_E));// in V
S = (Beta+1)*( (1+(Rth/R_E))/(Beta+1+(Rth/R_E)) );
I_C= I_C*10^3;// in mA
disp(S,"The stability factor is");
disp("The quiescent points : "+string(I_C)+" mA, "+
    string(V_CE)+" V")

// Note: In the book the calculated value of V_CE is
    correct as well as coding output, but at last
    they print wrong value (4.01 V)
```

Scilab code Exa 4.15 Value of R1 R2 and RE

```
// Exa 4.15
clc;
clear;
close;
format('v',5)
// Given data
S = 12;
V_CC = 16;// in V
R_C = 1.5 * 10^3;// in ohm
V_CE = 8;// in V
V_BE= 0.2;// in V
I_C = 4;// in mA
I_C = I_C * 10^-3;// in A
Beta = 50;
// Vth = V_CC*(R2/(R1+R2)) and Rth = (R1*R2)/(R1+R2)
    ;
//Applying KVL to input side, Vth - I_B*Rth - V_BE -
    I_E*R_E = 0          (i)
I_B = I_C/Beta;// in A
I_E = I_B*(1+Beta);// in A
```

```
// Applying KVL to output section,
R_E = (V_CC - (I_C*R_C) - V_CE)/I_E;// in ohm
//S = ((Rth+R3)*(1+Beta))/(Rth + ((1+Beta)*R_E))
                    (ii)
Rth= R_E*(1+Beta-S-Beta*S)/(S-1-Beta);// in ohm
V_BN= V_BE+I_E*R_E;//in V
Vth= V_BN+I_B*Rth;// in V
// Vth= V_CC*R2/(R1+R2) and Rth= R2*R1/(R1+R2), So
   Vth= V_CC*Rth/R1
R1= V_CC*Rth/Vth;// in ohm
R2= R1*Rth/(R1-Rth);// in ohm
R1= round(R1*10^-3);// in k ohm
R2= R2*10^-3;// in k ohm
R_E= R_E*10^-3;// in k ohm
disp(R1,"The value of R1 in k  is : ")
disp(R2,"The value of R2 in k  is : ")
disp(R_E,"The value of R_E in k  is : ")
```

Scilab code Exa 4.19 Region of transistor

```
// Exa 4.19
format('v',6)
clc;
clear;
close;
// Given data
h_FE = 100;
R = 50;// in k ohm
R = R * 10^3;// in ohm
R1 = 3;// in k ohm
R1 = R1 * 10^3;// in ohm
V1 = 10;// in V
V2 = 5;// in V
V_BE = 0.8;// in V
V_CE = 0.2;// in V
```

```
//Applying KVL in input side, V2 - (R*I_B)-V_BE = 0;
I_B = (V2-V_BE)/R;// in A
I_B = I_B * 10^3;// in mA
//Applying KVL to output side, V1 - (R1*I_C) - V_CE
    = 0;
I_C = (V1-V_CE)/R1;// in A
I_C = I_C * 10^3;// in mA
I_Bmin = I_C/h_FE;// in mA
if I_B>I_Bmin then
    disp("As the value of I_B ("+string(I_B)+" mA)
       is greater than the value of I_Bmin ("+string
       (I_Bmin)+" mA),")
    disp("So the transistor will be in saturation
       region.")
end
```

Scilab code Exa 4.20 Vo and minimum value of RC

```
// Exa 4.20
format('v',6)
clc;
clear;
close;
// Given data
V_BE= 0.8;// in V
V_CE= 0.2;// in V
Beta = 100;
h_FE = Beta;
V1 = 3;// in V
V2 = -10;// in V
R_B = 7*10^3;// in ohm
R_E = 3*10^3;// in ohm
R_C = 500;// in ohm
//Applying KVL to input side, V1 - (I_B+I_C)*Rc -
    V_BEsat - (R1*I_B) = 0 or I_B*(R_B+R_C)+I_C*R_C=
```

```
V1-V_BE                    (i)
// Applying KVL to output side, V2+I_C*R_E+V_CE+R_C*(I_B+I_C) = 0 or    I_B*R_C+I_C*(R_C+R_E)= -V2-V_CE              (ii)
A= [(R_B+R_C) R_C;R_C (R_C+R_E)];
B= [V1-V_BE -V2-V_CE];
C=B*A^-1;// Solving eq(i) and (ii) by matrix method
I_B= C(1);// in A
I_C= C(2);// in A
I_B=I_B*10^3;// in mA
I_C=I_C*10^3;// in mA
I_Bmin= I_C/h_FE;//in mA
if I_B>I_Bmin then
    disp("Part (a) :")
    disp("As the value of I_B ("+string(I_B)+" mA) is greater than the value of I_Bmin ("+string(I_Bmin)+" mA),")
    disp("So the transistor will be in saturation region.")
end
Vo= -V_CE-(I_B+I_C)*10^-3*R_C;// in V
disp(Vo,"Part (b) : The value of Vo in volts is : ")
V_BEactive= 0.7;// in V
V_BC= -0.5;
// V_BN= (1+Beta)*(V1-V_BEactive)*R_C/(R_B+(1+Beta)*R_C)          (iii)
// V_CN= Beta*R_E*(V1-V_BEactive)/(R_B+(1+Beta)*R_C)              (iv)
// and V_BC= V_BN-V_CN, so from eq(iii) and (iv)
R_C= (V_BC*R_B+Beta*R_E*(V1-V_BEactive))/((1+Beta)*(V1-V_BEactive)-V_BC*(1+Beta));// in ohm
disp(R_C,"Part (c) :The value of R_C in ohm is : ")

// Note : 1  In the book, the calculated value of I_B i.e 0.14mA is wrong.
// Note: 2   In the book the calculated value of R_C i.e 819    is wrong. we can easily check that on putting 0.819 k   in the last step.
```

Scilab code Exa 4.21 Q point value

```
// Exa 4.21
format('v',6)
clc;
clear;
close;
// Given data
V_CC = 10;// in V
R_C = 10;// in k ohm
R_C = R_C * 10^3;// in ohm
R_B = 100*10^3;// in ohm
Beta_dc = 100;
V_BE = 0.7;// in V
// Applying KVL to input section , V_CC = (I_E*R_E) +
    (I_B*R_B) + V_BE or
I_C = (V_CC-V_BE)/( R_C + (R_B/Beta_dc) );// in A
V_CE =V_CC - (I_C*R_C);// in V
I_C=I_C*10^3;// in mA
disp("DC load line shown in figure.")
disp("Q-points : "+string(V_CE)+" V, "+string(I_C)+"
    mA")
I_Csat =V_CC/R_C*10^3;// in mA
V_CEcutoff = V_CC;// in V
plot([V_CEcutoff ,0],[0,I_Csat]);
xlabel("V_CE in volts");
ylabel("I_C in mA")
title("DC load line")
```

Scilab code Exa 4.23 Value of RE

```
// Exa 4.23
format('v',5)
clc;
clear;
close;
// Given data
V_CC = 24;// in V
V_CE= 12;// in V
Rc = 5;// in k ohm
Rc = Rc * 10^3;// in ohm
Beta = 100;
I_C = 2;// in mA
I_C = I_C * 10^-3;// in A
//Applying KVL to the output section , V_CC = (I_C*
    R_C) + V_CE + (I_E*R_E) or
// (V_CC-V_CE)/I_C =Rc + R_E*(1+(1/Beta))    (on
    putting I_E= I_C+I_B and I_B = I_C/Beta)
R_E = (((V_CC-V_CE)/I_C)-Rc)*(1/(1+(1/Beta)));// in
    ohm
disp(R_E,"The value of R_E in ohm is");
```

Scilab code Exa 4.24 Limiting value of R1 and R2

```
// Exa 4.24
format('v',7)
clc;
clear;
close;
// Given data
S = 3;
Beta = 100;
I_C = 2;// in mA
I_C = I_C * 10^-3;// in A
R_E = 990;// in ohm
V_CC = 24;// in V
```

```
V_BE= 0.65;// in V
I_B = I_C/Beta;// in A
I_E= I_B+I_C;// in A
// S = ((Beta+1)*(Rth+R_E))/(Rth+(R_E*(1+Beta))),
   where Rth= R1*R2/(R1+R2)
Rth = ((R_E*Beta) - (S*R_E) - (S*R_E*Beta) + R_E)/(S
   -Beta-1);// in ohm
Vth= I_B*Rth+V_BE+I_E*R_E;// in V
// Vth= V_CC*R2/(R1+R2) or
R1= V_CC*Rth/Vth;// in ohm
R1= R1*10^-3;// in k ohm
R2= Vth*R1/(V_CC-Vth);// in k ohm
disp(R1,"The value of R1 in k ohm is : ");
disp(R2,"The value of R2 in k ohm is : ")
```

Scilab code Exa 4.25 Values of resistors

```
// Exa 4.25
format('v',7)
clc;
clear;
close;
// Given data
I_C =5 * 10^-3;// in A
V_CE = 8;// in V
V_E = 6;// in V
S = 10;
h_fc = 200;
Beta = h_fc;
V_CC = 20;// in V
V_BE = 0.6;// in V
I_B =I_C/Beta;// in A
I_E = I_C+I_B;// in A
// I_C*R_C = V_CC - V_CE - V_E;
R_C = (V_CC - V_CE - V_E)/I_C;// in ohm
```

```
R_C = R_C * 10^-3;// in k ohm
disp(R_C,"The value of R_C in k ohm is");
R_C = R_C * 10^3;// in ohm
//Voltage at point E, V_E =I_E*R_E;
R_E = V_E/I_E;// in ohm
R_E = R_E * 10^-3;// in k ohm
disp(R_E,"The value of R_E in k ohm is");
R_E = R_E * 10^3;// in ohm
// S = ((Beta+1)*(R_B+R_E))/( R_B+(R_E*(1+Beta)) ),
    where R_B= R1*R2/(R1+R2)
R_B = ((R_E*(1+Beta))-(S*R_E*(1+Beta)))/( S-(1+Beta)
    );// in ohm
// Vth = V_CC*(R2/(R1+R2)) = V_CC*(R_B/R1)
// Applying KVL we get , Vth= I_B*R_B+V_BE+V_E or
Vth = (I_B*R_B) + V_BE + V_E;// in V
R1 =(V_CC/Vth)*R_B;// in ohm
R1= R1*10^-3;// in k ohm
disp(R1,"The value of R1 in k ohm is");
R2 = (R1*Vth)/(V_CC-Vth);// in k ohm
disp(R2,"The value of R2 in k ohm is");
```

Scilab code Exa 4.26 VBB to saturate the transistor

```
// Exa 4.26
format('v',5)
clc;
clear;
close;
// Given data
V_CEsat = 0.1;// in V
V_BEsat = 0.6;// in V
h_fc = 50;
Beta = h_fc;
V_CC = 12;// in V
R_C = 1;// in k ohm
```

