# Scilab Textbook Companion for Electronics Engineering by P. Raja[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

# Impact Load And Stresses

**Scilab code Exa 1.1** Barrier potential

```
// Exa 1.1
clc;
clear;
close;
// Given data
T1 = 25;// in degree C
T2 = 100;// in degree C
del_T = T2-T1;// in degree C
V= 0.7;// barrier potential t 25 C in V
del_V = -(2)*del_T;// in mV
del_V= del_V*10^-3;// in V
V_B = V- abs(del_V);// in V
disp(V_B,"(i) When the junction temperature is 100
    C , the barrier potential of a silicon diode in
   V is");
T2 = 0;// in degree C
del_T = T2-T1;// in degree C
del_V = -(2)*del_T;// in mV
del_V= del_V*10^-3;//in V
V_B = V+del_V;// in V
disp(V_B,"(ii) When the junction temperature is 0
```

```
C , the barrier potential of a silicon diode in
V is");
```

**Scilab code Exa 1.2** Saturation current

```
// Exa 1.2
clc;
clear;
close;
// Given data
T1 = 25;// in degree C
T2 = 100;// in degree C
del_T = T2-T1;// in degree C
I_S = (2)^7 *5;// in nA
I_S = (1.07)^5*I_S;// in nA
disp(round(I_S),"The saturation current at 100
   degree C in nA is");
```

**Scilab code Exa 1.3** Load voltage and current

```
// Exa 1.3
clc;
clear;
close;
// Given data
V_L = 10;// in V
R_L = 1*10^3;// in
I_L = V_L/R_L;// in A
I_L = I_L*10^3;// mA
disp(V_L,"The load voltage in volts is : ")
disp(I_L,"The load current in mA is");
```

**Scilab code Exa 1.4** Load voltage and current

```
// Exa 1.4
clc;
clear;
close;
// Given data
v1 = 10;// in V
v2 = 0.7;// in V
V_L = v1-v2;// in V
disp(V_L,"The load voltage in V is");
R_L = 1*10^3;// in
I_L = V_L/R_L;// in A
disp(I_L*10^3,"The load current in mA is");
P_D = v2*I_L;// in watt
disp(P_D*10^3,"The diode Power in mW is");
```

---

**Scilab code Exa 1.5** Load voltage and current

```
// Exa 1.5
clc;
clear;
close;
// Given data
R_L1 = 1*10^3;// in ohm
R_L2 = 0.23;// in ohm
R_T = R_L1+R_L2;// in ohm
v1 = 10;// in V
v2 = 0.7;// in V
V_T = v1-v2;// in V
I_L = V_T/R_T;// in A
disp(I_L*10^3,"The load current in mA is");
```

```
V_L = I_L*R_L1;// in V
disp(V_L,"The load voltage in V is");
```

**Scilab code Exa 1.6** Value of Vo I1 ID1 and ID2

```
// Exa 1.6
clc;
clear;
close;
// Given data
V_o = 0.7;// in V
disp(V_o,"The value of V_o in V is");
E = 10;// in V
V_D = V_o;// in V
R = 330;// in ohm
I1 = (E - V_D)/R;// in A
I1 = I1*10^3;// in mA
disp(I1,"The value of I1 in mA is");
I_D1 = I1/2;// in mA
disp(I_D1,"The value of I_D1 in mA is");
I_D2 = I_D1;// in mA
disp(I_D2,"The value of I_D2 in mA is");
```

**Scilab code Exa 1.7** Value of Vo and ID

```
// Exa 1.7
clc;
clear;
close;
// Given data
V_i = 12;// in V
V_D1 = 0.7;// in V
V_D2 = 0.3;// in V
```

```
R = 5.6*10^3;// in ohm
V_o  = V_i - V_D1 - V_D2;// in V
disp(V_o,"The value of Vo voltage in V is");
I_D = V_o/R;// in A
I_D = I_D*10^3;// in mA
disp(I_D,"The value of I_D in mA is");
```

**Scilab code Exa 1.8** Value of current

```
// Exa 1.8
clc;
clear;
close;
// Given data
V1 = 24;// in V
V2 = 6;// in V
V_D1 = 0.7;// in V
R = 3*10^3;// in ohm
I = (V1 - V2 - V_D1)/R;// in A
I = I * 10^3;// in mA
disp(I,"The current in mA is");
```

**Scilab code Exa 1.9** Diode current

```
// Exa 1.9
clc;
clear;
close;
// Given data
r= 20;// in
R_B= 15;// in
V_K1= 0.2;// in V
V_K2= 0.6;// in V
```

```
V= 100;// in V
R1= 10*10^3;// in
// Vo= V_K1+r*I1 = V_K2+R_B*I2
// Resulting current I= I1+I2 or
// (V-Vo)/(R1) = (Vo-V_K1)/r + (Vo-V_K2)/R_B
Vo= (r*R_B*V+R1*R_B*V_K1+R1*r*V_K2)/(R1*R_B+R1*r+r*
    R_B);// in V
I1= (Vo-V_K1)/r;// in A
I2= (V_K2-Vo)/R_B;// in A
disp(I1*10^3,"The value of I1 in mA is : ")
disp(I2*10^3,"The value of I2 in mA is : ")
```

**Scilab code Exa 1.10** DC resistance levels

```
// Exa 1.10
clc;
clear;
close;
// Given data
I_D = 10;// in mA
I_D = I_D * 10^-3;// in A
V_D = 0.5;// in V
r_F1 = V_D/I_D;// in ohm
disp(r_F1,"The value of r_F1 in ohm is");
I_D = 20;// in mA
I_D = I_D * 10^-3;// in A
V_D = 0.8;// in V
r_F2 = V_D/I_D;// in ohm
disp(r_F2,"The value of r_F2 in ohm is");
I_D = -1;// in  A
I_D = I_D * 10^-6;// in A
V_D = -10;// in V
r_R = V_D/I_D;// in ohm
disp(r_R*10^-6,"The value of r_R in Mohm is");
```

```
// Note: There is calculation error to evaluate the value of r_F1. So the asnwer in the book is wrong.
```

**Scilab code Exa 1.11** Value of ID VD2 and Vo

```
// Exa 1.11
clc;
clear;
close;
// Given data
R= 5.6*10^3;// in
I_D = 0;// in A
V_D = 0;// in V
E= 12;// in V
Vo= I_D*R;// in V
disp(I_D,"The value of I_D in A is :");
disp(Vo,"The value of Vo in V is");
V_D1 = 0;// in V
V_D2 = E -V_D1 - Vo;// in  V
disp(V_D2,"The value of V_D2 in V is");
```

**Scilab code Exa 1.12** Value of I1 I2 and ID2

```
// Exa 1.12
clc;
clear;
close;
// Given data
E = 20;// in V
V_D1 = 0.7;// in V
V_D2 = 0.7;// in V
V2 = E - V_D1  - V_D2;// in V
```

```
R1 = 3.3*10^3;// in ohm
R2 = 5.6*10^3;// in ohm
I2 = V2/R2;// in A
I2 = I2*10^3;// in mA
disp(I2,"The current through resistor R2 in mA is ");
I1 = V_D2/R1;
I1 = I1 * 10^3;// in mA
disp(I1,"The current through resistor R1 in mA is");
I_D2 = I2-I1;// in mA
disp(I_D2,"The current through diode D2 in mA is");
```

**Scilab code Exa 1.13** Output voltage

```
// Exa 1.13
clc;
clear;
close;
// Given data
V1 = 12;// in V
V2 = 0.3;// in V
V_o = V1-V2;// in V
disp(V_o,"The output voltage in V is");
```

**Scilab code Exa 1.14** Value of ID

```
// Exa 1.14
clc;
clear;
close;
// Given data
disp("Part (a) Analysis using approximate diode model")
```

```
V_D = 0.7;// in V
disp(V_D,"The value of V_D in V is");
E = 30;// in V
V_R = E-V_D;// in V
disp(V_R,"The value of V_R in V is");
R = 2.2 * 10^3;// in ohm
I_D = V_R/R;
I_D = I_D * 10^3;// in mA
disp(I_D,"The value of I_D in mA is");
disp("Part (b) Analysis using ideal diode model")
V_D = 0;// in V
disp(V_D,"The value of V_D in V is");
V_R = E;// in V
disp(V_R,"The value of V_R in V is");
I_D = V_R/R;
I_D = I_D * 10^3;// in mA
disp(I_D,"The value of I_D in mA is");
```

**Scilab code Exa 1.15** Value of current

```
// Exa 1.15
clc;
clear;
close;
// Given data
V1 = 20;// in V
V2 = 0.7;// in V
V = V1-V2;// in V
R = 20;// in ohm
I = V/R;// in A
disp(I,"The current through resistance in A is");
```

**Scilab code Exa 1.16** Output voltage

```
// Exa 1.16
clc;
clear;
close;
// Given data
R1= 2;// in  k
R2= 2;// in  k
V=19;// in V
V_o = (V*R1)/(R1+R2);// in V
disp(V_o,"The output voltage in V is");
```

**Scilab code Exa 1.17** Value of Vo and ID

```
// Exa 1.17
clc;
clear;
close;
// Given data
V1 = 0.7;// in V
V2 = 5;// in V
V_o = V1-V2;// in V
R = 2.2*10^3;// in ohm
I_D = -V_o/R;
I_D = I_D * 10^3;// in mA
disp(V_o,"The output voltage in volts is : ")
disp(I_D,"The current through diode in mA is");
```

**Scilab code Exa 1.18** Output voltage and diode current

```
// Exa 1.18
clc;
clear;
close;
```

```
// Given data
V_gamma = 0.7;// in V
R1 = 5*10^3;// in ohm
R2 = 10*10^3;// in ohm
V=5;// in V
disp("Part (a)")
I_R2 = (V-V_gamma-(-V))/(R1+R2);// in A
I_D2 = I_R2;// in A
disp(I_D2*10^3,"The value of I_D1 and I_D2 in mA is");
V_o = V - (I_D2 * R1);// in V
disp(V_o,"The value of Vo in V is");
V_A = V_o - V_gamma;// in V
disp(V_A,"The value of V_A in V is");
disp("Part (b)")
V_I = 4;// in V
V_A= V_I-V_gamma;// in V
Vo= V_A+V_gamma;// in V
I_R1= (V-Vo)/R1;// in A
I_D2= I_R1;// in A
disp(I_D2*10^3,"The value of I_D2 in mA is : ")
I_R2= (V_A-(-V))/R2;// in A
I_D1= I_R2-I_R1;// in A
disp(I_D1*10^3,"The value of I_D1 in mA is : ")
disp(Vo,"The value of Vo in volts is : ")
```

**Scilab code Exa 1.19** Total current

```
// Exa 1.19
clc;
clear;
close;
// Given data
V_S = 6;// in V
V_D = 0.7;// in V
```

```
R = 10;// in K ohm
R = R*10^3;// in ohm
I_T = (V_S-V_D)/R;// in A
disp(I_T*10^6,"The total current in  A is");
```

**Scilab code Exa 1.20** Total current

```
// Exa 1.20
clc;
clear;
close;
// Given data
V_S = 5;// in V
V_D = 0.7;// in V
R1 = 1.2 * 10^3;// in ohm
R2 = 2.2 * 10^3;// in ohm
I_T = (V_S-V_D)/(R1+R2);
I_T = I_T * 10^3;// in mA
disp(I_T,"The total circuit current in mA is");
```

**Scilab code Exa 1.21** Total current

```
// Exa 1.21
clc;
clear;
close;
// Given Data
V_S = 4;// in V
V_D1 = 0.7;// in V
V_D2 = 0.7;// in V
R = 5.1*10^3;// in ohm
I_T = (V_S-V_D1-V_D2)/R;// in A
disp(round(I_T*10^6),"The total current in  A is");
```

**Scilab code Exa 1.22** Total current

```
// Exa 1.22
clc;
clear;
close;
// Given data
V_S = 10;// in V
R1 = 1.5*10^3;// in ohm
R2 = 1.8*10^3;// in ohm
I_T = V_S/(R1+R2);// in A
disp(I_T*10^3,"Using the ideal diode, the total
   current in mA is ");
V_D1 = 0.7;// in V
V_D2 = 0.7;// in V
I_T = (V_S-V_D1-V_D2)/(R1+R2);// in A
disp(I_T*10^3,"Using the pracitcal diode, the total
   current in mA is");
```

**Scilab code Exa 1.23** Value of Vo I1 ID1 and ID2

```
// Exa 1.23
clc;
clear;
close;
// Given data
V_S = 5;// in V
V2 = 3;// in V
R = 500;// in ohm
I_D2 = (V_S-V2)/R;// in A
I_D2 = I_D2 * 10^3;// in mA
disp(I_D2,"The diode current in mA is");
```

**Scilab code Exa 1.24** Diode current

```
// Exa 1.24
clc;
clear;
close;
// Given data
V_S = 2;// in V
R = 100;// in ohm
I_D = V_S/R;
I_D = I_D * 10^3;// in mA
disp("Part (a)")
disp(I_D,"The diode current in mA is");
V_K = 0.7;// in V
I_D1 = (V_S-V_K)/R;
I_D1 = I_D1*10^3;// in mA
disp("Part (b)")
disp(I_D1,"The diode current in mA is");
R_f = 30;// in ohm
I_D2 = (V_S - V_K)/(R+R_f);
I_D2 = I_D2 * 10^3;// in mA
disp("Part (c)")
disp(I_D2,"The diode current in mA is");
```