```
R_C = R_C * 10^3;// in ohm
R_B = 10;// in k ohm
R_B = R_B * 10^3;// in ohm
// The collector current,
I_C = (V_CC-V_CEsat)/R_C;// in A
I_B = I_C/Beta;// in mA
// The value of V_BB to saturate the transistor
V_BB = (I_B*R_B) + V_BEsat;// in V
disp(V_BB,"The value of V_BB to saturate the transistor in V is");
```

Scilab code Exa 4.27 IC and Vo

```
// Exa 4.27
format('v',6)
clc;
clear;
close;
// Given data
V_CC = 30;// in V
R1 = 90;// in k ohm
R1 = R1 * 10^3;// in ohm
R2 = 45;// in k ohm
R2 = R2 * 10^3;// in  ohm
R_C = 5;// in  k ohm
R_C = R_C * 10^3;// in ohm
R_E = 5;// in k ohm
R_E =R_E * 10^3;// in ohm
V_BE = 0.6;// in V
h_FE = 100;
Beta = h_FE;
I_CBO = 10;// in  A
I_CBO = I_CBO * 10^-6;// in A
V_BB = V_CC*(R2/(R1+R2));// in V
Vth = V_BB;// in V
```

```
R_BB = (R1*R2)/(R1+R2);// in ohm
Rth= R_BB;// in ohm
I_C = (V_CC-V_BE)/( (Rth/Beta)+R_E );// in A
I_CEO = (Beta+1)*I_CBO;// in A
// The value of I_C
I_C = I_C-I_CEO;// in A
I_C= I_C*10^3;// in mA
disp(I_C,"The value of I_C in mA is");
// The value of Vo
Vo =V_CC-(I_C*10^-3*R_C);// in V
disp(Vo,"The value of Vo in V is");

// Note: In the book, the putted value of V_CC (i.e
   20 V ) to evaluate the value of I_C is wrong, so
   the value of I_C in the book is wrong and due to
   this the value of Vo is also wrong.
```

Scilab code Exa 4.28 ICO and VCEQ

```
// Exa 4.28
format('v',6)
clc;
clear;
close;
// Given data
Beta = 130;
V_BE = 0.7;// in V
V_CC = 18;// in V
R1 = 510;// in k ohm
R1 = R1 * 10^3;// in ohm
R2 = 510;// in k ohm
R2 = R2 * 10^3;// in ohm
R_C = 9.1;// in k ohm
R_C = R_C * 10^3;// in ohm
R_E = 7.5*10^3;// in ohm
```

```
Vth = V_CC*(R2/(R1+R2));// in V
Rth = (R1*R2)/(R1+R2);// in ohm
//Applying KVL in the input loop, Vth = (I_B*Rth)+
   V_BE+(I_E*R_E) or
I_CQ = (Vth-V_BE)/( (Rth/Beta)+R_E+(R_E/Beta) );//
   in A          (On putting I_E = I_C+I_B and I_C =
   Beta*I_B)
I_CQ= I_CQ*10^3;// in mA
disp(I_CQ,"The value of I_CQ in mA is");
// Applying KVL in the output loop, V_CC = (I_C*R_C)
    + V_CEQ + (I_E*R_E);
V_CEQ = V_CC - (I_CQ*10^-3*( R_C+R_E+(R_E/Beta) ));
   // in V
disp(V_CEQ,"The value of V_CEQ in V is");
```

Scilab code Exa 4.29 ICQ and VCEQ

```
// Exa 4.29
format('v',6)
clc;
clear;
close;
// Given data
V_CC = 18;// in V
V_BE = 0.7;// in V
R1 = 510;// in k ohm
R1 = R1 * 10^3;// in ohm
Beta = 130;
R_E = 7.5;// in k ohm
R_E = R_E * 10^3;// in ohm
R_C = 9.1;// in k ohm
R_C = R_C * 10^3;// in ohm
// The value of I_CQ
I_CQ = (V_CC-V_BE)/( (R1/Beta)+R_E+(R_E/Beta) );//
   in A
```

```
I_CQ= I_CQ*10^3;// in mA
disp(I_CQ,"The value of I_CQ in mA is");
// The value of V_CEQ
V_CEQ = V_CC - I_CQ*10^-3*(R_C+R_E+(R_E/Beta));// in V
disp(V_CEQ,"The value of V_CEQ in V is");
```

Scilab code Exa 4.30 Q point

```
// Exa 4.30
format('v',5)
clc;
clear;
close;
// Given data
V_CC = 10;// in V
Beta = 90;
V_BE = 0.7;// in V
R_E = 4.7;// in k ohm
R_E = R_E * 10^3;// in ohm
R_B = 250;// in k ohm
R_B = R_B * 10^3;// in ohm
R = 1.2;// in k ohm
R = R * 10^3;// in ohm
//Applying KVL for input loop, V_CC = R_E*I_E + R_B*I_B + V_BE +I_E*R or
I_CQ = (Beta*(V_CC-V_BE))/( ((1+Beta)*(R_E+R))+R_B );// in A      (On putting I_E = I_C+I_B and I_B = I_C/Beta)
I_CQ=I_CQ*10^3;// in mA
disp(I_CQ,"The value of I_CQ in mA is");
I_CQ=I_CQ*10^-3;// in A
//Applying KVL for output loop, V_CC = ((I_CQ+(I_CQ/Beta))*R_E)+V_CEQ + ((I_CQ+(I_CQ/Beta))*R)
V_CEQ = V_CC - ( (I_CQ+(I_CQ/Beta)) * (R_E+R) );//
```

```
    in V
disp(V_CEQ,"The value of V_CEQ in V is");
// If beta is increased by 50% i.e
bita = Beta+Beta/2;
I_deshCQ = (bita*(V_CC-V_BE))/( ((1+bita)*(R_E+R))+
    R_B );// in A
I_deshCQ=I_deshCQ*10^3;// in mA
disp(I_deshCQ,"The value of I''CQ in mA is");
V_deshCEQ = V_CC - ( (I_CQ+(I_CQ/bita)) * (R_E+R) );
    // in V
disp(V_deshCEQ,"The value of V''CEQ in V is");

// Note: In the book, there is calculation error to
    evaluate the value of V'CEQ, So the answer in the
     book is wrong.
```

Scilab code Exa 4.34 Beta VCC and RB

```
// Exa 4.34
format('v',6)
clc;
clear;
close;
// Given data
I_B = 20;// in  A
I_B = I_B * 10^-6;// in A
R_C = 2.7;// in k ohm
R_C = R_C * 10^3;// in ohm
V_CE = 7.3;// in V
V_BE = 0.7;// in V
R_E = 0.68;// in k ohm
R_E = R_E * 10^3;// in ohm
V_E = 2.1;// in V
I_E = V_E/R_E;// in A
I_C =I_E-I_B;// in A  (as I_E = I_C+I_B)
```

```
Beta = I_C/I_B;
disp(Beta,"The value of beta is");
// Applying KVL to the output loop,
V_CC = (I_C*R_C) +V_CE + (I_E*R_E);// in V
disp(V_CC,"The value of V_CC in V is");
// Applying KVL to the output loop, V_CC = (I_B*R_B)
   +V_BE+(I_E*R_E) or
R_B = (V_CC-V_BE-(I_E*R_E))/I_B;// in ohm
R_B= R_B*10^-3;// k ohm
disp(R_B,"The value of R_B in k ohm is");
```

Scilab code Exa 4.36 Load line

```
// Exa 4.36
format('v',5)
clc;
clear;
close;
// Given data
V_CC = 20;// in V
R_C = 3.3;// in k ohm
R_C = R_C * 10^3;// in ohm
R_B = 1;// in Mohm
R_B = R_B * 10^6;// in ohm
V_CE = V_CC;// in V
I_C = V_CC/R_C;// in A
I_C=I_C*10^3;// in mA
// Plotting of the DC load line,
plot([V_CE,0],[0,I_C]);
xlabel("V_CE in volts.");
ylabel("I_C in mA.");
title("DC load line.")
disp(I_C,"At saturation, the value of I_C in mA is :
   ")
disp(V_CE,"At cut off, the value of V_CE in volts is
```

```
    : ")
disp("DC load line shown in figure.");
```

Scilab code Exa 4.37 VCE and IE

```
// Exa 4.37
format('v',6)
clc;
clear;
close;
// Given data
Beta = 100;
Rth = 1.8;// in k ohm
V_CC = 10;// in V
R2 = 2.2;// in k ohm
R2 = R2 * 10^3;// in ohm
R1 = 10;// in k ohm
R1 = R1 * 10^3;// in ohm
R_C=3.6*10^3;// in ohm
R_E = 1;// in k ohm
R_E = R_E * 10^3;// in ohm
V_BE = 0.7;// in V
Vth = (R2/(R1+R2))*V_CC;// in V
Rth = (R1*R2)/(R1+R2);// in ohm
// Applying KVL for input loop, Vth = (I_B*Rth)+V_BE
    +(I_E*R_E) or
I_E = (Vth-V_BE)/( R_E+(Rth/(Beta+1)) );// in A   (
    On putting I_E = (Beta+1)*I_B)
I_E= I_E*10^3;// in mA
disp(I_E,"The value of I_E in mA is");
I_B =I_E/(Beta+1);// in mA
I_C= I_E-I_B;// in mA
//Applying KVL for output loop, V_CC = (I_C*R_C) +
    V_CE + (I_E*R_E)
V_CE = V_CC - (I_C*10^-3*R_C) - (I_E*10^-3*R_E);//
```

```
    in V
disp(V_CE,"The value of V_CE in V is");
```

Scilab code Exa 4.38 Zi Zo and Av

```
// Exa 4.38
format('v',5)
clc;
clear;
close;
// Given data
h_fe = 110;
h_ie = 1.6;// in k ohm
h_ie = h_ie * 10^3;// in ohm
h_re = 2*10^-4;
h_oe = 20*10^-6;// in A/V
R_B = 470;// in k ohm
R_B = R_B * 10^3;// in ohm
R_C = 4.7;// in k ohm
Ri= 1.51*10^3;// in ohm
R_C =R_C * 10^3;// in ohm
Rin = h_ie - ( (h_fe*h_re*R_C)/(1+(h_oe*R_C)) );// in ohm
// The value of Zi,
Zi = (R_B*Ri)/(R_B+Ri);// in ohm
Zi= Zi*10^-3;// in k ohm
disp(Zi,"The value of Zi in k ohm");
Zi= Zi*10^3;// in ohm
R_L = R_C;// in ohm
// The voltag gain,
Av = -h_fe/( Zi*(h_oe+(1/R_L)) );
disp(Av,"The value of Av is");
Rs = 0;// in ohm
// The value of Zo
Zo = 1/( h_oe-( (h_fe*h_re)/(Zi+Rs) ) );// in ohm
```

```
Zo= Zo*10^-3;// k ohm
disp(Zo,"The value of Zo in k ohm is");
```

Chapter 5

Transistor Amplifier

Scilab code Exa 5.1 Value of C and hfe

```
// Exa 5.1
clc;
clear;
close;
format('v',6)
// Given data
R_C = 10;// in k ohm
R_C = R_C * 10^3;// in ohm
f = 2;// in kHz
f = f * 10^3;// in Hz
R = 8;// in  k ohm
R = R * 10^3;// in ohm
//Formula,  f = 1/(2*%pi*R*C*sqrt(6+((4*R_C)/R)));
C = 1/(2*%pi*R*f*sqrt(6+((4*R_C)/R)));// in F
C= C*10^6;// in  F
disp(C,"The value of capacitor in  F is");
h_fe= 23+29*R/R_C+4*R_C/R;
disp(h_fe,"The value of h_fe is : ")
```

Scilab code Exa 5.2 Value of C

```
// Exa 5.2
clc;
clear;
close;
format('v',6)
// Given data
f = 10;// in kHz
f = f * 10^3;// in Hz
R = 100;// in k ohm
R = R * 10^3;// in ohm
//Formula used, f = 1/(2*%pi*R*C);
C = 1/(2*%pi*R*f);// in F
C = round(C * 10^12);// in pF
disp(C,"The value of capacitor in pF is");
```

Scilab code Exa 5.3 Paraller and seried resonant frequency and Q factor

```
// Exa 5.3
clc;
clear;
close;
format('v',6)
// Given data
C = 0.06;// in pF
C = C * 10^-12;// in F
L = 0.5;// in H
R = 10;// in k ohm
R = R * 10^3;// in ohm
Cm = 1;// in pF
Cm = Cm * 10^-12;// in F
// The parallel resonant frequency
f_p = (1/(2*%pi))*( sqrt( (C+Cm)/(L*C*Cm) ) );// in
   Hz
```

```
f_p= f_p*10^-3;// in kHz
disp(f_p,"The parallel resonant frequency in kHz is");
// The series resonant frequency
f_s = 1/(2*%pi*(sqrt(L*C)));// in Hz
f_s= f_s*10^-3;// in kHz
disp(f_s,"The series resonant frequency in kHz is ");
omega_s = 2*%pi*f_s*10^3;// in rad/sec
// The Q factor of the crystal
Q = (omega_s*L)/R;
disp(Q,"The Q factor of the crystal is");
```

Scilab code Exa 5.4 h parameters

```
// Exa 5.4
clc;
clear;
close;
format('v',6)
// Given data
R1 = 6;// in ohm
R2 = 4;// in ohm
R3 = 4;// in ohm
h11 = R1+( (R2*R3)/(R2+R3) );// in ohm
disp(h11,"The value of h11 in ohm is");
// i2 = -i*1/2 and h21 = i2/i1 = (-i1/2)/2, So
h21 = -1/2;
disp(h21,"The value of h21 is");
// V1 = V2/2 and h12 = V1/V2 = (V2/2)/2, SO
h12 = 1/2;
disp(h12,"The value of h12 is");
Zo = R2+R3;// output resistance  in ohm
h22 = 1/Zo;// in mho
disp(h22,"The value of h22 in mho is");
```

Scilab code Exa 5.5 h parameters

```
// Exa 5.5
clc;
clear;
close;
format('v',6)
// Given data
R1 = 3;// in ohm
R2 = 6;// in ohm
R3 = 2;// in ohm
// V1 = (R1*I1)+  (R2*(I1+I2)) = ((R1+R2)*I1)+(R2*I2
    )    (i)
// V2 = (R3*I2) + (R2*(I1+I2)) = (R2*I1) + ((R1+R3)*
    I2) (ii)
// Standard h-parameter equation
//V1= h11*I1 +h12*I2 and V2= h21*I1 + h22*I2
// Comparing eq (i) and (ii) with standard equaation
    , we get
h11= R1+R2;
disp(h11,"The value of h11 is");
h12= R2;
disp(h12,"The value of h12 is");
h21= R2;
disp(h21,"The value of h21 is");
h22= R2+R3;
disp(h22,"The value of h22 is");
```

Scilab code Exa 5.7 Value of Ai Av Avs Ri and Ro

```
// Exa 5.7
```

```
clc;
clear;
close;
format('v',6)
// Given data
h_ic = 1.1;// in   k ohm
h_ic = h_ic * 10^3;// in ohm
h_rc = 1;
h_fc = -51;
h_oc = 25;// in   A /V
h_oc = h_oc * 10^-6;// in A/V
R_L = 10;// in k ohm
R_L = R_L * 10^3;// in ohm
R_S = R_L;// in ohm
// The current gain ,
Ai = -h_fc/(1+(h_oc*R_L));
disp(Ai,"The value of Ai is");
// The value of Ri
Ri = h_ic+(h_rc*Ai*R_L);// in ohm
Ri= Ri*10^-3;// in k ohm
disp(Ri,"The value of Ri in k ohm is");
Ri= Ri*10^3;// in ohm
// The value of A_V
A_V = (Ai*R_L)/Ri;
disp(A_V,"The value of A_V is");
Gamma_o = h_oc - ( (h_fc*h_rc)/(h_ic+R_S) );// in
   mho
// The value of Ro
Ro = round(1/Gamma_o);// in ohm
disp(Ro,"The value of Ro in ohm is");
A_VS = (A_V*Ri)/(Ri+R_S);
disp(A_VS,"The value of A_VS is");
```

Scilab code Exa 5.10 Ai Ri Av and gammaO

```
// Exa 5.10
clc;
clear;
close;
format('v',6)
// Given data
h_ie = 1.5;// in ohm
h_fe = 100;
h_re = 3 * 10^-4;
h_oe = 25 * 10^-6;// in  mho
V_CC = 20;// in V
R1 = 50 * 10^3;// in ohm
R2 = 5 * 10^3;// in ohm
R_C = 5 * 10^3;// in ohm
R_L = 10 * 10^3;// in ohm
R_S = 1;// in k ohm
Ri= 1.4*10^3;// in ohm
R_B = (R1*R2)/(R1+R2);// in ohm
R_Ldesh= R_L*R_C/(R_L+R_C);// in ohm
// Current gain for transisor ,
Ai= -h_fe/(1+h_oe*R_Ldesh);
// Overall current gain , A_I= Ai+Ib/I= Ai+R_B/(R_B+
   Ri)
A_I= Ai*R_B/(R_B+Ri);
disp(A_I,"The overall current gain is : ")
//Part (ii)
R_i= R_B*Ri/(R_B*Ri);// in k ohm
disp(R_i,"The value of Ri in k ohm is : ")
// Part (iii)
Av= A_I*R_Ldesh/Ri;// voltage gain for transistor
// overall voltage gain ,
A_VS=  Av*R_i/(R_S+R_i);
disp(A_VS,"The value of A_VS is : ")
// Part (iv)
R_S=R_S*10^3;// in ohm
R_Sdesh= R_S*R_B/(R_S+R_B);// in ohm
gamma_o= h_re*h_fe/(h_ie+R_Sdesh)-h_oe;// in mho
gamma_o= round(gamma_o*10^6);// in    mho
```

```
disp(gamma_o,"The value of gamma_o in    mho is : ")

// Note: In the book, all these calculated value is
   not accurate.
```

Scilab code Exa 5.11 Ai Ri Av Ro Ro1 and Ap

```
// Exa 5.11
clc;
clear;
close;
format('v',6)
// Given data
R_S = 800;// in ohm
R_L = 2;// in k ohm
R_L = R_L * 10^3;// in ohm
h_ie = 1.1;// in k ohm
h_ie = h_ie * 10^3;// in ohm
h_fe = 50;
h_oe = 25;// in  ohm
h_oe = h_oe * 10^-6;// in ohm
h_re = 2.5*10^-4;

// Part (a) : Exact analysis
disp("Part (a) : Exact analysis")
// The current gain
Ai_exact = -h_fe/(1+(h_oe*R_L));
disp(Ai_exact,"The current gain is");
// The input resistance
Ri = h_ie + (h_re*Ai_exact*R_L);// in ohm
Ri= Ri*10^-3;// in k ohm
disp(Ri,"The input resistance in k ohm is");
Ri= Ri*10^3;// in ohm
A_V = (Ai_exact*R_L)/Ri;
// The voltage gain,
```

```
A_VS = (A_V*Ri)/(Ri+R_S);
disp(A_VS,"The voltage gain is");
Gamma_o = h_oe - ( (h_re*h_fe)/(h_ie+R_S) );// in
   mho
// The output resistance
Ro = 1/Gamma_o;// in ohm
Ro= Ro*10^-3;// k ohm
disp(Ro,"The output resistance in k ohm is");
Ro= Ro*10^3;// ohm
// The power gain,
Ap = Ai_exact*A_V;
disp(Ap,"The power gain is");
// The output terminal resistance
Rot = (Ro*R_L)/(Ro+R_L);// in ohm
Rot= Rot*10^-3;// in k ohm
disp(Rot,"The output terminal resistance in k ohm is
   ");
Rot= Rot*10^3;// in ohm

// Part (b) : Approximate analysis
disp("Part (b) : Approximate analysis")
h_re =0;
h_oe = 0;
Ai_app = -h_fe/(1+(h_oe*R_L));
disp(Ai_app,"The value of Ai is");
Ri = h_ie+(h_re*Ai_app*R_L);
disp(Ri,"The value of Ri in ohm is");
A_V= Ai_app*R_L/Ri;
A_VS = (-A_V*h_ie)/(R_S+h_ie);
disp(A_VS,"The value of A_VS is");
Gamma_o = 18.42// in ohms
Gamma_o = Gamma_o * 10^-6;// in mho
// // The output resistance
Ro = 1/Gamma_o;// in ohm
Ro= Ro*10^-3;// k ohm
disp(Ro,"The output resistance in k ohm is");
Ro= Ro*10^3;// ohm
Ap = Ai_app*A_V;
```

```
disp(Ap,"The value of Ap is");
//The output terminal resistance , Rot = (Ro*R_L)/(Ro+R_L)= 20;// in k ohm
Rot= 20;// in k ohm
disp(Rot,"The output terminal resistance in k ohm is");
Rot= Rot*10^3;// in ohm
// Percentage error
Per_error= abs((Ai_exact-Ai_app)/Ai_exact*100);// in %
disp(Per_error,"The percentage error in % is");
```

Scilab code Exa 5.13 Voltage gain current gain and power gain

```
// Exa 5.13
clc;
clear;
close;
format('v',6)
// Given data
R_S = 600;// in ohm
r_i = 400;// in ohm
Vs = 1;// in mV
Vs = Vs * 10^-3;// in V
//Input voltage
Vi = Vs*(r_i/(R_S+r_i));// in V
// Input current
Ii =Vs/(R_S+r_i);// in A
Vo = 100;// in mV
Vo = Vo * 10^-3;// in V
R_L = 5;// in  k ohm
R_L = R_L * 10^3;// in ohm
// Output current
Io = Vo/R_L;// in A
// voltage gain
```