**Scilab code Exa 1.25** Value of Vo1 and Vo2

```
// Exa 1.25
clc;
clear;
close;
// Given data
```

```
R1= 1;// in  k
R2= 0.47;// in  k
V_o1 = 0.7;// in V
disp(V_o1,"The value of Vo1 in V is");
V_o2 = 0.3;// in V
disp(V_o2,"The value of Vo2 in V is");
I1 = (20-V_o1)/R1;// in mA
I2 = (V_o2-V_o1)/R2;// in mA
I = I1 + I2;// in mA
disp(I,"The current in mA is");
```

**Scilab code Exa 1.26** Output voltage and diode current

```
// Exa 1.26
clc;
clear;
close;
// Given data
V1 = 10;// in V
V2 = 0.7;// in V
R1 = 1*10^3;// in ohm
R2 = 2*10^3;// in ohm
I = (V1-V2)/(R1+R2);// in A
V_o = I * R2;// in V
disp(V_o,"The output voltage in V is");
I_D = I/2;// in A
disp(I_D*10^3,"The diode current in mA is");
```

**Scilab code Exa 1.27** Output voltage and diode current

```
// Exa 1.27
clc;
clear;
```

```
close;
// Given data
V1 = 20;// in V
V2 = 0.7;// in V
R = 4.7*10^3;// in ohm
I = (V1-V2)/R;// in A
I_D = I/2;// in A
disp(I_D*10^3,"The diode current in mA is");
V_o = I_D*R;// in V
disp(V_o,"The output voltage in V is");
```

**Scilab code Exa 1.28** Output voltage and diode current

```
// Exa 1.28
clc;
clear;
close;
// Given data
V1 = 15;// in V
V2 = 0.7;// in V
V3 = 5;// in V
R = 2.2;// in K ohm
I_D = (V1-V2+V3)/R;// in mA
disp(I_D,"The diode current in  mA is");
V_o = (R * I_D) - V3;// in V
disp(V_o,"The output voltage in V");
```

**Scilab code Exa 1.29** Current and output voltage

```
// Exa 1.29
clc;
clear;
close;
```

```
// Given data
V1 = 16;// in V
V2 = 0.7;// in V
V3 = V2;// in V
V4 = 12;// in V
R = 4.7;// in K ohm
I = (V1-V2-V3-V4)/R;// in mA
disp(I,"The current in mA is");
V_o = (I * 10^-3 * R * 10^3) + V4;// in V
disp(V_o,"The output voltage in V is");
```

# Chapter 2

# Diode Applications

**Scilab code Exa 2.1** Average current and load voltage

```
// Exa 2.1
clc;
clear;
close;
// Given data
R_L = 1000;// in ohm
N2byN1= 4;
Vi= '10*sin(omega*t)'
// V2= N2byN1*V1
// V2= 40*sin(omega*t)
Vm= N2byN1*10;// in V
V_Lav= Vm/%pi;// in V
disp(V_Lav,"The average load voltage in volts is : "
    )
Im= Vm/R_L;// in A
I_dc= Im/%pi;// in A
I_av = I_dc;// in A
I_av= I_av*10^3;// in mA
disp(I_av,"Average load current in mA is");
V_Lrms = Vm/2;// in V
disp(V_Lrms,"RMS load voltage in V is");
```

```
I_rms = V_Lrms/R_L;// in A
I_rms= I_rms*10^3;// in mA
disp(I_rms,"RMS load current in mA is");
Eta = I_av^2/I_rms^2*100;// in %
disp(Eta,"Efficiency in % is");
V2rms= Vm/sqrt(2);// in V
TUF = ((I_av )^2)/(V2rms*I_rms)*100;// in %
disp(TUF,"Transformer utilization factor in % is");
Gamma= sqrt(V_Lrms^2-I_av^2)/V_Lav*100;
disp(round(Gamma),"Ripple factor in % is");
```

**Scilab code Exa 2.2** Average RMS and peak value of current

```
// Exa 2.2
clc;
clear;
close;
// Given data
R_L = 1;// in K ohm
R_L = R_L * 10^3;// in ohm
V_m = 15;// in V
V_i = '15*sin(314*t)';
I_m= V_m/R_L;// in A
I_dc = I_m/%pi;// in A
I_dc = I_dc * 10^3;// in mA
disp(I_dc,"Average current through the diode in mA is");
I_drms = V_m/(2*R_L);
I_drms = I_drms * 10^3;// in mA
disp(I_drms,"RMS current in mA is");
I_m = V_m/R_L;
I_m = I_m*10^3;// in mA
disp(I_m,"Peak diode current in mA is");
PIV = 2*V_m;// in V
disp(PIV,"Peak inverse voltage in V is");
```

**Scilab code Exa 2.3** Required PIV

```
// Exa 2.3
clc;
clear;
close;
// Given data
R1 = 2.2*10^3;// in ohm
R2 = 4.7*10^3;// in ohm
R_AB = (R1*R2)/(R1+R2);// in ohm
Vi = 20;// in V
V_o = (Vi * R_AB)/(R_AB+R1);// in V
PIV= Vi;// in volts
disp(V_o,"The output voltage in V is");
disp(PIV,"Peak inverse voltage in volts is : ")
```

**Scilab code Exa 2.4** Required PIV

```
 // Exa 2.4
clc;
clear;
close;
// Given data
V_in  = 10;// in V
R1 = 2000;// in ohm
R2 = 2000;// in ohm
V_o = V_in * (R1/(R1+R2) );// in V
// Vdc= 5/(T/2)*integrate('sin(omega*t)','t',0,T/2)
   and omega*T= 2*%pi, So
Vdc= -5/%pi*(cos(%pi)-cos(0));// in V
disp(Vdc,"The value of Vdc in volts is : ");
```

```
PIV= V_in/2;// in V
disp(PIV,"The PIV value in volts is : ")
```

**Scilab code Exa 2.4.2** Peak magnitude of output waveform

```
 // Exa 2.4.2  (again 2.4)
clc;
clear;
close;
// Given data
V_in  = 10;// in V
R_L = 2000;// in ohm
R1 = 100;// in ohm
V_R= 0.7;// in V
V_o = V_in * ( (R_L)/(R1+R_L) );// in V
disp(V_o,"The peak magnitude of the positive output
   voltage in V is");
Vo=-V_R;// in V
disp(Vo,"The peak magnitude of the negative output
   voltage in V is : ")
```

**Scilab code Exa 2.7** Average load voltage

```
// Exa 2.7
clc;
clear;
close;
// Given data
V=240;// in V
R= 1;// in  k
R=R*10^3;// in
Vsrms= V/4;// in V
Vm= sqrt(2)*Vsrms;// in V
```

```
V_Ldc= -Vm/%pi;// in V
disp(V_Ldc,"The value of average load voltage in volts is : ")
```

**Scilab code Exa 2.8** DC output voltage

```
// Exa 2.8
clc;
clear;
close;
// Given data
V = 220;// in V
f=50;// in Hz
N2byN1=1/4;
R_L = 1;// in kohm
R_L= R_L*10^3;// in ohm
V_o = 220;// in V
V_s = N2byN1*V_o;// in V
V_m = sqrt(2) * V_s;// in V
V_Ldc = (2*V_m)/%pi;// in V
disp(V_Ldc,"Average load output voltage in V is");
P_dc = (V_Ldc)^2/R_L;// in W
disp(P_dc,"DC power delivered to load in watt is");
PIV = V_m;// in V
disp(PIV,"Peak inverse Voltage in V is");
f_o = 2*f;// in Hz
disp(f_o,"Output frequency in Hz is");
```

**Scilab code Exa 2.10** RMS value of signal voltage

```
// Exa 2.10
clc;
clear;
```

```
close;
// Given data
R_L = 20;// in ohm
I_Ldc = 100;// in mA
R2 = 1;// in ohm
R_F = 0.5;// in ohm
I_m = (%pi * I_Ldc)/2;// in mA
V_m = I_m*10^-3*(R2+R_F+R_L);// in V
V_srms = V_m/sqrt(2);// in V
disp(V_srms,"RMS value of secondary signal voltage in V is");
P_Ldc = (I_Ldc*10^-3)^2*R_L;// in Watt
disp(P_Ldc,"power delivered to load in Watt is");
PIV = 2*V_m;// in V
disp(PIV,"Peal inverse voltage in V is");
P_ac = (V_m)^2/(2*(R2+R_F+R_L));// in Watt
disp(P_ac,"Input power in Watt is");
Eta = P_Ldc/P_ac*100;// in %
disp(Eta,"Conversion efficiency in % is");
```

**Scilab code Exa 2.16** AC voltage

```
// Exa 2.16
clc;
clear;
close;
// Given data
V_dc = 12;// in V
R_L = 500;// in ohm
R_F = 25;// in ohm
I_dc = V_dc/R_L;// in A
V_m = I_dc * %pi * (R_L+R_F);// in V
V_rms = V_m/sqrt(2);// in V
V  = V_rms;// in V
disp(round(V),"The voltage in V is");
```

**Scilab code Exa 2.17** PIV

```
// Exa 2.17
clc;
clear;
close;
// Given data
V_dc = 100;// in V
V_m = (V_dc*%pi)/2;// in V
PIV = 2*V_m;// in V
disp(PIV,"Peak inverse voltage for center tapped FWR
    in V is");
PIV1 = V_m;// in V
disp(PIV1,"Peak inverse voltage for bridge type FWR
   in V is");
```

**Scilab code Exa 2.19** Required PIV rating

```
// Exa 2.19
clc;
clear;
close;
// Given data
V_Gamma = 0.7;// in V
R_f = 0;// in ohm
V_rms = 120;// in V
V_max = sqrt(2)*V_rms;// in V
R_L = 1;// in K ohm
R_L = R_L * 10^3;// in ohm
I_max = (V_max - (2*V_Gamma))/R_L;// in A
I_dc = (2*I_max)/%pi;// in mA
```

```
V_dc = I_dc * R_L;// in V
disp(V_dc,"The dc voltage available at the load in V
    is");
PIV = V_max;// in V
disp(PIV,"Peak inverse voltage in V is");
disp(I_max*10^3,"Maximum current through diode in mA
    is : ")
P_max = V_Gamma * I_max;// in W
disp(P_max*10^3,"Diode power rating in mW is");
```

**Scilab code Exa 2.20** Value of current

```
// Exa 2.20
clc;
clear;
close;
// Given data
V1 = 10;// in V
V2 = 0.7;// in V
V3 = V2;// in V
V = V1-V2-V3;// in V
R1 = 1;// in ohm
R2 = 48;// in ohm
R3 = 1;// in ohm
R = R1+R2+R3;// in ohm
I = V/R;// in A
I = I * 10^3;// in mA
disp(I,"Current in mA is");
```

**Scilab code Exa 2.21** AC and DC power output

```
// Exa 2.21
clc;
```

```
clear;
close;
// Given data
V_m = 50;// in V
r_f = 20;// in ohm
R_L = 800;// in ohm
I_m = V_m/(R_L+r_f);// in A
I_m = I_m * 10^3;// in mA
disp(round(I_m),"The value of Im in mA is");
I_dc = I_m/%pi;// in mA
disp(I_dc,"The value of I_dc in mA is");
I_rms = I_m/2;// in mA
disp(I_rms,"The value of Irms in mA is");
P_ac = (I_rms * 10^-3)^2 * (r_f + R_L);// in Watt
disp(P_ac,"AC power input in Watt is");
V_dc = I_dc * 10^-3*R_L;// in V
disp(V_dc,"DC output voltage in V is");
P_dc = (I_dc * 10^-3)^2 * (r_f + R_L);// in Watt
Eta = (P_dc/P_ac)*100;// in %
disp(Eta,"The efficiency of rectification in % is");

// Note: There is calculation error to evaluate the ac power input (i.e. P_ac), so the value of Eta is also wrong
```

**Scilab code Exa 2.22** Peak value of current

```
// Exa 2.22
clc;
clear;
close;
// Given data
R_L = 1;// in K ohm
R_L = R_L * 10^3;// in ohm
r_d = 10;// in ohm
```

```
V_m = 220;// in V
I_m = V_m/(r_d+R_L);// in A
disp(I_m,"Peak value of current in A is");
I_dc = (2*I_m)/%pi;// in A
disp(I_dc,"DC value of current in A is");
Irms= I_m/sqrt(2);// in A
r_f = sqrt((Irms/I_dc)^2-1)*100;// in %
disp(r_f,"Ripple factor in % is");
Eta = (I_dc)^2 * R_L/((Irms)^2*(R_L+r_d))*100;// in
   %
disp(Eta,"Rectification efficiency in % is");
```

**Scilab code Exa 2.23** Peak load voltage

```
// Exa 2.23
clc;
clear;
close;
// Given data
V_s = 12;// in V
R_L = 5.1;// in k ohm
R_L = R_L * 10^3;// in ohm
R_s = 1;// in K ohm
R_s = R_s * 10^3;// in ohm
V_L = (V_s*R_L)/(R_s+R_L);// in V
disp(V_L,"Peak load voltage in V is");
```