```
A_V =Vo/Vi ;
disp(A_V,"The voltage gain is");
// current gain
A_I = Io/Ii;
disp(A_I,"The current gain is");
// Power gain
P =A_V*A_I;
disp(P,"The power gain is");
```

Scilab code Exa 5.14 Gain of negative feedback amplifier

```
// Exa 5.14
clc;
clear;
close;
format('v',6)
// Given data
A = 125;
Beta = 1/10;
// Gain of negative feedback
Af = A/(1+(A*Beta));
disp(Af,"The gain of negative feedback is");
```

Scilab code Exa 5.15 Value of A and B

```
// Exa 5.15
clc;
clear;
close;
format('v',6)
// Given data
Af = 100;
Vi = 0.6;// in V
```

```
Vo =Af*Vi;// in V
Vi = 50;// in mV
Vi = Vi * 10^-3;// in V
// Internal gain of amplifier ,
A = Vo/Vi;
disp(A,"The value of A is : ");
B= ((A/Af)-1)/A;
disp(B,"The value of B is");
```

Scilab code Exa 5.16 Change in overall gain

```
// Exa 5.16
clc;
clear;
close;
format('v',6)
// Given data
A = 60;// in dB
A =10^(A/20);
Beta = 0.005;
dAbyA = -12/100;//gain reduction in %
dAf_byAf = (1/(1+(A*Beta)))*dAbyA;// change in
    overall gain
dAf_byAf = dAf_byAf * 100;// in %
disp(dAf_byAf,"The change in overall gain in % is");
disp("Thus, the overall gain will be reduced by 2%")
```

Scilab code Exa 5.17 Feedback Factor

```
// Exa 5.17
clc;
clear;
close;
```

```
format('v',7)
// Given data
Zo =  12.6;// in k ohm
Zo = Zo * 10^3;// in ohm
A = 60;// in dB
A = 10^(A/20)
Zof = 500;// in ohm
// Zof = Zo/(1+(A*Beta));
Beta = ((Zo/Zof)-1)/A;
disp(Beta,"The value of feed back factor is");
// Part (ii)
dAbyA= 20/100;// change in gain of basic amplifier
dAf_byAf =dAbyA*1/(1+A*Beta)*100;//change in overall gain in %
disp(dAf_byAf,"The change in overall gain for 20 % change in gain of the basic amplifier in % is");

// Note: In the book, there is calculation error to find the value of dAf/Af
```

Scilab code Exa 5.18 output and input voltage

```
// Exa 5.18
clc;
clear;
close;
format('v',6)
// Given data
Vo = 36;// in V
Vi = 0.028;// in V
A = Vo/Vi;
Vf = 1.2;
Vo = 100;
Beta = Vf/Vo;
// Gain with feedback
```

```
Af = A/(1+(A*Beta));
Vs = Vi;// in V
// Output voltage
Vo =Af*Vs;// in V
disp(Vo,"The output voltage in V is");
//Df =D/(1+(A*Beta));
DbyDf = 7/1;
ABeta = (DbyDf)-1;
Af =A/(1+(ABeta));
Vo = 36;// in V
// The input voltage ,
Vs =Vo/Af;
disp(Vs,"The input voltage is");
```

Scilab code Exa 5.19 Required feedback ration

```
// Exa 5.19
clc;
clear;
close;
format('v',6)
// Given data
dAf_byAf = 10/100;
dAbyA = 10;
A = 1000;
// dAf_byAf = dAbyA*(1/(1+(A*Beta)));
// The required feed back
Beta = ((dAbyA/dAf_byAf)-1)/A;
disp(Beta,"The required feed back is");
Af = A/(1+(A*Beta));// closed loop voltage gain
disp(Af,"The closed loop voltage gain is");
```

Scilab code Exa 5.20 Distortion and new value of input required

```
// Exa 5.20
clc;
clear;
close;
format('v',6)
// Given data
Vi= 10*10^-3;// input voltage in V
A=1000;// open loop voltage gain
Do= 10;//second harmonic distortion in %
feedback= 40;//feedback in dB
feedback= 10^(feedback/20);
// feedback= 1+A*bita or
bita= (feedback-1)/A
Af= A/(1+A*bita);
// New value of second harmonic distortion ,
Df= Do/(1+A*bita);// in %
disp(Df," The new value of second harmonic
    distortion in % is : ")
// New value of input required ,
Vs= Vi*(1+A*bita);// in V
disp(Vs,"The new value of input required in volts is
     : ")
```

Scilab code Exa 5.21 Gain input voltage output voltage with feedback

```
// Exa 5.21
clc;
clear;
close;
format('v',6)
// Given data
D = 10/100;
Df = 1/100;
A = 200;
Vs = 10;// in mV
```

```
Vs = Vs * 10^-3;// in V
// Df = D/(1+A*Beta);
Beta = (((D/Df)-1)/A);
// gain with feedback
Af = A/(1+(A*Beta));
disp(Af,"The gain with feedback is : ");
// The output voltage
Vo = Af*Vs;// in V
disp(Vo,"The output voltage in V is : ");
// The input voltage
Vin = Df+(-Beta*Vo);// in V
disp(Vin,"The input voltage in V is : ");
```

Scilab code Exa 5.22 Input and output impedance

```
// Exa 5.22
clc;
clear;
close;
format('v',8)
// Given data
A = 10000;
Beta = 0.02;
Zi = 1;// in k ohm
Zi = Zi * 10^3;// in ohm
Zo = 10;// in k ohm
Zo = Zo * 10^3;// in ohm
// The input impedance
Zif = Zi*(1+(A*Beta));// in ohm
Zif= Zif*10^-3;// in k ohm
disp(Zif,"The input impedance in k ohm is");
// The output impedance
Zof = Zo/(1+(A*Beta));// in ohm
Zof= Zof*10^-3;// in k ohm
disp(Zof,"The output impedance in k ohm is");
```

```

// Note: In the book, there is calculation error to
   find the value of Zof because 10/201 will be
   0.04975 not 0.4975
```

Scilab code Exa 5.23 Gain and frequency responce

```
// Exa 5.23
clc;
clear;
close;
format('v',6)
// Given data
A = 400;
Beta = 0.01;
// The gain with feedback
Af =A/(1+(A*Beta));
disp(Af,"The gain with feedback is");
f_L = 200;// in Hz
// The Lower cut-off frequency with feedback
f_LF = f_L/(1+(A*Beta));// in Hz
disp(f_LF,"The Lower cut-off frequency with feedback
    in Hz is");
f_H = 40;// in kHz
f_H = f_H * 10^3;// in Hz
// The Upper cut-off frequency with feedback
f_HF = f_H*(1+(A*Beta));// in Hz
f_HF=f_HF*10^-3;// in k Hz
disp(f_HF,"The Upper cut-off frequency with feedback
    in kHz is");

// Note: In the book, there is calculation error to
   find the value of gain with feedback i.e. Af, so
   the answer in the book is wrong.
```

Scilab code Exa 5.24 Feedback fraction

```
// Exa 5.24
clc;
clear;
close;
// Given data
format('v',6)
A = 4000;
R1 = 1;// in k ohm
R1 = R1 * 10^3;// in ohm
R2 = 9;// in k ohm
R2 = R2 * 10^3;// in ohm
Beta = R1/(R1+R2);// feedback fraction
disp(Beta,"The feedback fraction is");
// The overall voltage gain with feedback
Af = A/(1+(A*Beta));
disp(Af,"The overall voltage gain with feedback is")
    ;
Vs = 2;// in mV
//Af = Vo/Vs;
// The output voltage
Vo = Af*Vs;// in mV
disp(Vo,"The output voltage in mV is");
```

Scilab code Exa 5.25 Percentage reduction in harmonic distortion

```
// Exa 5.25
clc;
clear;
close;
format('v',6)
```

```
// Given data
A = 54.8;
A = 20 * log(A);
Beta = 1/50;// feedback factor
// gain with feedback
Af = A/(1+(A*Beta));
//Distortion with feedback , Df = D/(1+(A*Beta))
Df = 1;
D = 12;
Pd = (Df/D)*100;// percenatge change in distortion in %
disp(Pd,"The percentage reduction in harmonic distortion in % is");
```

Scilab code Exa 5.26 Minimum gain required for oscillation

```
// Exa 5.26
clc;
clear;
close;
format('v',6)
// Given data
// Part(iii)
Vf_byVo= 1/3;
bita= Vf_byVo;
// A*bita>=1 or
// The minimum gain required for oscillation
Amin= 1/bita;
disp(Amin,"The minimum gain required for oscillation is : ")
```

Scilab code Exa 5.27 Stability of an amplifier

```
// Exa 5.27
clc;
clear;
close;
format('v',9)
// Magnitude of loop gain, Mag_Tf= bita*100/(sqrt(1+(f/10^5)^2))^3          (i)
// Phase of loop gain, P_Tf= -3*atand(f/10^5)                                          (ii)
f_180= tand(180/3)*10^5;// from eq(ii), frequency at which phase becomes -180
bita= 0.20;
T_f_180= bita*100/(sqrt(1+(f_180/10^5)^2))^3;// from eq (i), the magnitude of loop gain at f_180 for bita= 0.20
disp(T_f_180,"The magnitude of loop gain for beta = 0.20 is : ")
bita= 0.02;
T_f_180= bita*100/(sqrt(1+(f_180/10^5)^2))^3;// from eq (i), the magnitude of loop gain at f_180 for bita= 0.20
disp(T_f_180,"The magnitude of loop gain for beta = 0.20 is : ")
disp("Hence system is unstable for beta=0.20 and stable for beta= 0.02 because at beta= 0.20 gain is greater than 1.")
```

Scilab code Exa 5.29 Frequency of oscillations

```
// Exa 5.29
clc;
clear;
close;
format('v',6)
```

```
// Given data
L = 0.01;// in H
C = 10;// in pF
C = C * 10^-12;// in F
// The frequency of oscillation
f = 1/(2*%pi*sqrt(L*C));// in Hz
f = f * 10^-3;// in kHz
disp(f,"The frequency of oscillation in kHz is");

// Note: In the book, the calculation is wrong.
```

Scilab code Exa 5.30 Range of variable capacitor

```
// Exa 5.30
clc;
clear;
close;
format('v',6)
// Given data
L = 150;// in  H
L = L * 10^-6;// in H
// f = 1/(2*%pi*sqrt(L*C)) or C = 1/(4*%pi^2*f^2*L)
//For f= 500 kHz
f1 = 500;// in kHz
f1 = f1 * 10^3;// in Hz
C1 = 1/(4*%pi^2*f1^2*L);// in F
//For f= 1500 kHz
f2 = 1500;// in kHz
f2 = f2 * 10^3;// in Hz
C2 = 1/(4*%pi^2*f2^2*L);// in F
C1= C1*10^12;// in pF
C2= C2*10^12;// in pF
disp("The required capacitor range is : "+string(C2)
   +" pF to "+string(C1)+" pF")

```

```
// Note: The answer in the book is wrong.
```

Scilab code Exa 5.31 Operating frequency and feedback fraction

```
// Exa 5.31
clc;
clear;
close;
format('v',6)
// Given data
L = 100;// in  H
L = L * 10^-6;// in H
A=10;
C1 = 0.001;// in  F
C1 = C1 * 10^-6;// in F
C2 = 0.01;// in  F
C2 = C2 * 10^-6;// in F
C = (C1*C2)/(C1+C2);// in F
f = 1/(2*%pi*sqrt( L*C ));// in Hz
f = round(f * 10^-3);// in kHz
disp(f,"The operating frequency in kHz is");
Beta = C1/C2;// feedback fraction
disp(Beta,"The feed back fraction is");
//Minimum gain to sustain oscillations , Amin*Beta = 1;
Amin = 1/Beta;
disp(Amin,"The minimum gain to sustain oscillation is");
// A = R_C/R_E;
R_C = 2.5;// in ohm
R_E = R_C/A;// in ohm
disp(R_E,"The emitter resistance in ohm is");
```

Scilab code Exa 5.32 Value of capacitor of oscillatory

```
// Exa 5.32
clc;
clear;
close;
format('v',6)
// Given data
L1 = 0.1;// in mH
L1 = L1 * 10^-3;// in H
L2 = 10;// in mH
L2 = L2 * 10^-3;// in H
L = 150;// in  H
L = L * 10^-6;// in H
f = 4110;// in kHz
f = f * 10^3;// in Hz
//Frequency of oscillations , f = 1/(2*%pi*sqrt(L*C))
    , So
C = 1/(4*(%pi^2)*(f^2)*L );// in F
C = round(C * 10^12);// in pF
disp(C,"The value of capacitor in pF is");
```

Scilab code Exa 5.33 Value of C

```
// Exa 5.33
clc;
clear;
close;
format('v',6)
// Given data
f = 1;// in kHz
f = f * 10^3;// in Hz
R = 10;// in k ohm
R = R * 10^3;// in ohm
omega = 2*%pi*f;//in rad/sec
```

```
phi = 60;// in degree
// tand(phi) = Alpha_C/R = 1/(omega*C*R);
C = 1/(omega*R*tand(phi));// in F
C = C * 10^6;// in  F
disp(C,"The value of C in  F is");
```

Scilab code Exa 5.34 Frequency of oscillations

```
// Exa 5.34
clc;
clear;
close;
format('v',8)
// Given data
R2 = 200;// in k ohm
R2 = R2 * 10^3;// in ohm
R1 = R2;// in ohm
C2 = 250;// in pF
C2 = C2 * 10^-12;// in F
C1 = C2;// in F
R = R2;// in ohm
C = C2;// in F
// Frequency of oscillations,
f = 1/(2*%pi*R*C);// in Hz
disp(f,"The frequency in Hz is");

// Note: The answer in the book is not accurate.
```

Scilab code Exa 5.36 Frequency of oscillations

```
// Exa 5.36
clc;
clear;
```

```
close;
format('v',5)
// Given data
C1 = 300;// in pF
C2 = 100;// in pF
Ceq = (C1*C2)/(C1+C2);// in pF
Ceq = Ceq * 10^-12;// in F
L = 50;// in   H
L = L * 10^-6;// in H
// The frequency of oscillation
f = 1/(2*%pi*sqrt(L*Ceq));// in Hz
f = f * 10^-6;// in MHz
disp(f,"The frequency of oscillation in MHz is");
// For maintaining oscillation , A_loop >=1 and
    Aopenloop*Beta = 1;
// Beta = C2/C1;
Aopenloop = C1/C2;
disp(Aopenloop,"The minimum gain for maintaining
    oscillation is");
```

Chapter 6

Operational Amplifiers

Scilab code Exa 6.m.1 CMRR

```
// Exa Misc. 6.1
clc;
clear;
close;
format('e',8)
// Given data
Vid = 1;// in mV
Vo = 120;// in mV
V_CM = 1;// in mV
Ad = Vo/Vid;
Vo = 20;// in  V
Vo = Vo * 10^-3;// in mV
A_CM = Vo/V_CM;
Vo = 120;// in mV
// The value of CMRR for the circuit
CMRR = Vo/A_CM;
disp(CMRR,"The value of CMRR for the circuit is");
```

Scilab code Exa 6.m.2 Closed loop gain

```
// Exa Misc. 6.2
clc;
clear;
close;
format('v',6)
// Given data
R1 = 10;// in k ohm
R_F = 1000;// in k ohm
// Vin/R1 = -Vo/R_F and Vo/Vin = Ao = -R_F/R1
Ao = abs(-R_F/R1);// in k ohm
disp(Ao,"The closed loop gain is");
Vin = 30;// in mV
Vin = Vin  * 10^-3;// in V
// The output voltage,
Vo =-Ao*Vin;// in V
disp(Vo,"The output voltage in V is");

// Note: The loop gain will be unit less.
```

Scilab code Exa 6.m.3 Range of voltage gain

```
// Exa Misc. 6.3
clc;
clear;
close;
format('v',6)
// Given data
R1min = 10;// in k ohm
R1max = 20;// in k ohm
R_F = 300;// in k ohm
// The closed loop voltage gain corresponding to
   R1min,
Ao_min = -R_F/R1min;
// The closed loop voltage gain corresponding to
   R1max,
```

```
Ao_max = -R_F/R1max;
disp("The range of voltage gain is : "+string(Ao_max)+" to "+string(Ao_min));
```

Scilab code Exa 6.m.4 Range of output voltage

```
// Exa Misc. 6.4
clc;
clear;
close;
format('v',6)
// Given data
R_F = 500;// in k ohm
R_desh = 20;// in k ohm
Vin = 0.5;// in V
Rd_desh = 0;
R1min = 20;// in k ohm
R1max = 50;// in k ohm
// Ao = Vo/Vin = (1+(R_F/R1));
Vo_max = Vin*(1+(R_F/R1min));// output voltage corresponding to R1min
Vo_min = Vin*(1+(R_F/R1max));// output voltage corresponding to R1max
disp("Range of output voltage is : "+string(Vo_min)+" volts to "+string(Vo_max)+" volts.");
```

Scilab code Exa 6.m.5 Minimum and maximum closed loop voltage gain

```
// Exa Misc. 6.5
clc;
clear;
close;
format('v',6)
```

```
// Given data
R1 = 2;// in k ohm
Rdas = 2;// in k ohm
R_Fmin = 2;// in k ohm
R_Fmax = 102;// in k ohm
// Ao = -R_F/R1;
// The minimum closed loop voltage gain
Aomin = -R_Fmin/R1;
disp(Aomin,"The minimum closed loop voltage gain is");
//The maximum closed loop voltage gain
Aomax = -R_Fmax/R1;
disp(Aomax,"The maximum closed loop voltage gain is");
```

Scilab code Exa 6.m.6 Maximum and minimum closed loop voltage gain

```
// Exa Misc. 6.6
clc;
clear;
close;
format('v',6)
// Given data
R1 = 10;// in k ohm
R_F = 0;
// Ao = (1+(R_F/R1));
// The minimum closed loop voltage gain
Aomin = (1+(R_F/R1));
disp(Aomin,"The minimum closed loop voltage gain is");
R_F = 100;// in k ohm
// The maximum closed loop voltage gain
Aomax = (1+(R_F/R1));
disp(Aomax,"The maximum closed loop voltage gain is");
```

Scilab code Exa 6.m.7 Closed loop voltage gain

```
// Exa Misc. 6.7
clc;
clear;
close;
format('v',7)
// Given data
R1 = 220;// in ohm
R_F = 47;// in k ohm
R_F =R_F * 10^3;// in ohm
// The closed loop voltage for switch position -1
Ao = -R_F/R1;
disp(Ao,"The closed loop voltage for switch position
    -1 is");
R_F = 18;// in k ohm
R_F = R_F * 10^3;// in ohm
// The closed loop voltage for switch position -2
Ao = -R_F/R1;
disp(Ao,"The closed loop voltage for switch position
    -2 is");
R_F = 39;// in k ohm
R_F = R_F * 10^3;// in ohm
// The closed loop voltage for switch position -3
Ao = -R_F/R1;
disp(Ao,"The closed loop voltage for switch position
    -3 is");
```

Scilab code Exa 6.m.8 Closed loop voltage gain

```
// Exa Misc. 6.8
```

```
clc;
clear;
close;
format('v',6)
// Given data
R_F = 120;// in k ohm
Rdas1 = 6;// in k ohm
Rddas1 = 3;// in k ohm
R1 = Rdas1;// in k ohm
// For switch position -1 , the closed loop voltage
   gain ,
Ao = 1+(R_F/R1);
disp(Ao,"The closed loop voltage gain for switch
   position -1 is : ");
R1 = (Rdas1*Rddas1)/(Rdas1+Rddas1);// in k ohm
// For switch position -2, the closed loop voltage
   gain ,
Ao = 1+(R_F/R1);
disp(Ao,"The closed loop voltage gain for switch
   position -2 is : ");
```

Scilab code Exa 6.m.9 Output voltage

```
// Exa Misc. 6.9
clc;
clear;
close;
format('v',6)
// Given data
R_F = 20;// in k ohm
R1 = 20;// in k ohm
R2 = 10;// in k ohm
Vin1 = 2;// in V
Vin2 = 1;// in V
// The output voltage , by using super position
```

```
    theorm
Vo = ((-R_F/R1)*Vin1) + ((1+(R_F/R1))*Vin2);
disp(Vo,"The output voltage is");
```

Scilab code Exa 6.m.10 Voltage produced at output terminal

```
// Exa Misc. 6.10
clc;
clear;
close;
format('v',6)
// Given data
R_F = 60;// in ko hm
R1 = 20;// in k ohm
Vin1 = 2;// in V
Vin2 = 0.1;// in V
// The output voltage, by using super position
    theorm,
Vo = ((-R_F/R1)*Vin1) + ((1+(R_F/R1))*Vin2);// in V
disp(Vo,"The output voltage in V is");
```

Scilab code Exa 6.m.11 Output voltage

```
// Exa Misc. 6.11
clc;
clear;
close;
format('v',6)
// Given data
R1 = 10;// in k ohm
R2 = 20;// in k ohm
R3 = 10;// in k ohm
R_F = 20;// in k ohm
```

```
Vin1 = 2;// in V
Vin2 = 1;// in V
// The output voltage ,
Vo = ((-R_F/R1)*Vin1) - ((R_F/R2)*Vin2);// in V
disp(Vo,"The output voltage in V is");
```

Scilab code Exa 6.m.12 Output voltage

```
// Exa Misc. 6.12
clc;
clear;
close;
format('v',6)
// Given data
R_F = 20;// in k ohm
R1 = 10;// in k ohm
R2 = 20;// in k ohm
Vin1 = 2;// in V
Vin2 = 2;// in V
Vin3 = 2;// in V
// The output voltage , by using super position
   theorm ,
Vo = ((-R_F/R1)*Vin1) + (-Vin2*R_F/R2+Vin2) + ((R_F
   /(((R1*R2)/(R1+R2))))*Vin3);// in V
disp(Vo,"The voltage is appeared at the output
   terminal in V is");
```

Scilab code Exa 6.m.13 Output voltage