**Scilab code Exa 2.24** Load current

```
// Exa 2.24
clc;
clear;
close;
```

```
// Given data
V_s = 10;// in V
R_L = 100;// in ohm
I_L = V_s/R_L;// in A
disp(I_L,"The load current during posotive half cycle in A is");
I_D2 = 0;// in A
R2 = R_L;// in ohm
I_L1 = -(V_s)/(R2+R_L);// in A
disp(I_L1,"The load current during negative half cycle in A is");
```

**Scilab code Exa 2.25** Value of Vdc

```
// Exa 2.25
clc;
clear;
close;
// Given data
V_m = 50;// in V
V_dc = (2*V_m)/%pi;// in V
disp(V_dc,"The dc voltage in V is");
```

**Scilab code Exa 2.26** DC voltage

```
// Exa 2.26
clc;
clear;
close;
// Given data
R1 = 1.1;// in K ohm
R2 = 2.2;// in K ohm
Vi= 170;// in V
```

```
V_o = (Vi*R1)/(R1+R2);// in V
disp(V_o,"The output voltage in V is");
V_dc = (2*V_o)/%pi;// in V
disp(V_dc,"The dc voltage in V is");
```

# Chapter 3

# Special Purpose Diodes

**Scilab code Exa 3.1** Zener current

```
// Exa 3.1
clc;
clear;
close;
// given data
V1 = 18;// in V
V2 = 10;// in V
R = 270;// in ohm
I_S = (V1-V2)/R;// in A
V_L = 10;// in V
R_L = 1;// in K ohm
R_L = R_L*1000;// in ohm
I_L = V_L/R_L;// in A
I_Z = I_S-I_L;// in A
disp(I_Z*10^3,"The zener current in mA is");
```

**Scilab code Exa 3.5** Load voltage

```
// Exa 3.5
clc;
clear;
close;
// Given data
I_Z = 2*10^-3;// in A
R_Z = 8.5;// in V
del_VL = I_Z*R_Z;// in V
V1 = 10;// in V
disp(del_VL,"Change in load voltage in V is");
V_L = V1 + del_VL;// in V
disp(V_L,"The load voltage in V is");

// Note: There is calculation error to evaluate the
   value of del_VL. So the answer in the book is
   wrong.
```

**Scilab code Exa 3.6** The value of VL VR IZ and PZ

```
// Exa 3.6
clc;
clear;
close;
// Given data
R_L = 1.2;// in K ohm
R_L = R_L * 10^3;// in ohm
V_i = 16;// in V
R_i = 1;// in K ohm
R_i = R_i * 10^3;// in ohm
V = (R_L * V_i)/(R_L + R_i);// in V
V_L = V;// in V
disp(V_L,"The load voltage in V is");
V_R = V_i - V_L;// in V
disp(V_R,"The voltage in V is");
I_Z = 0;// A
```

```
disp(I_Z,"The zener diode current in A is");
V_Z = 10;// in V
P_Z = V_Z*I_Z;// in W
disp(P_Z,"Power dissipation in watt is");
```

**Scilab code Exa 3.7** Resistance of device

```
// Exa 3.7
clc;
clear;
close;
// Given data
I_Z1 = 20;// in mA
I_Z1= I_Z1*10^-3;// in A
I_Z2 = 30;// in mA
I_Z2= I_Z2*10^-3;// in A
V_Z1 = 5.6;// in V
V_Z2 = 5.75;// in V
del_IZ = I_Z2-I_Z1;// in A
del_VZ = V_Z2-V_Z1;// in V
r_Z = del_VZ/del_IZ;// in ohm
disp(r_Z,"Resistance of zener diode in ohm is");
```

**Scilab code Exa 3.8** Range of RL and IL

```
// Exa 3.8
clc;
clear;
close;
// Given data
R = 1;// in K ohm
R = R * 10^3;// in ohm
V_Z = 10;// in V
```

```
V_i = 50;// in V
I_ZM = 32;// in mA
I_ZM= I_ZM*10^-3;// in A
R_Lmin = (R*V_Z)/(V_i-V_Z);// in ohm
disp(R_Lmin,"The minimum value of R_L in ohm is : ")
V_R = V_i-V_Z;// in V
I_R = V_R/R;// in A
I_Lmin = I_R-I_ZM;// in A
disp(I_Lmin*10^3,"The minimum value of I_L in mA is
    : ");
R_Lmax = V_Z/I_Lmin;// in ohm
disp(R_Lmax*10^-3,"The maximum value of R_L in kohm
    is");
```

**Scilab code Exa 3.9** Range of value of Vi

```
// Exa 3.9
clc;
clear;
close;
// Given data
V_Z = 20;// in V
R_L = 1.2;// in K ohm
R_L = R_L * 10^3;// in ohm
R = 220;// in ohm
I_ZM = 60;// in mA
I_ZM= I_ZM*10^-3;// in A
Vi_min = (R_L + R)/R_L*V_Z;// in V
disp(Vi_min,"The minimum value of Vi in V is");
V_L= V_Z;// in V
I_L= V_L/R_L;// in A
Vi_max= (I_ZM+I_L)*R+V_Z;// in V
disp(Vi_max,"The maximum value of Vi in V is");
```

**Scilab code Exa 3.10** Zener diode operation

```
// Exa 3.10
clc;
clear;
close;
// Given data
V1 = 18;// in V
V2 = 270;// in V
R = 1;// in K ohm
R = R*1000;// in ohm
V = (V1*R)/(V2+R);// in V
disp(V,"The open circuit voltage in volts is");
if V>=10 then
    disp("The zener diode is operating in the breakdown region.")
end
```

---

**Scilab code Exa 3.11** Value of VL IL IZ and IR

```
// Exa 3.11
clc;
clear;
close;
// Given data
R_L = 300;// in ohm
R = 200;// in ohm
V_i = 20;// in V
V = (R_L/(R_L+R))*V_i;// in V
disp(V,"The value of V_L in Volts is");
V_L = 10;// in V
V_Z= V_L;// in V
```

```
I_L = V_L/R_L;// A
disp(I_L*10^3,"The value of I_L in mA is");
I_R = (V_i-V_L)/R;// in A
disp(I_R*10^3,"The value of I_R in mA is");
I_Z = I_R-I_L;// in A
disp(I_Z*10^3,"The value of I_Z in mA is");
// Formula V_Z= R_L*V_i/(R_L+R)
R_L= R*V_Z/(V_i-V_Z);// in ohm
disp(R_L,"The value of R_L in ohm is : ")
```

**Scilab code Exa 3.12** Range of input voltage

```
// Exa 3.12
clc;
clear;
close;
// Given data
V_Z = 5;// in V
I_Zmin = 2;// in mA
I_Zmin= I_Zmin*10^-3;// in A
I_Zmax = 20;// in mA
I_Zmax=I_Zmax*10^-3;// in A
R_L = 1;// in kohm
R_L = R_L * 10^3;// in ohm
I_L = V_Z/R_L;// in A
I = I_L + I_Zmin;// in A
Vin_min = V_Z + (I*R_L);// in V
disp(Vin_min,"The minimum input voltage in V is");
I = I_L + I_Zmax;// in A
Vin_max = V_Z + I* R_L;// in V
disp(Vin_max,"The maximum input voltage in V is");
```

**Scilab code Exa 3.13** Design a zener voltage regulator

```
// Exa 3.13
clc;
clear;
close;
// Given data
V_in1 = 18;// in V
V_in2 = 22;// in V
V_o = 6;// in V
I_L = 50;// in mA
I_L= I_L*10^-3;// in A
I_Zmin = 5;// in mA
I_Zmin= I_Zmin*10^-3;// in A
P_Z = 0.5;// in Watt
V_Z= 6;// in V
I_Zmax = P_Z/V_Z;// in A
disp(I_Zmax*10^3,"Zener diode current in mA is");
R_S1 = (V_in2 - V_Z)/(I_L+I_Zmax);// in ohm
disp(R_S1,"The minimum value of Rs in ohm is");
R_S2 = (V_in1-V_Z)/(I_L+I_Zmin);// in ohm
disp(R_S2,"The maximum value of Rs in ohm is");
```

**Scilab code Exa 3.14** Range of Vi

```
// Exa 3.14
clc;
clear;
close;
// Given data
R_S = 91;// in ohm
V_Z = 8;// in V
P_Z = 400;// in mW
P_Z= P_Z*10^-3;// in W
R_L = 0.22;// in K ohm
R_L = R_L * 10^3;// in ohm
I_L = V_Z/R_L;// in A
```

```
I_Z = P_Z/V_Z;// in A
disp(I_Z*10^3,"The value of I_Zmax in mA is : ")
Vin_min = (V_Z*(R_S+R_L))/R_L;// in V
disp(Vin_min,"The minimum input voltage in V is");
I_R = I_L + I_Z;// in A
Vin_max = V_Z + (I_R*R_S);// in V
disp(Vin_max,"The maximum input voltage in V is");
```

**Scilab code Exa 3.15** The value of RS and RL

```
// Exa 3.15
clc;
clear;
close;
// Given data
V_L = 12;// in V
I_Lmin = 0;// in mA
I_Lmin =I_Lmin *10^-3;// in A
I_Lmax = 200;// in mA
I_Lmax =I_Lmax *10^-3;// in A
I_Zmin = 5;// in mA
I_Zmin= I_Zmin*10^-3;// in A
I_Zmax = 200;// in mA
I_Zmax= I_Zmax*10^-3;// in A
V_i = 16;// in V
V_Z = V_L;// in V
disp(V_Z,"The value of V_Z in V is");
R_Lmin = V_L/I_Lmax;// in ohm
disp(R_Lmin,"The minimum value of R_L in ohm is");
// R_L2 = V_L/I_Lmin;// in ohm
disp("The maximum value of R_L in ohm is");
disp("infinite")
I_Z = I_Zmin+I_Zmax;// in A
disp(I_Z*10^3,"The zener current in mA is");
P_Zmax = V_Z*I_Z;// in Watt
```

```
disp(P_Zmax,"The maximum value of Pz in Watt is");
R_S = (V_i-V_L)/(I_Zmin+I_Lmax);// in ohm
disp(R_S,"The value of R_S in ohm is ");
```

**Scilab code Exa 3.16** The value of VL IL IZ and IR

```
// Exa 3.16
clc;
clear;
close;
// Given data
V_in = 20;// in V
R_S = 220;// in ohm
V_Z = 10;// in V
P_Z = 400;// in mW
// Part (I)
R_L = 200;// in ohm
disp("Part (I) For R_L= 200  ")
V_L = V_Z;// in V
disp(V_L,"Load voltage in V is");
I_L = V_L/R_L;// in A
disp(I_L,"Load current in A is");
I_R = (V_in-V_Z)/R_S;// in A
disp(I_R,"The current through resistor in A is");
I_Z = I_R-I_L;// in A
disp(I_Z,"The value of I_Z in A is");
// Part (II)
R_L = 50;// in ohm
disp("Part (II) For R_L= 50  ")
V_L = V_Z;//
disp(V_L,"Load voltage in V is");
I_L = V_L/R_L;// in A
disp(I_L,"Load current in A is");
I_R = (V_in-V_Z)/R_S;// in A
disp(I_R,"The current through resistor in A is");
```

```
I_Z = I_R-I_L;// in A
disp(I_Z,"Zener current in A is");
disp("For both values of R_L, the current I_R is less than I_L and I_Z is negative. It shows that given circuit can not work successfully as a voltage regulator")
```

**Scilab code Exa 3.17** Safe voltage range of V

```
// Exa 3.17
clc;
clear;
close;
// Given data
I_Zmin = 1;// in mA
I_Zmin=I_Zmin*10^-3;// in A
I_Zmax = 5;// in mA
I_Zmax=I_Zmax*10^-3;// in A
I_Lmin = 0;// in mA
I_Lmin=I_Lmin*10^-3;// in A
I_Lmax = 4;// in mA
I_Lmax=I_Lmax*10^-3;// in A
R = 5;// in kohm
R = R * 10^3;// in ohm
V_Z = 50;// in V
disp("Part (A)")
V_max = (I_Zmax+ I_Lmin)*R+V_Z;// in V
disp(V_max,"The maximum Voltage in V is");
V_min = (I_Zmin+I_Lmax)*R + V_Z;// in V
disp(V_min,"The minimum Voltage in V is");
disp("Part (B)")
V_L = 50;// in V
V_in = 75;// in V
R_L = 15;// in kohm
R_L= R_L*10^3;// in ohm
```

```
I_L = V_L/R_L;// in A
V_max = (I_Zmax+I_L)*R+V_Z;// in V
disp(round(V_max),"The maximum Voltage in V is");
V_min = (I_Zmin+I_L)*R+V_Z;// in V
disp(round(V_min),"The minimum Voltage in V is");
```

**Scilab code Exa 3.18** Range of load currents

```
// Exa 3.18
clc;
clear;
close;
// Given data
V_S = 7.5;// in V
V_Z = 5;// in V
R_S = 4.75;// in ohm
I_Zmin= 0.05;// in A
I_Zmax=1.0;// in A
I_S = (V_S-V_Z)/R_S;// in A
I_Lmax= I_S-I_Zmin;// in A
disp(I_Lmax,"The maximum value of load current in A is : ")
// when
V_S= 10;// in V
I_S = (V_S-V_Z)/R_S;// in A
I_Lmin= I_S-I_Zmax;// in A
disp(I_Lmin,"The minimum value of load current in A is : ")
disp("Thus, the range of load current for regulation is "+string(I_Lmin)+" <= I_L <= "+string(I_Lmax)+" A")
```

# Chapter 4

# Bipolar Junction Transistors

**Scilab code Exa 4.1** Current gain and base current

```
// Example 4.1
clc;
clear;
close;
// Given data
I_C= 0.9;// in mA
I_E=1;// in mA
alpha = I_C/I_E;
disp(alpha,"Current gain is : ")
// Formula I_E= I_B+I_C
I_B= I_E-I_C;// in mA
disp(I_B,"The base current in mA is : ")
```

---

**Scilab code Exa 4.2** Base current

```
// Example 4.2
clc;
clear;
```

```
close;
// Given data
alpha= 0.97;
I_E=1;// in mA
// Formula alpha = I_C/I_E;
I_C= alpha*I_E;// in mA
// Formula I_E= I_B+I_C
I_B= I_E-I_C;// in mA
disp(I_B,"The base current in mA is : ")
```

**Scilab code Exa 4.3** The value of bita

```
// Example 4.3
clc;
clear;
close;
// Given data
// Part (i)
a= 0.90;
B=a/(1-a);
disp(B,"At alpha= 0.90, the value of Bita is : ")
// Part (ii)
a= 0.99;
B=a/(1-a);
disp(B,"At alpha= 0.99, the value of Bita is : ")
```

**Scilab code Exa 4.4** Alpha rating

```
// Example 4.4
clc;
clear;
close;
// Given data
```

```
bita= 50;
I_E= 10;// in mA
I_B= 200*10^-3;// in mA
alfa= bita/(1+bita)
disp(alfa,"The value of alfa is : ")
I_C= alfa*I_E;// in mA
disp(I_C,"The value of I_C in mA using the value of
    alpha is : ")
I_C= bita*I_B;// in mA
disp(I_C,"The value of I_C in mA using the value of
    bita is : ")
```

**Scilab code Exa 4.5** The value of IB IC VCE and PD

```
// Example 4.5
clc;
clear;
close;
// Given data
V_BB= 10;// in V
V_CC= 10;// in V
V_BE= 0.7;// in V
R_B= 1;// in  M
R_B= R_B*10^6;// in
R_C= 2;// in  k
R_C= R_C*10^3;// in
bita= 300;
I_B= (V_BB-V_BE)/R_B;// in A
I_C= bita*I_B;// in A
V_CE= V_CC-I_C*R_C;// in V
P_D= V_CE*I_C;// in W
disp(I_B*10^6,"The value of I_B in   A is : ")
disp(I_C*10^3,"The value of I_C in mA is : ")
disp(V_CE,"The value of V_CE in volts is : ")
disp(P_D*10^3,"The value of P_D in mW is :")
```

**Scilab code Exa 4.6** Collector current

```
// Example 4.6
clc;
clear;
close;
// Given data
bita= 100;
V_BE= 0;// in V
V_BB= 15;// in V
R_B= 470;// in k
R_B= R_B*10^3;// in
V_CC= 15;// in V
R_C= 3.6;// in k
R_C= R_C*10^3;// in
I_B= (V_BB-V_BE)/R_B;// in A
I_C= bita*I_B;// in A
V_CE= V_CC-I_C*R_C;// in V
I_E= I_C+I_B;// in A
disp(I_B*10^6,"The base current in  A is : ")
disp(I_C*10^3,"The collector current in mA is : ")
disp(V_CE,"The value of V_CE in volts is : ")
disp(I_E*10^3,"The emitter current in mA is ; ")
```

**Scilab code Exa 4.7** Collector emitter voltage

```
// Example 4.7
clc;
clear;
close;
// Given data
```

```
bita= 100;
V_BE= 0.7;// in V
V_BB= 15;// in V
R_B= 470;// in k
R_B= R_B*10^3;// in
V_CC= 15;// in V
R_C= 3.6;// in k
R_C= R_C*10^3;// in
I_B= (V_BB-V_BE)/R_B;// in A
I_C= bita*I_B;// in A
V_CE= V_CC-I_C*R_C;// in V
disp(I_B*10^6,"The base current in  A is : ")
disp(I_C*10^3,"The collector current in mA is : ")
disp(V_CE,"The value of V_CE in volts is : ")
```

**Scilab code Exa 4.8** DC load line and operating point

```
// Example 4.8
clc;
clear;
close;
// Given data
V_CC= 15;// in V
V_BE= 0.7;// in V
R_C= 1;// in k
R_C= R_C*10^3;// in
R_E= 2;// in k
R_E= R_E*10^3;// in
R1= 10;// in k
R1= R1*10^3;// in
R2= 5;// in k
R2= R2*10^3;// in
V_CE= 0:0.1:V_CC
I_C= (V_CC-V_CE)/(R_C+R_E)*10^3;// in mA
plot(V_CE,I_C);
```

```
xlabel("V_CE in volts");
ylabel("I_C in mA");
title("DC load line");
V_B= V_CC*R2/(R1+R2);// in V
I_E= (V_B-V_BE)/R_E;// in A
I_C= I_E;// in A
I_CQ= I_C;// in A
V_CE= V_CC-I_C*(R_C+R_E);// in V
disp("Q-point is : "+string(V_CE)+" V, "+string(I_CQ*10^3)+" mA")
disp("DC load line shown in figure")
```

**Scilab code Exa 4.9** Emitter current

```
// Example 4.9
clc;
clear;
close;
// Given data
V_BB= 1.8;// in V
V_BE= 0.7;// in V
R1= 10;// in k
R2= 2.2;// in k
R_E= 1;// in k
bita= 200;
R= R1*R2/(R1+R2);// in k
R=R*10^3;// in
R_E= R_E*10^3;// in
I_E= (V_BB-V_BE)/(R_E+R/bita);// in mA
disp(I_E*10^3,"The emitter current in mA is : ")
disp("This is extremely close to 1.1 mA, the value we get with the simplified analysis.")
```

**Scilab code Exa 4.10** Design a fixed bias circuit

```
// Example 4.10
clc;
clear;
close;
// Given data
V_CC= 10;// in V
V_BE= 0.7;// in V
V_CE= 5;// in V
bita= 100;
I_C= 5;// in mA
// Applying KVL to collector circuit, V_CC-V_CE-I_C*R_C =0
R_C= (V_CC-V_CE)/I_C;// in k
disp(R_C,"The value of R_C in k  is : ")
I_B= I_C/bita;// in mA
disp(I_B*10^3,"The value of I_B in  A is : ")
// Applying KVL to base circuit, V_CC-I_B*R_B-V_BE=0
R_B= (V_CC-V_BE)/I_B;// in k
disp(R_B,"The value of R_B in k  is :")
// Note: In the book, there is an error in calculating the value of I_B, but they putted the correct value of I_B to evaluate the value of R_B
```

---

**Scilab code Exa 4.11** DC load line and operating point

```
// Example 4.11
clc;
clear;
close;
// Given data
V_CC= 6;// in V
```

```
V_BE= 0.7;// in V
bita= 100;
R_C= 2;// in  k
R_C= R_C*10^3;// in
R_B= 530;// in  k
R_B= R_B*10^3;// in
R1= 10;// in  k
R1= R1*10^3;// in
R2= 5;// in  k
R2= R2*10^3;// in
V_CE= 0:0.1:V_CC;// in V
I_C= (V_CC-V_CE)/(R_C)*10^3;// in mA
plot(V_CE,I_C);
xlabel("V_CE in volts");
ylabel("I_C in mA");
title("DC load line");
I_B= (V_CC-V_BE)/R_B;// in A
I_CQ= I_B*bita;// in A
V_CE= V_CC-I_CQ*R_C;// in V
disp("Q-point is : "+string(V_CE)+" V, "+string(I_CQ
    *10^3)+" mA")
disp("DC load line shown in figure")
```

**Scilab code Exa 4.12** Operating point

```
// Example 4.12
clc;
clear;
close;
// Given data
V_CC= 12;// in V
V_BE= 0.7;// in V
bita= 100;
R_C= 10;// in  k
R_C=R_C*10^3;// in
```

```
R_B= 100;// in
R_B=R_B*10^3;// in
I_BQ= (V_CC-V_BE)/((1+bita)*R_C+R_B);// in A
I_CQ= bita*I_BQ;// in A
V_CEQ= V_CC-(I_CQ+I_BQ)*R_C;// in volts
disp("Q-Point value for the circuit is "+string(V_CEQ)+" V and "+string(I_CQ*10^3)+" mA")
// For dc load line when
I_C=0;
V_CE= V_CC-(I_C+I_BQ)*R_C;// in V
disp(V_CE,"At I_C=0, the value of V_CE in volts is : ")
// When
V_CE= 0;
I_C= (V_CC-I_BQ*R_C)/R_C;// in A
disp(I_C*10^3,"At V_CE=0, the value of I_C in mA is : ")
```

**Scilab code Exa 4.13** Collector to base bias circuit

```
// Example 4.13
clc;
clear;
close;
// Given data
V_BE= 0.7;// in V
V_CC= 15;// in V
V_CE= 5;// in V
I_C= 5;// in mA
I_C=I_C*10^-3;// in A
bita= 100;
I_B= I_C/bita;// in A
// Applying KVL to collector circuit , V_CC= (I_C+I_B)*R_C+V_CE
R_C= (V_CC-V_CE)/(I_C+I_B);// in
```

```
// Applying KVL to base circuit , V_CC= (I_C+I_B)*R_C+I_B*R_B+V_BE
R_B= (V_CC-V_BE-R_C*(I_C+I_B))/I_B;// in
disp(R_C*10^-3,"The value of R_C in k  is : ")
disp(R_B*10^-3,"The value of R_B in k  is : ")
```

**Scilab code Exa 4.14** The value bita VCC and RB

```
// Example 4.14
clc;
clear;
close;
// Given data
I_B= 20*10^-6;// in A
V_CE= 7.3;// in V
V_BE= 0.6;// in V
V_E= 2.1;// in V
R_E= 0.68*10^3;// in
R_C= 2.7*10^3;// in
I_E= V_E/R_E;// in A
I_C= I_E;// in A (approx)
bita= round(I_C/I_B);
V_CC= V_CE+I_C*R_C+I_E*R_E;// in V
// From V_CC= I_B*R_B+V_BE+V_E
R_B= (V_CC-(V_BE+V_E))/I_B;// in
disp(bita,"The value of bita is : ")
disp(V_CC,"The value of V_CC in volts is : ")
disp(R_B*10^-3,"The value of R_B in k  is : ")

// Note: In  the book, there is an error to calculate the value of R_B, hence the value of R_B in the book is wrong.
```

**Scilab code Exa 4.15** The value of IC and VCE

```
// Exa 4.15
clc;
clear;
close;
// Given data
V_CC = 18;// in V
bita = 90;
R_C = 2.2 * 10^3;// in ohm
R_E = 1.8*10^3;// in ohm
R_B = 510*10^3;// in ohm
I_B = V_CC/( (bita*(R_C+R_E))+R_B );// in A
I_C = bita*I_B;// in A
disp(I_C*10^3,"The value of I_C in mA is");
V_CE = I_B*R_B;// in V
disp(V_CE,"The value of V_CE in V is");
```

---

**Scilab code Exa 4.16** Value of IBQ and ICQ

```
// Exa 4.16
clc;
clear;
close;
// Given data
bita = 50;
V_CC = 12;// in V
V_BE = 0.7;// in V
R_B = 240;// in kohm
R_B = R_B*10^3;// in ohm
I_C = 2.35 * 10^-3;// in A
R_C = 2.2;// in kohm
R_C = R_C * 10^3;// in ohm
I_BQ = (V_CC - V_BE)/R_B;// in A
disp(I_BQ*10^6,"The value of I_BQ in   A is");
```

```
I_CQ = bita*I_BQ;// in A
disp(I_CQ*10^3,"The value of I_CQ in mA is");
V_CEQ = V_CC - (I_C*R_C);// in V
disp(V_CEQ,"The value of V_CEQ in V is");
V_B = V_BE;// in V
disp(V_B,"The value of V_B in V is");
V_BC = V_B -V_CEQ;// in V
disp(V_BC,"The voltage in V is");

// Note: In the book, there is a calculation error to evaluating the value of V_CEQ. So the answer in the book is wrong
```

---

**Scilab code Exa 4.17** Value of IB and IC

```
// Exa 4.17
clc;
clear;
close;
// Given data
V_CC = 18;// in V
V_BE = 0.7;// in V
R_C = 3.3;// in kohm
R_C = R_C * 10^3;// in ohm
R_B = 210;// in kohm
R_B  = R_B * 10^3;// in ohm
bita = 75;
R_C = 3.3;// in kohm
R_C = R_C * 10^3;// in ohm
R_E = 510;// in ohm
I_B = (V_CC-V_BE)/( R_C+R_B+bita*(R_C+R_E) );// A
disp(round(I_B*10^6),"The value of I_B in  A is");
I_C = bita*I_B;// in A
disp(I_C*10^3,"The value of I_C in mA is : ")
V_C = V_CC - (I_C*R_C);// in V
```