```
// Exa Misc. 6.13
clc;
clear;
close;
```

```
format('v',6)
// Given data
R1 = 20;// in k ohm
R3 = 10;// in k ohm
R2 = R3;// in k ohm
R_F = 20;// in k ohm
Vin1 = 2;// in V
Vin2 = 2.1;// in V
// The input voltage at non-inverting terminal,
V_A = (R2*Vin2)/R1;// in V
// The output voltage, by using super position
   theorm,
Vo = ((-R_F/R1)*Vin1) + ((1+(R_F/R1))*(R1/(R2+R3))*
   V_A);// in V
disp(Vo,"The output voltage in V is");
```

Scilab code Exa 6.m.15 Maximum loop voltage gain

```
// Exa Misc. 6.15
clc;
clear;
close;
format('v',6)
// Given data
//Output voltage of the amplifier, Vo = (1+(Rf/Rin))
   *Vin and voltage gain, Av = Vo/Vin = 1+(Rf/Rin)
Rf = 0;
Rin = 2;// in k ohm
Avmin = 1+(Rf/Rin);
Rf = 100;// in k ohm
// The maximum loop voltage gain
Avmax = 1+(Rf/Rin);
disp(Avmax,"The maximum loop voltage gain is");
```

Scilab code Exa 6.m.18 Output voltage and percentage error due to common mode

```
// Exa Misc. 6.18
clc;
clear;
close;
format('v',6)
// Given data
Ad = 5*10^5;// differential mode gain
CMRR = 80;// in dB
A_CM = Ad/(10^(CMRR/20));// common mode gain
V1 = 745;// in  V
V1 = V1 * 10^-6;// in V
V2 = 740;// in  V
V2 = V2 * 10^-6;// in V
// CMRR = 20*log( Ad/A_CM );
// //output voltage in differential mode gain
Vod = Ad*(V1-V2);// in V
disp(Vod,"The output voltage in differential mode
    gain in volts is : ")
//output voltage due to common mode gain
Vo_CM = A_CM*((V1+V2)/2);//in V
disp(Vo_CM,"The output voltage due to common mode
    gain in volts is : ")
Pr = (Vo_CM/Vod)*100;// percentage error in %
disp(Pr,"The percentage error due to common mode in
    % is")
```

Scilab code Exa 6.m.19 Input impedance voltage gain and power gain

```
// Exa Misc. 6.19
```

```
clc;
clear;
close;
format('v',6)
// Given data
R1 = 1;// in Mohm
// The input impedance
Rin = R1;// in Mohm
disp(Rin,"The input impedance in Mohm is");
R2 = 1;// in Mohm
// The voltage gain
Avf = -R2/R1;// Voltage gain
disp(Avf,"The voltage gain is");
```

Scilab code Exa 6.m.21 Output voltage

```
// Exa Misc. 6.21
clc;
clear;
close;
format('v',6)
// Given data
i1 = 1;//input current for first op-amp in mA
i1 = i1 * 10^-3;// in A
R_F = 1;// in k ohm
R_F = R_F * 10^3;// in ohm
// Output voltage at first op-amp stage
Vo = -i1*R_F;// in V
R1 = 10;// in k ohm
R2 = 1;// in k ohm
// The output voltage,
Vg1 = Vo*(1+(R1/R2));// in V
disp(Vg1,"The output volatge in V is");
```

Scilab code Exa 6.m.22 Output voltage

```
// Exa Misc. 6.22
clc;
clear;
close;
format('v',6)
// Given data
R_S3 = 10;// in k ohm
R_S2 = R_S3;// in k ohm
R_S1 = R_S3;// in k ohm
Rf = 10;// in k ohm
Vs1 = 0.2;// in V
Vs2 = 0.5;// in V
Vs3 = 0.8;// in V
// I = I1+6I2+I3;
// I = (Vs1/R_S1) + (Vs2/R_S2) + (Vs3/R_S3);
// I = - If;
// Vo = -If*Rf;
Vo = (Rf/R_S1)*(Vs1+Vs2+Vs3);// in V (as R_S1= R_S2
    =R_S3)
disp(Vo,"The value of Vo in volts is : ");
disp("But the supply voltage of 10 V is used, so the
     op-amp will reach in saturation.");
disp("Hence, output voltage is -10 volts.")
```

Scilab code Exa 6.m.25 Current through RL resistor

```
// Exa Misc. 6.25
clc;
clear;
close;
```

```
format('v',6)
// Given data
//Ratio of R2/R1 =  R3/R4 = 4 and R_L = -Vi/R3
Vi = 3.7;// in V
R3 = 2;// in k ohm
R3 = R3 * 10^3;// in ohm
// The current through R_L,
I_L = -Vi/R3;// in A
I_L= I_L*10^3;// in mA
disp(I_L,"The current through R_L in mA is");
```

Scilab code Exa 6.1 Common mode gain

```
// Exa 6.1
clc;
clear;
close;
format('v',6)
// Given data
CMRR = 10^5;
Ad = 10^5;
// CMRR = Ad/A_CM;
// The common mode gain of the op-amp
A_CM = Ad/CMRR;
disp(A_CM,"The common mode gain of the op-amp is");
```

Scilab code Exa 6.2 Slew rate

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

```
// Given data
del_V = 20;//change in voltage in V
del_t = 4;//change in time in  S
SR = del_V/del_t;//slew rate in V/ S
disp(SR,"The slew rate in V/ S is");
```

Scilab code Exa 6.3 Slew rate

```
// Exa 6.3
clc;
clear;
close;
format('v',6)
// Given data
del_V = 0.75;//chagne in voltage in V
del_t = 50;//change in time in ns
// The slew rate
SR = del_V/(del_t*10^-3);// in  s
disp(SR,"The slew rate in V/  -sec is");
```

Scilab code Exa 6.4 Closed loop voltage gain and input impedance

```
// Exa 6.4
clc;
clear;
close;
format('v',6)
// Given data
R1 = 1;// in k ohm
R_F = 4.7;// in k ohm
//The closed loop voltage gain , Ao = Vo/Vin = -R_F/R1;
Ao = -R_F/R1;
```

```
disp(Ao,"The closed loop voltage gain is");
// The input impedance
Ri = R1;// in k ohm
disp(Ri,"The input impedance in k ohm is");
```

Scilab code Exa 6.5 R1 and R2

```
// Exa 6.5
clc;
clear;
close;
format('v',6)
// Given data
Ao = -20;
Ri = 5;// in k ohm
R1 = Ri;// in k ohm
disp(R1,"The value of R1 in k ohm is");
// Closed loop voltage gain for inverting amplifier,
    Ao = -R_F/R1 or
R_F = -Ao*R1;// in k ohm
disp(R_F,"The value of R_F in k ohm is");
```

Scilab code Exa 6.6 Output voltage

```
// Exa 6.6
clc;
clear;
close;
format('v',6)
// Given data
R1 = 20;// in k ohm
R_F = 300;// in k ohm
Vin = 1.25;// in V
```

```
// Ao = Vo/Vin = -R_F/R1;
Ao = -R_F/R1;
// Output voltage ,
Vo = Ao*Vin;// in V
disp(Vo,"The output voltage in V is");
```

Scilab code Exa 6.7 R1 and Rf

```
// Exa 6.7
clc;
clear;
close;
format('v',6)
// Given data
Ao = -4;// in V/V
R_T= 100;// total resistance in k ohm
// R1+R_F= R_T              (i)
// Ao= -R_F/R1                  (ii)
R_F= R_T/(1-1/Ao);// in k ohm            (From eq (i)
    and (ii))
R1= -R_F/Ao;// in k ohm
disp(R1,"The value of R1 in k ohm is");
disp(R_F,"The value of R_F in k ohm is");
```

Scilab code Exa 6.8 Output voltage

```
// Exa 6.8
clc;
clear;
close;
format('v',6)
// Given data
R1 = 15;// in k ohm
```

```
R_F = 450;// in k ohm
Vin = -0.25;// in V
// Vo = Ao*Vin
Vo = (1+R_F/R1)*abs(Vin);// in V    (on putting, Ao
   = 1+(R_F/R1))
disp(Vo,"The output voltage in V is");
```

Scilab code Exa 6.9 R1 and Rf

```
// Exa 6.9
clc;
clear;
close;
format('v',6)
// Given data
Ao = 1.5;// in V/V
R = 10;// in k ohm
// Ao = (1+(R_F/R1))
disp("The relation of R1 and R_F can be implemented
    in two ways : ");
disp("(i) : When R_F= R || R, in this condition")
// When R_F= R || R
R1= R;//in k ohm
R_F= R1*(Ao-1);// in k ohm
disp(R1,"The value of R1 in k ohm is : ");
disp(R_F,"The value of R_F in k ohm is : ")
// When both resistor connected in series
disp("(ii) : When both resistor connected in series,
     in this condition")
R1= 2*R;// in k ohm
R_F= R1*(Ao-1);// in k ohm
disp(R1,"The value of R1 in k ohm is : ");
disp(R_F,"The value of R_F in k ohm is : ")
```

Scilab code Exa 6.10 R1 and Rf

```
// Exa 6.10
clc;
clear;
close;
format('v',6)
// Given data
Ao = 10;
// Ao = (1+(R_F/R1));
//Given that maximum value of resistor should not exceed 30 k , so we select
R_F= 27;// in k ohm
R1= R_F/(Ao-1);// in k ohm
disp(R_F,"The value of R_F in k ohm is");
disp(R1,"The value of R1 in k ohm is");
```

Scilab code Exa 6.11 Output voltage

```
// Exa 6.11
clc;
clear;
close;
format('v',6)
// Given data
Va = 0.2;// in V
Vb = -0.5;// in V
Vc = 0.8;// in V
Ra = 33;// in k ohm
Rb = 22;// in  k ohm
Rc = 11;// in  k ohm
R_F = 66;// in k ohm
```

```
// Using Superposition theorm, the output voltage
Vo = (-((R_F/Ra)*Va)) -(((R_F/Rb)*Vb)) -(((R_F/Rc)*
    Vc));// in V
disp(Vo,"The output voltage in V is");
```

Scilab code Exa 6.13 Output voltage

```
// Exa 6.13
clc;
clear;
close;
format('v',6)
// Given data
Va = 6;// in V
Vb = -3;// in V
Vc = -0.75;// in V
Ra = 10;// in k ohm
Rb = 2.5;// in k ohm
Rc = 4;// in k ohm
R_F = 10;// in k ohm
// The output voltage
Vo = (-((R_F/Ra)*Va)) -(((R_F/Rb)*Vb)) -(((R_F/Rc)*
    Vc));// in V
disp(Vo,"The output voltage in V is");
```

Scilab code Exa 6.14 Closed loop differential gain and output voltage

```
// Exa 6.14
clc;
clear;
close;
format('v',6)
// Given data
```

```
R1 = 100;// in ohm
R2 = R1;// in ohm
R3 = 3.9;// in k ohm
R3 = R3 * 10^3;// in ohm
R_F = R3;// in ohm
Vx = -3.2;// in V
Vy = -3;// in V
// output voltage due to Vx, Vox = -(R_F/R1)*Vx and
   due to Vy, Voy = (R3/(R2+R3)) * (1+(R_F/R1))*Vy
// Vo = Vox + Voy =  -(R_F/R1)*Vx + (R_F/R1)*Vy   (
   as R1=R2 and R3=Rf)
//So, Aod = Vo/(Vx-Vy) = -R_F/R1;
Aod = -R_F/R1;
disp(Aod,"The closed loop differential gain is");
Vo = (-R_F/R1)*(Vx-Vy);// in V
disp(Vo,"The output voltage in V is");
```

Chapter 7

Junction Field Effect Transistor

Scilab code Exa 7.1 Transfer characteristics

```
// Exa 7.1
clc;
clear;
close;
format('v',6)
// Given data
I_DSS = 14;// in mA
V_GSoff = -6;// in V
V_GS= 0:-0.1:V_GSoff;// in V
I_D= I_DSS*(1-V_GS/V_GSoff)^2;// in mA
// Ploting of the dc transfer characteristics
plot(V_GS,I_D);
xlabel("V_GS in volts")
ylabel("I_D in mA")
title("Transfer characteristics of a JFET")
disp("Transfer characteristics of a JFET shown in
    figure.")
```

Scilab code Exa 7.2 Drain current

```
// Exa 7.2
clc;
clear;
close;
format('v',6)
// Given data
I_DSS = 30;// in mA
V_GSoff = -8;// in V
V_GS = -5;// in V
// The value of drain current
I_D = I_DSS * ((1-(V_GS/V_GSoff))^2);// in mA
disp(I_D,"The value of drain current in mA is");
```

Scilab code Exa 7.3 Value of RS and RD

```
// Exa 7.3
clc;
clear;
close;
format('v',4)
// Given data
I_D = 1.5;// in mA
I_D = I_D*10^-3;// in A
V_DS = 10;// in V
I_DSS = 5;// in mA
I_DSS = I_DSS * 10^-3;// in A
V_P = -2;// in V
V_DD = 20;// in V
// I_D = I_DSS*((1-(V_GS/V_P))^2);
// ((V_GS/2)+1) = sqrt(I_D/I_DSS);
V_GS = 2*( (sqrt(I_D/I_DSS))-1 );// in V
V_G = 0;// in V
// V_GS = V_G-V_S;
V_S = -V_GS;// in V
R_S = V_S/I_D;// in ohm
```

```
R_S= R_S*10^-3;// in k ohm
disp(R_S,"The value of R_S in k ohm is");
R_S= R_S*10^3;// in ohm
// V_DD = (I_D*R_D) + V_DS + (I_D*R_S);
R_D = (V_DD-V_DS-(I_D*R_S))/I_D;// in ohm
R_D = round(R_D * 10^-3);// in k ohm
disp(R_D,"The value of R_D in k ohm is");
```

Scilab code Exa 7.4 VDS and VGS

```
// Exa 7.4
clc;
clear;
close;
format('v',6)
// Given data
V_DD = 30;// in V
R_D = 5;// in k ohm
R_D = R_D * 10^3;// in ohm
I_D = 2.5;// in mA
I_D = I_D * 10^-3;// in A
R_S = 200;// in ohm
// V_DD = (I_D*R_D) + V_DS + (I_D*R_S);
V_DS = V_DD - (I_D*(R_D+R_S));// in V
disp(V_DS,"The value of V_DS in V is");
// The value of V_GS
V_GS = -I_D*R_S;// in V
disp(V_GS,"The value of V_GS in V is");
```

Scilab code Exa 7.5 Pinch off voltage and chanel half width

```
// Exa 7.5
clc;
```

```
clear;
close;
format('v',4)
// Given data
Alpha = 3*10^-6;// in m
N_D = 10^21;// in electrons/cm^3
q = 1.6 * 10^-19;// in C
Epsilon_o = (36*%pi*10^9)^-1;
Epsilon = 12*Epsilon_o;
// The pinch of voltage
V_P = ((q*N_D)/(2*Epsilon))*(Alpha^2);// in V
disp(V_P,"The pinch of voltage in V is");
// Part (ii)
format('e',9)
VGSbyVp= 1/2;
// V_GS = ((1-b/Alpha)^2)*V_P
// The channel half width
b = Alpha*( 1-sqrt(VGSbyVp));// in m
b=b*10^2;// in cm
disp(b,"The channel half width in cm is");
```

Scilab code Exa 7.6 VGS gm Rs and Rd

```
// Exa 7.6
clc;
clear;
close;
format('v',5)
// Given data
V_P = -2;// in V
I_DSS = 1.65;// in mA
I_D = 0.8;// in mA
V_DD = 24;// in V
// I_D =I_DSS*(( 1-(V_GS/V_P) )^2);
V_GS = V_P*(1-sqrt(I_D/I_DSS))
```

```
disp(V_GS,"The value of V_GS in V is");
// Part (b)
g_mo = (-2*I_DSS)/V_P;// in mA/V
g_m = g_mo*(1-(V_GS/V_P));// in mA/V
disp(g_m,"The value of gm in mA/V is");
// Part (c)
// The value of R_S
R_S = -V_GS/(I_D*10^-3);// in ohm
disp(R_S,"The value of R_S in ohm is");
// Part (d)
Av= 20;//voltage gain in dB
Av= 10^(Av/20);
// r_d >> Rd and |Av|= gm*Rd
Rd= Av/g_m;// in k ohm
disp(Rd,"The value of Rd in k ohm is : ")

// Note: The value of R_S in the book is quite different from the coding output because in the book the calculated value of V_GS is not correct, correct value is -0.61
```

Scilab code Exa 7.7 VGS IDQ VDS VD VG and VS

```
// Exa 7.7
clc;
clear;
close;
format('v',6)
// Given data
I_DSS =10;// in mA
V_P = -8;// in V
V_GG = 2;// in V
V_GS = -V_GG;// in V
V_DD = 16;// in V
R_D = 2;// in k ohm
```

```
R_D = R_D * 10^3;// in ohm
disp(V_GS,"The value of V_GS in V is");
// Part (b)
// The value of I_DQ
I_DQ = I_DSS * (1-V_GS/V_P)^2;// in mA
disp(I_DQ,"The value of I_DQ in mA is");
// Part (c)
// The value of V_DS
V_DS = V_DD - (I_DQ*10^-3*R_D);// in V
disp(V_DS,"The value of V_DS in V is");
// Part (d)
// The value of V_D
V_D = V_DS;// in V
disp(V_D,"The value of V_D in V is");
// Part (e)
// The value of V_G
V_G = V_GS;// in V
disp(V_G,"The value of V_G in V is");
// Part (f)
// The value of V_S
V_S = 0;// in V
disp(V_S,"The value of V_S in V is");
```

Scilab code Exa 7.8 Value of RGS

```
// Exa 7.8
clc;
clear;
close;
format('v',6)
// Given data
V_GS = 10;// in V
I_G = 0.001;// in  A
I_G = I_G * 10^-6;// in A
// The resistance between gate and source
```

```
R_GS = V_GS/I_G;// in ohm
R_GS = R_GS * 10^-6;// in Mohm
disp(R_GS,"The resistance between gate and source in
    M ohm is");
```

Scilab code Exa 7.9 AC drain resistance

```
// Exa 7.9
clc;
clear;
close;
format('v',6)
// Given data
delV_DS = 1.5;// in V
delI_D = 120;// in  A
delI_D = delI_D*10^-6;// in A
// The ac drain resistance of the JFET
r_d = delV_DS/delI_D;// in ohm
r_d= r_d*10^-3;// in k ohm
disp(r_d,"The ac drain resistance of the JFET in k
   ohm is");
```

Scilab code Exa 7.10 Transconductance

```
// Exa 7.10
clc;
clear;
close;
format('v',6)
// Given data
I_D1 = 1.2;// in mA
I_D2 = 1.5;// in mA
// change in gate to source voltage,
```

```
delI_D = I_D2-I_D1;// in mA
V_GS2 = -4.10;// in V
V_GS1 = -4.25;// in V
delV_GS = V_GS2-V_GS1;// in V
// The transconductance
g_m = delI_D/delV_GS;// in mA/V
disp(g_m,"The transconductance in mA/V is");
```

Scilab code Exa 7.11 Id and gm

```
// Exa 7.11
clc;
clear;
close;
format('v',6)
// Given data
I_DSS = 8.4;// in mA
V_P = -3;// in V
V_GS = -1.5;// in V
// The value of I_D,
I_D = I_DSS*((1-(V_GS/V_P))^2);// in mA
disp(I_D,"The value of I_D in mA is");
g_mo = (-2*I_DSS)/V_P;// in mA/V
// The value of g_m
g_m = g_mo*(1-(V_GS/V_P));// in mA/V
disp(g_m,"The value of g_m in mA/V is");
```

Scilab code Exa 7.12 Pinch off voltage for Si and Ge

```
// Exa 7.12
clc;
clear;
close;
```

```
format('v',6)
// Given data
rho = 10;// in ohm-cm
epsilon_o = 8.86*10^-12;// in c^2/Nm^2
a = 2*10^-4;// in cm
// V_P= q*N_A*a^2/(2*epsilon)          (i)
//  and sigma= n*miu*q = N_A*miu*q => N_A= 1/(q*miu*
    rho)     (ii)
// From eq(i) and (ii), V_P = (a^2)/(2*miu_p*Epsilon
    *rho)
miu_p= 500;// in cm^2/V-sec   (for Si)
epsilon= 12*epsilon_o;// for Si
// The pinch off voltage for Si
V_P = (a^2)/(2*miu_p*epsilon*rho);//in V
disp(V_P,"Part (a) : The pinch off voltage for Si in
     volts is : ")
miu_p= 1800;// in cm^2/V-sec   (for Ge)
epsilon= 16*epsilon_o;// for Ge
// The pinch off voltage for Ge
V_P = (a^2)/(2*miu_p*epsilon*rho);//in V
disp(V_P,"Part (b) : The pinch off voltage for Ge in
     volts is : ")
```

Scilab code Exa 7.14 gm rd Zi Zo and Av

```
// Exa 7.14
clc;
clear;
close;
format('v',6)
// Given data
I_DSS = 16*10^-3;// in A
V_P = 4;// in V
V_GS= 2.86;//in V
Yos = 25;// in   S
```