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

**Scilab code Exa 4.18** Value of VCC RB and RC

```
// Exa 4.18
clc;
clear;
close;
// Given data
V_BE = 0.7;// in V
I_B = 40 * 10^-6;// in A
V_CC = 20;// in V (From the load line)
disp(V_CC,"The voltage in V is");
I_C = 8;// in mA
R_C = V_CC/I_C;// in kohm
disp(R_C,"The resistance in kohm is");
R_B = (V_CC - V_BE)/I_B;// in ohm
disp(R_B*10^-3,"The resistance in kohm is");
```

**Scilab code Exa 4.19** VCE for the voltage divider bias configuration

```
// Exa 4.19
clc;
clear;
close;
// Given data
R1 = 47;// in kohm
R1=  R1*10^3;// in ohm
R2 = 10;// in kohm
R2= R2*10^3;// in ohm
R_E = 1.1;// in kohm
R_E = R_E * 10^3;// in ohm
R_C = 2.4;// in kohm
```

```
R_C = R_C * 10^3;// in ohm
V_CC = -18;// in V
V_B = (R2*V_CC)/(R1+R2);// in V
V_BE = -0.7;// in V
V_E = V_B - V_BE;// in V
I_E = abs(V_E)/R_E;// in A
V_CE = V_CC + (I_E)*(R_C+R_E);// in V
disp(V_B,"The value of V_B in volts is : ");
disp(I_E*10^3,"The value of I_E in mA is : ")
disp(V_CE,"The value of V_CE in V is");
```

**Scilab code Exa 4.20** Value of IB and IC

```
// Exa 4.20
clc;
clear;
close;
// Given data
V_BE = 0.8;// in V
V_CE = 0.2;// in V
V1 = 5;// in V
R_B = 50;// in kohm
R_B= R_B*10^3;// in ohm
R_C = 3;// in K ohm
R_C = R_C * 10^3;// in ohm
bita = 100;
R_E = 2;// in kohm
R_E= R_E*10^3;// in ohm
I_B = (V1-V_BE)/(R_B+(1+bita)*R_E);// in A
disp(I_B*10^6,"The value of I_B in  A is");
V_CC = 10;// in V
I_Csat = (V_CC - V_CE - (I_B*R_E))/(R_C+R_E);//in A
disp(I_Csat*10^3,"The value of I_C(sat) in mA is");
I_Bmin = I_Csat /bita;// in A
disp(I_Bmin*10^6,"The minimum value of I_B in  A is
```

```
  : ");

// Note: There is calculation error to evaluate the
   value of I_Csat in the book, so the answer in the
    book is wrong
```

---

**Scilab code Exa 4.21** Operating point

```
// Exa 4.21
clc;
clear;
close;
// Given data
R1 = 5;// in kohm
R1= R1*10^3;// in ohm
R2 = 5;// in kohm
R2= R2*10^3;// in ohm
R_B = R1*R2/(R1+R2);// in ohm
R_E = 1;// in kohm
R_E = R_E * 10^3;// in ohm
V_EE = 3;// in V
V_Th = (R2*V_EE)/(R1+R2);// in V
V_BE = 0.7;// in V
bita = 44;
I_B = (V_EE - V_BE - V_Th)/( ((1+bita)*R_E)+R_B);//
   in A
I_BQ = I_B;// in A
disp(I_BQ*10^6,"The value of I_BQ in   A is");
I_C = bita*I_BQ;// in A
disp(I_C*10^3,"The value of I_C in mA is");
I_E = (1+bita)*I_B;// in A
disp(I_E*10^3,"The value of I_E in mA is");
V_EC = (I_E*R_E)-V_EE;// in V
disp(V_EC,"The value of V_EC in V is");
disp("Q-point is "+string(V_EC)+" V, "+string(I_C
```

```
*10^3)+" mA")
```

**Scilab code Exa 4.22** The region of operation

```
// Exa 4.22
clc;
clear;
close;
// Given data
V_BE = 0.7;// in V
V_BB = 5;// in V
R_B = 100;// in kohm
R_B = R_B * 10^3;// in ohm
R_E = 2;// in kohm
R_E = R_E * 10^3;// in ohm
bita = 100;
I_B = (V_BB-V_BE)/( R_B+((1+bita)*R_E) );// in A
disp(I_B*10^3,"The value of I_B in mA is");
V_B = V_BB-(I_B*10^-3*R_B);// in V
I_C = bita*I_B;// in A
disp(I_C*10^3,"The value of I_C in mA is");
V_CC = 10;// in V
V_C = V_CC-(I_C*R_E);// in V
disp(V_C,"The voltage in V is");
disp("Transistor is in active region is valid")
```

**Scilab code Exa 4.23** Value of IB IC VCE VC VE VB and VBC

```
// Exa 4.23
clc;
clear;
close;
// Given data
```

```
V_CC = 20;// in V
V_BE = 0.7;// in V
R_B = 430;// in kohm
R_B = 430 * 10^3;// in ohm
bita = 50;
R_E = 1;// in kohm
R_E = R_E * 10^3;// in ohm
R_C = 2;// in kohm
R_C = R_C * 10^3;// in ohm
I_B = (V_CC - V_BE)/(R_B +(1+bita)*R_E);// in A
disp(I_B*10^6,"The base current in  A is");
I_C = bita*I_B;// in A
disp(I_C*10^3,"The collector current in mA is");
V_CE = V_CC - I_C*(R_C+R_E);// in V
disp(V_CE,"The value of V_CE in V is");
V_C = V_CC - (I_C*R_C);// in V
disp(V_C,"The value of V_C in V is");
V_E = V_C - V_CE;// in V
disp(V_E,"The value of V_E in V is");
V_B = V_BE+V_E;// in V
disp(V_B,"The value of V_B in V is : ")
V_BC = V_B-V_C;// in V
disp(V_BC,"The value of V_BC in V is");
```

**Scilab code Exa 4.24** Value of ICQ and VCEQ

```
// Exa 4.24
clc;
clear;
close;
// Given data
V_CC = 20;// in V
V_BE = 0.7;// in V
R_B = 680;// in kohm
R_B = R_B * 10^3;// in ohm
```

```
R_C = 4.7;// in kohm
R_C = R_C * 10^3;// in ohm
bita = 120;
I_B = (V_CC - V_BE)/(R_B+bita*R_C);// in A
I_CQ = bita*I_B;// in A
disp(I_CQ*10^3,"The value of I_CQ in mA is");
V_CEQ = V_CC - (I_CQ*R_C);// in V
disp(V_CEQ,"The value of V_CEQ in V is");
V_B = V_BE;// in V
V_C = 11.26;// in V
V_E = 0;// in V
disp(V_E,"The value of V_E in V is");
V_BC = V_B - V_C;// in V
disp(V_BC,"The value of V_BC in V is");
```

**Scilab code Exa 4.25** IB IC and VC

```
// Exa 4.25
clc;
clear;
close;
// Given data
V_CC = 16;// in V
V_BE = 0.7;// in V
R_B = 470;// in kohm
R_B= R_B*10^3;// in ohm
bita = 120;
R_C = 3.6;// in kohm
R_C= R_C*10^3;// in ohm
R_E = 0.51;// in kohm
R_E= R_E*10^3;// in ohm
I_B = (V_CC - V_BE)/(R_B+bita*(R_C+R_E));// in A
disp(I_B*10^6,"The base current in   A is");
I_C  = bita*I_B;// in A
disp(I_C*10^3,"The collector current in mA is");
```

```
V_C = V_CC - I_C*R_C;// in V
disp(V_C,"The collector voltage in V is");
```

**Scilab code Exa 4.26** ICQ and VCEQ

```
// Exa 4.26
clc;
clear;
close;
// Given data
V_CC = 10;// in V
V_BE = 0.7;// in V
R_B = 250;// in kohm
R_B= R_B*10^3;// in ohm
bita = 90;
R_C = 4.7;// in kohm
R_C= R_C*10^3;// in ohm
R_E = 1.2;// in kohm
R_E= R_E*10^3;// in ohm
I_BQ = (V_CC - V_BE)/(R_B + bita*(R_C+R_E));// in A
disp(I_BQ*10^6,"The base current at Q-point in  A is");
I_CQ = bita*I_BQ;// in A
disp(I_CQ*10^3,"The collector current at Q-point in mA is");
V_CEQ = V_CC - (I_CQ*(R_C+R_E));// in V
disp(V_CEQ,"Collector emitter voltage at Q point in V is");
```

**Scilab code Exa 4.27** Range of possible value for VC

```
// Exa 4.27
clc;
```

```
clear;
close;
// Given data
V_CC = 12;// in V
V_BE = 0.7;// in V
R_B = 150;// in kohm
R_B= R_B*10^3;// in ohm
bita = 180;
R_C = 4.7;// in kohm
R_C= R_C*10^3;// in ohm
R_E = 3.3;// in kohm
R_E= R_E*10^3;// in ohm
I_B = (V_CC-V_BE)/(R_B + bita*(R_C+R_E));// in A
disp(I_B*10^6,"The base current in  A is");
```

**Scilab code Exa 4.28** Value of VE IC VC and IB

```
// Exa 4.28
clc;
clear;
close;
// Given data
V_B = 4;// in V
V_BE = 0.7;// in V
R_E = 1.2;// in kohm
R_E= R_E*10^3;// in ohm
V_E = V_B-V_BE;// in V
R_C = 2.2;// in kohm
R_C= R_C*10^3;// in ohm
R_B= 330;// in kohm
R_B= R_B*10^3;// in ohm
bita = 180;
I_B = 7.11 * 10^-6;// in A
V_CC = 18;// in V
disp("Part (a)")
```

```
disp(V_E,"The value of V_E in V is");
I_C = V_E/R_E;// in A
disp("Part (b)")
disp(I_C*10^3,"The value of I_C in mA is : ")
V_C =V_CC - (I_C*R_C);// in V
disp("Part (c)")
disp(V_C,"The value of V_C in V is");
V_CE = V_C-V_E;// in V
disp("Part (d)")
disp(V_CE,"The value of V_CE in V is : ")
//I_C = bita*I_B;// in A
//disp(I_C*10^3,"The value of I_C in mA is : ")
//V_CC= 12;// in V
//R_C = 4.7;// in kohm
//R_C= R_C*10^3;// ohm
//V_C = V_CC - (I_C*R_C);// in V
//disp(V_C,"The value of V_C in V is");
//R_B = 1.15*10^6;// in ohm
//R_E = 3.3*10^3;// in ohm
//I_B = (V_CC - V_BE)/(R_B + bita*(R_C+R_E));// in A
//disp(I_B*10^6,"The value of I_B in  A is : ")
//I_C = bita*I_B;// in A
//disp(I_C*10^3,"The value of I_C in mA is : ")
//V_C = V_CC - (I_C * R_C);// in V
//disp(V_C,"The value of V_C in V is : ")
//disp("We conclude that collector voltage V_C
    varies from 5.98 V to 8.30 V");
//disp("Part (e)")
I_B = (V_CC - (I_C*R_C) - V_BE - V_E)/R_B;// in A
disp(I_B*10^6,"Base current in  A is");
bita = I_C/I_B;
disp(bita,"Current gain is");
```

**Scilab code Exa 4.29** Base current

```
// Exa 4.29
clc;
clear;
close;
// Given data
I_E = 10;// in mA
I_C = 9.95;// in mA
I_B = I_E-I_C;// in mA
disp(I_B,"The base current in mA is");
```

**Scilab code Exa 4.30** Current gain

```
// Exa 4.30
clc;
clear;
close;
// Given data
I_C = 10;// in mA
I_B = 0.1;// in mA
bita = I_C/I_B;
disp(bita,"The current gain is");
```

**Scilab code Exa 4.31** Base current

```
// Exa 4.31
clc;
clear;
close;
// Given data
V_BE = 0.7;// in V
V_BB = 10;// in V
R_B = 470;// in kohm
R_B = R_B * 10^3;// in ohm
```

```
I_B = (V_BB-V_BE)/R_B;// in A
disp(I_B*10^6,"The base current in  A is");
```

**Scilab code Exa 4.32** Collector emitter voltage

```
// Exa 4.32
clc;
clear;
close;
// Given data
V_BB = 10;// in V
V_BE = 0;// in V
R_B = 470;// in kohm
R_B = R_B * 10^3;// in ohm
I_B = (V_BB - V_BE)/R_B;// in A
bita = 200;
I_C = bita*I_B;// in A
V_CC = 10;// in V
R_C = 820;// in ohm
V_CE = V_CC  - (I_C*R_C);// in V
disp("Part (a) : For ideal approximation")
disp(V_CE,"The collector emitter voltage in V is");
P_D = V_CE * I_C;// in W
disp(P_D*10^3,"Power dissipation in mW is");
disp("Part (b) : For second approximation")
V_BE = 0.7;// in V
I_B = (V_BB-V_BE)/R_B;// in A
I_C = bita*I_B;// in A
V_CE = V_CC - (I_C*R_C);// in V
disp(V_CE,"The collector emitter voltage in V is");
P_D = V_CE * I_C;// in W
disp(P_D*10^3,"Power dissipation in mW is");
```

**Scilab code Exa 4.33** Collector emitter voltage

```
// Exa 4.33
clc;
clear;
close;
// Given data
V_BE = 0;// in V
V_BB = 12;// in V
R_B = 680;// in kohm
R_B = R_B * 10^3;// in ohm
I_B = (V_BB-V_BE)/R_B;// in A
beta_dc = 175;
I_C = beta_dc*I_B;// in A
V_CC = 12;// in V
R_C = 1.5;// in kohm
R_C = R_C * 10^3;// in ohm
V_CE = V_CC - (I_C*R_C);// in V
disp("Part (a) For ideal approximation")
disp(V_CE,"The collector emitter voltage in V is");
P_D = V_CE * I_C;// in mW
disp(P_D*10^3,"Transistor power in mW is");
disp("Part (b) For second approximation")
V_BE1 = 0.7;// in V
I_B = (V_BB-V_BE1)/R_B;// in A
I_C = beta_dc * I_B;// in A
V_CE = V_CC - (I_C*R_C);// in V
disp(V_CE,"Collector emitter voltage in V is");
P_D = V_CE * I_C;// in W
disp(P_D*10^3,"Power dissipation in mW is");
```

**Scilab code Exa 4.34** Load line

```
// Exa 4.34
clc;
```

```
clear;
close;
// Given data
V_CC = 20;// in V
R_C = 3.3;// in kohm
R_C = R_C * 10^3;// in ohm
I_C = V_CC/R_C;// in A
disp(I_C*10^3,"Collector current in mA is");
V_CE = V_CC;// in V
disp(V_CE,"Collector emitter voltage in V is");
V_CE=0:0.1:20 ;// in V
I_C= (V_CC-V_CE)/(R_C*10^-3);// in mA
plot(V_CE,I_C);
xlabel("V_CE in volts")
ylabel("I_C in mA")
title("DC load line")
disp("DC load line shown in figure")
```

**Scilab code Exa 4.35** Voltage between collector and ground

```
// Exa 4.35
clc;
clear;
close;
// Given data
V_BB = 10;// in V
V_BE = 0.7;// in V
R_B = 1;// in kohm
R_B = 1 * 10^6;// in ohm
I_B = (V_BB-V_BE)/R_B;// in A
disp(I_B*10^6,"The base current in  A is");
beta_dc = 200;
I_C = beta_dc * I_B;// in A
disp(I_C*10^3,"The collector current in mA is");
V_CC = 20;// in V
```

```
R_C = 3.3;// in kohm
R_C = R_C * 10^3;// in ohm
V_CE = V_CC - I_C*R_C;// in V
disp(V_CE,"The collector voltage in V is");
```

**Scilab code Exa 4.36** Voltage between collector and ground

```
// Exa 4.36
clc;
clear;
close;
// Given data
V_BB = 5;// in V
V_BE = 0.7;// in V
R_B = 680;// in kohm
R_B = 680*10^3;// in ohm
I_B = (V_BB-V_BE)/R_B;// in A
disp(I_B*10^6,"The base current in  A is : ")
beta_dc= 150;
I_C = beta_dc * I_B;// in A
disp(I_C*10^3,"The collector current in mA is");
V_CC = 5;// in V
R_C = 470;// in ohm
V_CE = V_CC-(I_C*R_C);// in V
disp(V_CE,"Voltage between collector and ground in V
    is ");
```

**Scilab code Exa 4.37** Collector voltage

```
// Exa 4.37
clc;
clear;
close;
```

```
// Given data
V_BB = 2.5;// in V
V_BE = 0.7;// in V
V_E = V_BB-V_BE;// in V
disp(V_E,"The emitter voltage in V is");
R_E = 1.8;// in kohm
R_E = R_E * 10^3;// in ohm
I_E = V_E/R_E;// in A
I_C= I_E;// in A
V_CC = 20;// in V
R_C = 10;// in kohm
R_C = R_C * 10^3;// in ohm
V_C = V_CC-(I_C*R_C);// in V
disp(V_C,"The collector voltage in V is");
```

**Scilab code Exa 4.38** Emitter voltage

```
// Exa 4.38
clc;
clear;
close;
// Given data
V_CC = 25;// in V
R2 = 2.2;// in kohm
R1 = 10;// in kohm
V_BB = (V_CC * R2)/(R1+R2);// in V
V_BE = 0.7;// in V
V_E = V_BB - V_BE;// in V
disp(V_E,"The emitter voltage in V is");
R_E = 1;// in kohm
R_E = R_E * 10^3;// in ohm
I_E = V_E/R_E;// in A
I_C= I_E;// in A
V_CC = 25;// in V
R_C = 3.6;// in kohm
```

```
R_C = R_C * 10^3;// in ohm
V_C = V_CC - (I_C*R_C);// in V
disp(V_C,"Collector voltage in V is");
```

**Scilab code Exa 4.39** Q point

```
// Exa 4.39
clc;
clear;
close;
// Given data
V_BB = 4.50;// in V
V_E = 3.8;// in V
V_C = 11.32;// in V
I_C = 3.8;// in mA
I_C=I_C*10^-3;// in A
V_BE = 0.7;// in V
R1 = 10;// in kohm
R2 = 2.2;// in kohm
R_B = (R1*R2)/(R1+R2);// in kohm
R_B = R_B * 10^3;// in ohm
I_B = (V_BB-V_BE)/R_B;// in A
disp(I_B*10^3,"The base current in mA is");
V_CE = V_C-V_E;// in V
disp(V_CE,"Collector emitter voltage in V is");
disp("Thus the Q-point is : "+string(V_CE)+" V, "+
   string(I_B*10^3)+" mA") ;

// Note: There is calculation error to evaluate the
   value of I_B. So the answer in the book is wrong.
```

# Chapter 5

# Transistor Circuits

**Scilab code Exa 5.1** Value of C

```
// exa 5.1
clc;
clear;
close;
// Given data
R1 = 600;// in ohm
R2 = 1000;// in ohm
R_TH = (R1*R2)/(R1+R2);// in ohm
X_C = 37.5;// in ohm
f = 1;// in kHz
f= f*10^3;// in Hz
C = 1/(2*%pi * f*X_C);// in F
disp(C*10^6,"Value of C in  F is");
```

**Scilab code Exa 5.2** Voltage gain

```
// Exa 5.2
clc;
```

```
clear;
close;
// Given data
R_C= 3.6*10^3;// in ohm
R_L= 10*10^3;// in ohm
r_c = (R_C*R_L)/(R_C+R_L);// in ohm
V_CC = 10;// in V
V_BE = 0.7;// in V
R_E = 1;// in kohm
R_E = R_E * 10^3;// in ohm
R1 = 10;// in kohm
R1= R1*10^3;// in ohm
R2 = 2.2;// in  kohm
R2= R2*10^3;// in ohm
V_B = (V_CC*R2)/(R1+R2);// in V
I_E = (V_B-V_BE)/R_E;// in A
V = 25*10^-3;// in V   // only value is given in the
    book
r_e = V/I_E;// in ohm
A_V = round(r_c/r_e);
disp(A_V,"The voltage gain is");
V_in = 2;//in mV
V_out = A_V*V_in;// in mV
disp(V_out,"The output voltage in mV is");
```

**Scilab code Exa 5.3** Output voltage

```
// Exa 5.3
clc;
clear;
close;
// Given data
A_V = 117;
r_e = 22.7;// in ohm
bita = 300;
```

```
Zin_base = bita*r_e;// in ohm
R1 = 2.2*10^3;// in  ohm
R2 = 10*10^3;// in ohm
Zin_stage = (Zin_base*R1*R2)/(Zin_base*R1+R1*R2+R2*
    Zin_base);// in ohm
R = 600;// in ohm
V = 2;// in mV
V_in = (Zin_stage/(R+Zin_stage))*V;// in mV
V_out = A_V * V_in;// in mV
disp(round(V_out),"The output voltage in mV is");
```

**Scilab code Exa 5.4** Input impedance

```
// Exa 5.4
clc;
clear;
close;
// Given data
R1 = 4.3;// in K ohm
R1= R1*10^3;// in ohm
R2 = 10;// in K ohm
R2= R2*10^3;// in ohm
r_e = (R1*R2)/(R1+R2);// in ohm
bita = 200;
V=25;// in mV
I= 1;// in mA
r_e_desh= V/I;// in ohm
Zin_base = bita*(r_e + r_e_desh);// in ohm
disp(Zin_base*10^-3,"The input impedence of the base
     in k  is : ")
R3 = 10*10^3;// in ohm
Zin_stage = (R2*R3*Zin_base)/(R2*Zin_base+R3*
    Zin_base+R2*R3);// in ohm
disp(Zin_stage*10^-3,"The input impedance of the
    stage in k  is");
```

```
disp("Because the input impedence of base is much larger than the input impedence")
disp(" of the stage, usually approximate the input impedence of the stage as the parallel")
Zin_stage= R2*R3/(R2+R3);// in ohm
disp(" of the biasing resistor only ")
disp(string(Zin_stage*10^-3)+" k ")
```

**Scilab code Exa 5.5** Value of RB

```
// Exa 5.5
clc;
clear;
close;
// Given data
V_CE = 0.2;// in V
V_BE= 0.7;// in V
R = 1;// in kohm
R = R * 10^3;// in ohm
V = 10;// in V
I_C = (V-V_CE)/R;// in A
beta_min = 50;
I_B = I_C/beta_min;// in A
I_B1 = V*I_B;// in A
V1 = 5;// in V
R_B = (V1-V_BE)/I_B1;// in ohm
disp(R_B*10^-3,"The base resistance in k  is");
```

**Scilab code Exa 5.6** Lowest frequency

```
// Exa 5.6
clc;
clear;
```

```
close;
// Given data
R = 10;// in K ohm
R = R * 10^3;// in ohm
X_C = 0.1 * R;
C = 47;// in  F
C = C * 10^-6;// in F
f = 1/(2*%pi * X_C *C) ;// in Hz
disp(f,"Lowest frequency in Hz is");
```

**Scilab code Exa 5.7** Lowest frequency

```
// Exa 5.7
clc;
clear;
close;
// Given data
C = 220;// in  F
C = C * 10^-6;// in F
R1 = 10;// in kohm
R1 = R1 * 10^3;// in ohm
R2 = 2.2;// in kohm
R2 = R2 * 10^3;// in ohm
R_TH = (R1*R2)/(R1+R2);// in ohm
X_C = 0.1*R_TH;// in ohm
f = 1/(2*%pi*C*X_C);// in Hz
disp(f,"The lowest frequency in Hz is");
```

**Scilab code Exa 5.8** AC beta

```
// Exa 5.8
clc;
clear;
```

```
close;
// Given data
i_c = 15;// in mA
i_c = i_c * 10^-3;// in A
i_b = 100;// in   A
i_b = i_b * 10^-6;// in A
bita = i_c/i_b;
disp(bita,"The value of ac bita is");
```

**Scilab code Exa 5.9** Output voltage

```
// Exa 5.9
clc;
clear;
close;
// Given data
R_C = 3.6;// in kohm
R_C= R_C*10^3;// in ohm
R_L = 10;// in kohm
R_L=R_L*10^3;// in ohm
R_TH = (R_C*R_L)/(R_C+R_L);// in ohm
V_CC = 10;// in V
R2 = 2.2;// in kohm
R2 = R2 * 10^3;// in ohm
R1 = 10;// in kohm
R1 = R1 * 10^3;// in ohm
V_BE = 0.7;// in V
V_B = (V_CC*R2)/(R1+R2);// in V
R_E = 1;// in kohm
R_E = R_E *10^3;// in ohm
I_E = (V_B-V_BE)/R_E;// in A
V1 = 25;// in mV
V1 = V1*10^-3;// in V
r_e = V1/(I_E);// in ohm
A_v = (R_TH)/r_e;
```

```
V_in = 2;// in mV
V_in = V_in * 10^-3;// in V
V_out = A_v*V_in;// in V
disp(V_out,"The output voltage in V is");
```

**Scilab code Exa 5.10** Voltage gain

```
// Exa 5.10
clc;
clear;
close;
// Given data
R_L = 10;// in kohm
R_L= R_L*10^3;// in ohm
R_C = 3.6;// in kohm
R_C= R_C*10^3;// in ohm
r_e_desh = 22.73;// in ohm
R_L_desh = R_L/2;// in ohm
A_v = ( (R_C*R_L_desh)/(R_C+R_L_desh))/r_e_desh;
disp(A_v,"The voltage gain is");
```