```
Yos= Yos* 10^-6;// in S
R_S= 2.2*10^3;// in ohm
//gm = gmo * (1-(V_GS/V_P)) or
gm= 2*I_DSS/V_P*(1-V_GS/V_P);// in A/V
gm= gm*10^3;// in mA/V
disp(gm,"Part (i) : The value of gm in mS or mA/V is
   ");
gm= gm*10^-3;// in A/V
r_d = 1/Yos;// in ohm
r_d= r_d*10^-3;// in k ohm
disp(r_d,"The value of r_d in k ohm is");
r_d= r_d*10^3;// in ohm
// Part (ii)
Zi = 1;// in Mohm
miu = r_d*gm;
Zof_int= r_d/(1+miu)
// The value of Zo
Zo= Zof_int*R_S/(Zof_int+R_S);// in ohm
// The value of Av
Av= miu*R_S/(r_d+(1+miu)*R_S);
disp(Zi,"Part (ii) : The value of Zi in M ohm is : "
   )
disp(Zo,"Part (iii) : The value of Zo in ohm is : ")
disp(Av,"Part (iv) : The value of Av is : ")
```

Scilab code Exa 7.16 Voltage gain

```
// Exa 7.16
clc;
clear;
close;
format('v',6)
// GIven data
g_m = 2*10^-3;// in A/V
r_d = 10;// in k ohm
```

```
r_d = r_d * 10^3;// in ohm
R_D = 50;// in k ohm
R_D = R_D * 10^3;// in ohm
R_L = 50;// in k ohm
R_L = R_L * 10^3;// in ohm
f = 1;// in kHz
f = f * 10^3;// in Hz
C = 2;// in nF
C = C * 10^-9;// in F
omega= 2*%pi*f;// in radian/sec
R = (r_d*R_D*R_L)/( (r_d*R_D)+(R_D*R_L)+(R_L*r_d) );
    // in ohm
// The voltage gain,
Av = -g_m*R;
disp(Av,"Part (a) : The voltage gain is");
// Part (b) For small value of Cb,
Av = -g_m*( (r_d*R_D)/(r_d+R_D) );
Ro = (r_d*R_D)/(r_d+R_D);// in ohm
X_C = 1/(omega*C);// in ohm
Av= abs(Av)*R_L/(-%i*X_C+Ro+R_L);
Mag_Av= abs(Av);// magnitude of voltage gain
Phase_Av= atand(imag(Av),real(Av));// phase angle of
     voltage gain in
disp(Mag_Av,"Part (b) : Magnitude of voltage gain is
     : ");
disp(Phase_Av,"The phase angle of voltage gain in
    degree is: ")
```

Scilab code Exa 7.17 Quiescent drain current drain to source voltage and Av

```
// Exa 7.17
clc;
clear;
close;
```

```
format('v',6)
// Given data
V_DD = 30;// in V
R_D = 12;// in k ohm
R_S= 1.5;// in k ohm
V_GS = -0.47;// in V
V_P = -2.4;// in V
I_DSS = 3;// in mA
I_D= poly(0,'I_D');
I_D= I_D-I_DSS*(1-(V_GS/V_P)*I_D)^2;
// On solving equation by polynomial method,
   quiescent drain current
I_D= roots(I_D)
I_D= I_D(2);// in mA
disp(I_D,"The quiescent drain current in mA is : ")
V_D= round(V_DD-I_D*R_D);//in V
V_S= -V_GS*R_S;// in V
// The quiescent drain to source voltage
V_DS= ceil(V_D-V_S);// in V
disp(V_DS,"The quiescent drain to source voltage in
   volts is : ")
// gm= gmo*(1-V_GS/V_P)= -2*I_DSS/V_P*(1-V_GS/V_P)
 gm=-2*I_DSS/V_P*(1+V_S/V_P);//in mA/V
 // The small signal voltage gain
 Av= -gm*R_D;
 disp(Av,"The small signal voltage gain is : ")
```

Scilab code Exa 7.18 Voltage gain and change in output voltage

```
// Exa 7.18
clc;
clear;
close;
format('v',5)
// Given data
```

```
I_DSS = 5.6;// in mA
V_P = -4;// in V
g_m = 2;// in mA/V
R_S = 10;// in k ohm
A_V = (g_m*R_S)/(1+(g_m*R_S));
Vi = 10;// in V
// Change in output voltage,
delVo = A_V*Vi;// in V
disp(delVo,"The changes in Vo in V is");
```

Scilab code Exa 7.19 Change in output voltage

```
// Exa 7.19
clc;
clear;
close;
format('v',6)
// Given data
V_CC= 24;// in V
V_SS= -12// in V
R_D= 4.7;// in k ohm
R_S= 10;// in k ohm
V_P= -4;// in V
I_DSS= 5.6;// in mA
// For
Vi= 0;
I_D= poly(0,'I_D') ;
V_GS= Vi-V_SS-I_D*R_S;// in V
I_D= I_D-I_DSS*(1-V_GS/V_P)^2
// Evaluating the value of I_D by using polynomial
    method,
I_D= roots(I_D);// in mA
I_D= I_D(2);// taking lower value
Vo1= V_SS+I_D*R_S;//in V
disp(Vo1,"For Vi= 0 V, the output voltage in volts
```

```
   is : ")
// For
Vi= 10;// in V
I_D= poly(0,'I_D') ;
V_GS= Vi-V_SS-I_D*R_S;// in V
I_D= I_D-I_DSS*(1-V_GS/V_P)^2
// Evaluating the value of I_D by using polynomial
   method,
I_D= roots(I_D);// in mA
I_D= I_D(2);// taking lower value
Vo2= V_SS+I_D*R_S;//in V
disp(Vo2,"For Vi= 10 V, the output voltage in volts
   is : ")
del_Vo= Vo2-Vo1;// in V
disp("This compares well with "+string(del_Vo)+" V
   of small signal model.")
```

Scilab code Exa 7.20 Vds Id and VGS

```
// Exa 7.20
clc;
clear;
close;
format('v',6)
// Given data
V_DD = -60;// in V
R1 = 1.3;// in Mohm
R1 = R1 * 10^3;// in ohm
R2 = 200;// in k ohm
I_DSS = -4;// in mA
V_P = 4;// in V
R_S= 4;// in k ohm
R_D= 18;// in k ohm
V_GG = V_DD * (R2/(R1+R2));// in V
R_G = (R2*R1)/(R1+R2);// in k ohm
```

```
V_G = -8;// in V
I_D= poly(0,'I_D');
V_S= I_D*R_S;// in V
V_GS= V_G-V_S;// in V
I_D= I_D-I_DSS*(1-V_GS/V_P)^2;
// Evaluating the value of I_D by using, polynomial method,
I_D= roots(I_D);// in mA
I_D= I_D(2);// in mA
V_S= I_D*R_S;// in V
V_GS= V_G-V_S;// in V
V_DS= V_DD-I_D*(R_D+R_S);// in V
disp(I_D,"The value of I_D in mA is : ")
disp(V_GS,"The value of V_GS in volts is: ")
disp(V_DS,"The value of V_DS in volts is : ")
```

Scilab code Exa 7.21 IDQ VGSQ and VDS

```
// Exa 7.21
clc;
clear;
close;
format('v',5)
// Given data
I_DSS= 6;// in mA
V_P= -4;// in V
R_S= 0.43;// in k ohm
R_D= 1.2;// in k ohm
V_DD= 12;// in V
I_D= poly(0,'I_D');
V_GS= -I_D*R_S;// in V
I_D= I_D-I_DSS*(1-V_GS/V_P)^2;
// Evaluating the value of I_D by using polynomial method,
I_D= roots(I_D);// in mA
```

```
I_D= I_D(2);//in mA (taking lower value)
V_GSQ= -I_D*R_S// in V
disp(I_D,"The value of I_DQ in mA is : ")
disp(V_GSQ,"The value of V_GSQ in volts is : ")
// part (b)
// Applying KVL, V_DD-I_D*R_D-V_DS-I_D*R_S=0 or
V_DS= V_DD-I_D*(R_D+R_S);// in V
disp(V_DS,"The value of V_DS in volts is : ")

// Note: In the book, the calculated value of I_D is
    wrong due to this all the answer in the book is
   wrong.
```

Chapter 8

Metal Oxide Semiconductor Field Effect Transistor

Scilab code Exa 8.1 Transfer Characteristics

```
// Exa 8.1
clc;
clear;
close;
format('v',6)
// Given data
I_DSS= 10;// in mA
V_P= -4;// in V
V_GS= 0:-0.1:V_P;// in V
// The value of I_D,
I_D= I_DSS*(1-V_GS/V_P)^2;// in mA
plot(V_GS,I_D)
xlabel("V_GS in volts");
ylabel("I_D in mA");
title("Transfer characteristics for an n-channel
    depletion-type MOSFET");
disp("Transfer characteristics for an n-channel
    depletion-type MOSFET shown in figure.")
```

Scilab code Exa 8.2 Value of VDS

```
// Exa 8.2
clc;
clear;
close;
format('v',6)
// Given data
V_DD= 20;// in V
V_GS = 0;// in V
I_DSS = 10;// in mA
I_P = I_DSS;// in mA
I_D = I_DSS;// in mA
R_D = 1.5;// in k ohm
// The drain to source voltage,
V_DS = V_DD - (I_D*R_D);// in V
disp(V_DS,"The value of V_DS in V is");
```

Scilab code Exa 8.3 Drain curent

```
// Exa 8.3
clc;
clear;
close;
format('v',7)
// Given data
I_Don = 5;// in mA
V_GS = 8;// in V
V_GST = 4;// in V
K = I_Don/((V_GS-V_GST)^2);// in mA/V^2
// Drain current when V_GS= 6 V
V_GS= 6;// in V
```

```
I_D = K*((V_GS-V_GST)^2);// in mA
disp(I_D,"The drain current in mA is");
```

Scilab code Exa 8.4 Value of ID

```
// Exa 8.4
clc;
clear;
close;
format('v',5)
// Given data
I_Don = 10;// in mA
V_GS = -12;// in V
V_Ton = -3;// in V
if V_GS<0 then
    disp("Since the value of V_GS is negative, hence
        the device is P-channel")
end
K = I_Don/((V_GS-V_Ton)^2);// in mA/V
V_GS = -6;// in V
// The drain current,
I_D = K*( (V_GS-V_Ton)^2 );// in mA
disp(I_D,"The value of I_D in mA is");

// Note: The answer in the book is not accurate.
```

Scilab code Exa 8.5 IDQ and VDS

```
// Exa 8.5
clc;
clear;
close;
format('v',9)
```

```
// Given data
I_Don = 5;// in mA
V_GSon = 7;// in V
V_T = 4;// in V
V_DD = 9;// in V
R_D = 1.2;// in k ohm
R_S = 0.5;// in k ohm
K = (I_Don)/((V_GSon-V_T)^2);// in mA/V^2
// The value of drain current,
I_D = K*((V_GSon-V_T)^2);// in mA
disp(I_D,"The value of I_D in mA is");
//The drain to source voltage, V_DS = V_DD - (I_D*R_D) - (I_D*R_S);
V_DS = V_DD - (I_D*(R_D+R_S));// in V
disp(V_DS,"The value of V_DS in V");

// Note: The answer in the book is not accurate.
```