**Scilab code Exa 5.11** Input impedance

```
// Exa 5.11
clc;
clear;
close;
// Given data
R_E = 1;// in kohm
R_E = R_E * 10^3;// in ohm
R_L = 3.3;// in kohm
R_L = R_L * 10^3;// in ohm
r_e = (R_E*R_L)/(R_E+R_L);// in ohm
```

```
V_CC = 15;// in V
R2 = 2.2;// in K ohm
R2 = R2 * 10^3;// in ohm
R1 = R2;// in ohm
V_B = (V_CC*R2)/(R1+R2);// in V
V_BE = 0.7;// in V
R_E = 1;// in K ohm
R_E = R_E * 10^3;// in ohm
I_E = (V_B-V_BE)/R_E;// in A
V1 = 25*10^-3;// in V
r_e1 = V1/I_E;
bita = 200;
Zin_base = bita*(r_e+r_e1);// in ohm
disp(Zin_base*10^-3,"The input impedence of the base
    in k  is : ")
Zin_stage = (R1*R2*Zin_base)/(R1*R2+R2*Zin_base+R1*
   Zin_base);// in ohm
disp(Zin_stage*10^-3,"The input impedance of the
   stage in k  is");
```

**Scilab code Exa 5.12** Voltage gain and ac load voltage

```
// Exa 5.12
clc;
clear;
close;
// Given data
r_e = 767.44;
r_e1 = 3.68;
V_in = 1;// in V
A_v = round(r_e/(r_e+r_e1));
disp(A_v,"The voltage gain is : ")
V_o = A_v*V_in;// in V
disp(V_o,"The load voltage in V is");
```

# Chapter 6

# Field Effect Devices

**Scilab code Exa 6.1** Drain voltage

```
// Exa 6.1
clc;
clear;
close;
// Given data
V_D = 10;// in V
R = 10*10^3;// in ohm
I_D = V_D/R;// in A
V_P = 4;// in V
I_DSS = 10;// in mA
I_DSS = I_DSS * 10^-3;// in A
R_DS  = V_P/I_DSS;// in ohm
V_D = (R_DS/(R+R_DS))*V_D;// in V
disp(V_D,"The drain voltage in V is");
```

**Scilab code Exa 6.2** Drain voltage

```
// Exa 6.2
```

```
clc;
clear;
close;
// Given data
V_P = 4;// in V
I_DSS = 10;// in mA
I_DSS  =I_DSS  *10^-3;// in A
R_DS = V_P/I_DSS;// in ohm
V_DD = 30;// in V
I_D = 2.5;// in mA
R_D = 2;// in kohm
V_D = V_DD - (I_D*R_D);// in V
disp(V_D,"The drain voltage in V is");
```

**Scilab code Exa 6.3** DC load line and operating point

```
// Exa 6.3
clc;
clear;
close;
// Given data
R2 = 1;// in M ohm
R2 = R2*10^6;// in ohm
R1 = 2;// in M ohm
R1 = R1*10^6;// in ohm
V_DD = 30;// in V
R_D= 1*10^3;// in ohm
V_G = (R2/(R1+R2))*V_DD;// in V
R_S= 2*10^3;// in ohm
I_D= V_G/R_S;// in A
V_D= V_DD-I_D*R_D;// in V
V_DS= V_D-V_G;// in V
R_D= R_D+R_S;// in ohm
I_Dsat=V_DD/R_D*10^3;// in mA
disp(I_D*10^3,"The value of I_D in mA is : ")
```

```
disp(V_DS,"The value of V_DS in volts is : ")
disp("Thus the Q-point is "+string(V_DS)+" V, "+
   string(I_D*10^3)+" mA")
disp("DC load line shown in figure")
V_D= 0:0.1:V_DD;// in V
I_D= (V_DD-V_D)/R_D*10^3;// in mV
plot(V_D,I_D);
ylabel("I_D in mA");
xlabel("V_DS in volts");
title("DC load line")
```

**Scilab code Exa 6.4** Drain current

```
// Exa 6.4
clc;
clear;
close;
// Given data
V_DD = 15;// in V
R = 3;// in kohm
I_D = V_DD/R;// in mA
R_D = 1;// in kohm
V_D = V_DD - (I_D*R_D);// in V
disp(V_D,"The drain voltage in V is");
```

**Scilab code Exa 6.5** Output voltage

```
// Exa 6.5
clc;
clear;
close;
// Given data
R_D = 3.6;// in K ohm
```

```
R_L = 10;// in K ohm
r_d = (R_D*R_L)/(R_D+R_L);// in K ohm
g_m = 5000;// in  S
g_m= g_m*10^-6;// in S
A_v = g_m *r_d;
V_out = A_v;// in V
disp(V_out*10^3,"The output volatge in mV is ");
```

**Scilab code Exa 6.6** Minimum value of VDS

```
// Exa 6.6
clc;
clear;
close;
// Given data
V_GS = -2;// in V
V_P = -5;// in V
V_DS = V_GS-V_P;// in V
I_DSS = 8;// in mA
I_DS = I_DSS*( 1-(V_GS/V_P) )^2;// in mA
disp(I_DS,"The drain current in mA is");
```

**Scilab code Exa 6.7** Drain current

```
// Exa 6.7
clc;
clear;
close;
// Given data
I_DSS = 8.4;// in mA
I_DSS= I_DSS*10^-3;// in A
V_P = -3;// in V
V_GS = -1.5;// in V
```

```
I_D = I_DSS*( 1-(V_GS/V_P) )^2;// in A
disp(I_D*10^3,"The drain current in mA is");
V_GS1 = 0;// in V
g_mo = -( (2*I_DSS)/V_P );// in A/V
g_m = g_mo*(1-(V_GS/V_P));// in A/V
disp(g_m*10^3,"Transconductacne at V_G=-1.5 V,  in
    mA/V is");
```

**Scilab code Exa 6.8** Minimum value of VDS

```
// Exa 6.8
clc;
clear;
close;
// Given data
V_P = -4;// in V
V_GS = -2;// in V
I_DSS = 10;// in mA
I_DSS= I_DSS*10^-3;// in A
I_D = I_DSS*(1-(V_GS/V_P))^2;// in A
disp(I_D*10^3,"The drain current in  mA is");
V_DS = V_P;// in V
disp(V_DS,"The minimum value of V_DS in V is ");
```

**Scilab code Exa 6.9** Gate source voltage

```
// Exa 6.9
clc;
clear;
close;
// Given data
I_DSS = -40;// in mA
V_P = 5;// in V
```

```
I_D = -15;// in mA
V_GS = V_P*(1-sqrt(I_D/I_DSS));// in V
disp(V_GS,"The gate source voltage in V is");
```

**Scilab code Exa 6.10** Value of ID and VGS

```
// Exa 6.10
clc;
clear;
close;
// Given data
I_DSS = 4;// in mA
I_DSS= I_DSS*10^-3;// in A
V_P = -4;// in V
V_GG = -2;// in V
V_GS = V_GG;// in V
disp(V_GS,"The value of V_GS in V is");
I_D = I_DSS*(1-(V_GS/V_P))^2;// in A
disp(I_D*10^3,"The value of I_D in mA is");
V_DD = 10;// in V
R_D = 5;// in kohm
R_D = R_D * 10^3;// in ohm
V_DS = V_DD - (I_D*R_D);// in V
disp(V_DS,"The value of V_DS in V is");
```

**Scilab code Exa 6.11** Value of IDQ VD VS and VDS

```
// Exa 6.11
clc;
clear;
close;
// Given data
V_DD= 20;// in V
```

```
R1= 2.1*10^6;// in
R2= 270*10^3;// in
R_D= 4.7;// in  k
R_S= 1.5;// in  k
I_DSS= 8;// in mA
V_P= -4;// in V
V_G= V_DD*R2/(R1+R2);// in V
// V_GS= V_G-R_S*I_D     (as Vs= I_D*R_S) and
// I_D= I_DSS*(1-V_GS/V_P)^2;// in A
// I_D= I_DSS*(1-(V_G-R_S*I_D)/V_P)^2;// in mA  or
// I_D= I_D^2*I_DSS*R_S^2/V_P^2  + I_D*(2*R_S*I_DSS/V_P-2*V_G*R_S*I_DSS/V_P^2-1) + I_DSS*(1+V_G^2/V_P^2-2*V_G/V_P)
a= I_DSS*R_S^2/V_P^2;// assumed
b= 2*R_S*I_DSS/V_P-2*V_G*R_S*I_DSS/V_P^2-1;// assumed
c= I_DSS*(1+V_G^2/V_P^2-2*V_G/V_P);// assumed
root= [a b c];
I_D= roots(root);// in mA
I_D= I_D(2);// discarding maximum value as it will be less than I_DSS
I_DQ= I_D;// in mA
disp(I_DQ,"The value of I_DQ in mA is : ")
V_GSQ= V_G-R_S*I_D;// in V
disp(V_GSQ,"The value of V_GSQ in V is : ")
V_DSQ= V_DD-I_DQ*(R_D+R_S);// in V
disp(V_DSQ,"The value of V_DSQ in V is : ")
V_S= I_D*R_S;// in V
V_D= V_S+V_DSQ;//in V
V_DS= V_D-V_G;// in V
disp(V_S,"The value of V_S in V is : ")
disp(V_D,"The value of V_D in V is : ")
disp(V_DS,"The value of V_DS in V is : ")
```

**Scilab code Exa 6.12** Value of IDQ VGSQ VDS VD and VS

```
// Exa 6.12
clc;
clear;
close;
// Given data
V_DD= 20;// in V
I_DSS= 9;// in mA
V_BB= -10;// in V
R_S= 1.5;// in  k
R_D= 1.8;// in  k
V_P= -3;// in V
V_G=0;
// V_S= I_D*R_S+V_BB;
// V_GS= V_G-V_S or
// V_GS= V_G-(I_D*R_S+V_BB)
// I_D= I_DSS*(1-V_GS/V_P)^2 or
// I_D^2*R_S^2 + I_D*[2*R_S*V_BB+2*V_P*R_S-V_P^2/I_DSS]+[V_P^2+V_BB^2+2*V_BB*V_P]
root= [R_S^2 2*R_S*V_BB+2*V_P*R_S-V_P^2/I_DSS V_P^2+V_BB^2+2*V_BB*V_P]
I_D= roots(root);// in mA
I_D= I_D(2);// discarding maximum value as it will be less than I_DSS
I_DQ= I_D;// in mA
disp(I_DQ,"The value of I_DQ in mA is : ")
V_GS= V_G-(I_D*R_S+V_BB);// in V
V_GSQ= V_GS;// in V
disp(V_GSQ,"The value of V_GSQ in volts is : ")
V_DS= V_DD-I_D*(R_D+R_S)-V_BB;// in V
disp(V_DS,"The value of V_DS in volts is : ")
V_S= I_D*R_S+V_BB;// in V
disp(V_S,"The value of V_S in volts is : ");
V_D= V_S+V_DS;// in V
disp(V_D,"The value of V_D in volts is : ")
```

**Scilab code Exa 6.13** Value of IDQ VGSQ and IDSS

```
// Exa 6.13
clc;
clear;
close;
// Given data
V_S = 1.7;// in V
R_S = 0.51;// in kohm
R_S= R_S*10^3;// in ohm
V_DD = 18;// in V
R_D = 2*10^3;// in ohm
V_GS = -1.7;// in V
V_P = - 4.5;// in V
I_DQ = V_S/R_S;//in A
disp(I_DQ*10^3,"The value of I_DQ in mA is");
V_GSQ = -V_S;// in V
disp(V_GSQ,"The value of V_GSQ in V is");
I_DSS = I_DQ/( (1-(V_GS/V_P))^2 );// in A
disp(I_DSS*10^3,"The value of I_DSS in mA is");
V_D = V_DD - (I_DQ*R_D);// in V
disp(V_D,"The value of V_D in V is");
V_DS = V_D-V_S;// in V
disp(V_DS,"The value of V_DS in V is");
```

**Scilab code Exa 6.14** Transfer curve

```
// Exa 6.14
clc;
clear;
close;
// Given data
I_DSS = 12;// in mA
V_GS = 0;// in V
I_D = 0;// in mA
```

```
V_P = -6;// in V
V_GS= 0:-0.1:V_P;// in V
I_D = I_DSS*(1-(V_GS/V_P))^2;// mA
subplot(1,2,1)
plot(V_GS,I_D);
xlabel("V_GS in volts")
ylabel("I_D in mA")
title("n-channel device")
V_P = 6;// in V
V_GS= 0:0.1:V_P;// in V
I_D = I_DSS*(1-(V_GS/V_P))^2;// mA
subplot(1,2,2)
plot(V_GS,I_D);
xlabel("V_GS in volts")
ylabel("I_D in mA")
title("p-channel device")
```

**Scilab code Exa 6.15** Drain current

```
// Exa 6.15
clc;
clear;
close;
// Given data
I_DSS = 30;// in mA
V_GS = -5;// in V
V_GS_off = -8;// in V
I_D = I_DSS*(1-(V_GS/V_GS_off))^2;// in mA
disp(I_D,"The drain current in mA is");
```

**Scilab code Exa 6.16** Value of RS and RD

```
// Exa 6.16
```

```
clc;
clear;
close;
// Given data
I_D = 1.5;// in mA
I_DSS = 5;// in mA
V_P = -2;// in V
V_GS = V_P*(1-sqrt(I_D/I_DSS));// in V
V_G = 0;// in V
V_S = V_G-V_GS;// in V
R_S = V_S/I_D;// in kohm
disp(R_S*10^3,"The source resistance in ohm is");
V_DD = 20;// in V
V_DS= 10;// in V
R_D = (V_DD-(V_DS+(I_D*R_S)))/(I_D);// in kohm
disp(R_D,"The diode resistance in K ohm is");
```

**Scilab code Exa 6.17** Value of VGS gm RS and RD

```
// Exa 6.17
clc;
clear;
close;
// Given data
I_D = 0.8;// in mA
I_D= I_D*10^-3;// in A
I_DSS = 1.645;// in mA
I_DSS= I_DSS*10^-3;// in A
V_P = -2;// in V
V_GS = V_P * (1-sqrt(I_D/I_DSS));// in V
disp(V_GS,"The gate source voltage in V is");
g_mo = -((2*I_DSS)/V_P);// in A/V
g_m = g_mo*(1-(V_GS/V_P));// in A/V
disp(g_m*10^3,"The transconductance in mA/V is");
R_S = -(V_GS/I_D);// in ohm
```

```
disp(R_S,"The source resistance in ohm is");
AdB= 20;// in dB
A= 10^(AdB/20);
R_D= A/g_m;// in ohm
disp(R_D*10^-3,"The value of R_D in k   is : ")

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

**Scilab code Exa 6.18** Value of VGS IDQ VDS VD VG and VS

```
// Exa 6.18
clc;
clear;
close;
// Given data
V_GG = 2;// in V
V_GS = -V_GG;// in V
disp(V_GS,"The value of V_GS in V is");
I_DSS = 10;// in mA
V_P = -8;// in V
I_D = I_DSS*(1-(V_GS/V_P))^2;// in mA
I_DQ= I_D;// in mA
disp(I_DQ,"The value of I_DQ in mA is");
R_D = 2;// in K ohm
V_DD = 16;// in V
V_DS = V_DD - (I_D*R_D);// in V
disp(V_DS,"The value of V_DS in V is");
V_D = V_DS;// in V
disp(V_D,"The value of V_D in V is");
V_G = V_GS;// in V
disp(V_G,"The value of V_G in V is");
V_S = 0;// in V
disp(V_S,"The value of V_S in V is");
```

**Scilab code Exa 6.19** Resistance between gate and source

```
// Exa 6.19
clc;
clear;
close;
// Given data
V_GS = 10;// in V
I_G = 0.001;// in  A
R_GS = V_GS/I_G;// in M
disp(R_GS,"The gate source resistance in M  is");
```

**Scilab code Exa 6.20** AC drain resistance

```
// Exa 6.20
clc;
clear;
close;
// Given data
del_VDS = 1.5;// in V
del_ID = 120 * 10^-6;// in A
r_d = del_VDS/del_ID;// in ohm
r_d = r_d * 10^-3;// in kohm
disp(r_d,"The drain resistance of the JFET in K ohm is");
```

**Scilab code Exa 6.21** Value of ID and gm

```
// Exa 6.21
```

```
clc;
clear;
close;
// Given data
I_DSS  = 8.4;// in mA
V_P = -3;// in V
V_GS = -1.5;// in V
I_D = I_DSS*(1-(V_GS/V_P))^2;// in mA
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 g_m in mA/V is");
```

**Scilab code Exa 6.22** Value of gm ID and VDS

```
// Exa 6.22
clc;
clear;
close;
// Given data
V_DD= 20;// in V
I_DSS= 9;// in mA
V_P= -3;// in V
R1= 0.3*10^3;// in  k
R2= 1.7*10^3;//in  k
R_D= 3.2;// in  k
R=1;// in  k
V_G= V_DD*R1/(R1+R2);// in V
//I_D= I_DSS*[1-V_GS/V_P]^2
                                    (i)
// V_G= V_GS+I_D*R or I_D= (V_G-V_GS)/R      (ii)
// From (i) and (ii)
//V_GS*1/V_P^2+V_GS*[1/(R*I_DSS)-2/V_P]+[1-V_G/(R*
   I_DSS)]=0
V_GS= [1/V_P^2 1/(R*I_DSS)-2/V_P 1-V_G/(R*I_DSS)];
V_GS= roots(V_GS);
```

```
V_GS= V_GS(2);// in V (selecting lower value)
I_D= I_DSS*[1-V_GS/V_P]^2;// in mA
disp(I_D,"The value of I_D in mA is : ")
V_S= I_D*R;//in V
V_D= V_DD-I_D*R_D;// in V
V_DS= V_D-V_S;// in V
gm= -2*I_DSS/V_P*(1-V_GS/V_P);// in mA/V
disp(V_DS,"The value of V_DS in volts is : ")
disp(gm,"The transconductance in mA/V is : ")
```

**Scilab code Exa 6.23** Voltage gain

```
// Exa 6.23
clc;
clear;
close;
// Given data
r_d = 25;// in k
R1 = r_d;// in k
R2 = r_d;// in k
g_m = 2;//mA/V
g_m= g_m*10^-3;// in A/V
R_L = (r_d*R1*R2)/(r_d*R1+R1*R2+R2*r_d);// in k
R_L= R_L*10^3;// in
A_v = -g_m*R_L;
disp(A_v,"The voltage gain is ");
```

**Scilab code Exa 6.24** Input resistance of the gate

```
// Exa 6.24
clc;
clear;
close;
```

```
// Given data
V_GS = 15;// in V
I_G = 1;// in nA
I_G =I_G * 10^-9;// in A
R_in = V_GS/I_G;// in
disp(R_in*10^-9,"Input resistance in G  is");
```

**Scilab code Exa 6.25** Maximum drain current

```
// Exa 6.25
clc;
clear;
close;
// Given data
I_DSS = 20;// in mA
V_P = 4;// in V
I_D = I_DSS;// in mA
disp(I_D,"The maximum drain current in mA is");
V_GS = -V_P;// in V
disp(V_GS,"The gate source cut off voltage in volts is");
R_DS = V_P/I_DSS;// in k
disp(R_DS*10^3,"The value of ohmic resistance in is");
```

**Scilab code Exa 6.26** Gate voltage and drain current

```
// Exa 6.26
clc;
clear;
close;
// Given data
I_DSS= 16*10^-3;// in A
```

```
V_GSoff= -6;//in V
V_GS= V_GSoff/2;// in V
I_D= I_DSS*(1-V_GS/V_GSoff)^2;// in A
disp(I_D*10^3,"The drain current in mA is : ")
V_GS= abs(V_GSoff)/2;// in V
disp(V_GS,"The gate voltage in volts is : ")
```

**Scilab code Exa 6.27** Drain saturation current

```
// Exa 6.27
clc;
clear;
close;
// Given data
V_DD = 15;// in V
R_D = 10;// in kohm
R_D = R_D * 10^3;// in ohm
I_D = V_DD/R_D;// in A
disp(I_D*10^3,"The drain current in mA is");
V_D = V_DD - I_D*R_D;// in V
disp(V_D,"The drain voltage in V is");
```

**Scilab code Exa 6.28** DC load line and operating point

```
// Exa 6.28
clc;
clear;
close;
// Given data
R2 = 1;// in M ohm
R2 = R2 * 10^6;// in ohm
R1 = 1.5;// in M ohm
R1 = R1 * 10^6;// in ohm
```

```
V_DD = 25;// in V
V_G = (R2*V_DD)/(R1+R2);// in V
R_S = 22;// in kohm
R_S = R_S * 10^3;// in ohm
I_D = V_G/R_S;// in A
disp(I_D*10^3,"The drain current in mA is ");
R_D = 10;// in  kohm
R_D = R_D * 10^3;// in ohm
V_D = V_DD - (I_D*R_D);//in V
V_S = 10;// in V
V_DS = V_D - V_S;// in V
disp(V_DS,"The Drain source voltage in V is");
disp("Thus the Q-point is : "+string(V_DS)+" V, "+
   string(I_D*10^3)+" mA")
I_Dsat = V_DD/R_D;// in A
V_DS = V_DD;// in V
V_D= 0:0.1:25;// in V
I_D= (V_DD-V_D)/R_D*10^3;// in mA
plot(V_D,I_D);
xlabel("V_DS in volts");
ylabel("I_D in mA");
title("DC load line");
disp("DC load line shown in figure")
```

**Scilab code Exa 6.29** Drain current

```
// Exa 6.29
clc;
clear;
close;
// Given data
V_SS = 25;// in V
V_GS = 0;// in V
R_S = 18;// in kohm
R_S = R_S * 10^3;// in ohm
```

```
I_D = (V_SS-V_GS)/R_S;// in A
disp(I_D*10^3,"The drain current in mA is");
V_DD = 25;// in V
R_D = 7.5;// in kohm
R_D = R_D * 10^3;// in ohm
V_D = V_DD - (I_D*R_D);// in V
disp(V_D,"The drain voltage in V is");
```

**Scilab code Exa 6.30** AC output voltage

```
// Exa 6.30
clc;
clear;
close;
// Given data
R_D = 1;// in kohm
R_D = R_D * 10^3;// in ohm
V_in = 2;// in mV
V_in = V_in * 10^-3;// in V
R_L = 10;// in kohm
R_L = R_L * 10^3;// in ohm
r_d = (R_D*R_L)/(R_D+R_L);// in ohm
g_m = 3000;//in  S
g_m = g_m * 10^-6;// in S
A_v = g_m*r_d;
V_out = A_v*V_in;// in V
V_out = V_out * 10^3;// in mV
disp(V_out,"The output Voltage in mV is");
```

# Chapter 7

# MOSFET

**Scilab code Exa 7.1** Output voltage

```
// Exa 7.1
clc;
clear;
close;
// Given data
V_GS = 0;// in V
I_D = 4;// in mA
R = 2;// in kohm
V_DD = 15;// in V
V_DS = V_DD - (I_D*R);// in V
g_m = 2000;// in   S
g_m= g_m*10^-6;// in S
g_mo = g_m;// in S
R_D = 2;// in kohm
R_D = R_D * 10^3;// in ohm
R_L = 10;// in  kohm
R_L = R_L * 10^3;// in ohm
r_d = (R_D*R_L)/(R_D+R_L);// in ohm
A_v = g_m*r_d;
V_in = 20;// in mV
V_out = A_v * V_in;// in mV
```

```
disp(V_out,"The output voltage in mV is");
```

**Scilab code Exa 7.2** LED current

```
//Exa 7.2
clc;
clear;
close;
// Given data
V1 = 20;// in V
V2 = 2;// in V
V = V1-V2;// in V
R = 1;// in  kohm
R = R * 10^3;// in ohm
I_D = V/R;// in A
I_D = I_D * 10^3;// in mA
disp(I_D,"The drain current in mA is");
```

**Scilab code Exa 7.3** Transfer characteristics

```
// Exa 7.3
clc;
clear;
close;
// Given data
I_DSS = 10;// in mA
V_GS = 0;// in V
I_D = 0;// in mA
V_P = -4;// in V
V_GS= 0:-0.1:V_P;// in V
I_D = I_DSS*(1-(V_GS/V_P))^2;// 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")
```

**Scilab code Exa 7.4** Value of VDS

```
// Exa 7.4
clc;
clear;
close;
// Given data
V_GS = 0;// in V
I_DSS = 10;// in mA
I_D = I_DSS;// in mA
R_D = 1.5;// in kohm
V_DD = 20;// in V
V_DS = V_DD - (I_D*R_D);// in V
disp(V_DS,"The value of V_DS in V is");
```

**Scilab code Exa 7.5** Drain current

```
// Exa 7.5
clc;
clear;
close;
// Given data
I_D = 5;// in mA
V_GS1 = 8;// in V
V_GS2 = 4;// in V
V_GS = 6;// in V
K = I_D/(V_GS1-V_GS2)^2;// in mA/V^2
I_D = K*(V_GS-V_GS2)^2;// in mA
disp(I_D,"The drain current in mA is");
```

**Scilab code Exa 7.6** Value of K

```
// Exa 7.6
clc;
clear;
close;
// Given data
V_T = 1;// in V
I_D = 4;// in mA
V_GS = 5;// in V
V_GSth = 1;// in V
K = I_D/(V_GS-V_GSth)^2;// in mA/V^2
disp(K,"The value of K in mA/V^2 is");
```

**Scilab code Exa 7.7** Region of operation

```
// Exa 7.7
clc;
clear;
close;
// Given data
V_GS = 3;// in V
V_GSth=2;// inV
// Part (a)
V_DS= 0.5;// in V
if V_DS<(V_GS-V_GSth) then
    disp("Transistor is in ohmic region")
else
    disp("Transistor is in saturation region")
end

```

```
// Part (b)
V_DS= 1;// in V
if V_DS<(V_GS-V_GSth) then
    disp("Transistor is in ohmic region")
else
    disp("Transistor is in saturation region")
end

// Part (c)
V_DS= 5;// in V
if V_DS<(V_GS-V_GSth) then
    disp("Transistor is in ohmic region")
else
    disp("Transistor is in saturation region")
end
```

**Scilab code Exa 7.8** Value of ID

```
// Exa 7.8
clc;
clear;
close;
// Given data
I_DSS = 4;// in mA
V_GSoff = -2;// in V
V_GS = -0.5;// in V
I_D = I_DSS*(1-(V_GS/V_GSoff))^2;// in mA
disp(I_D,"At V_GS=-0.5 V, the drain current in mA is
   ");
V_GS = -1;//in V
I_D = I_DSS*(1-(V_GS/V_GSoff))^2;// in mA
disp(I_D,"At V_GS=-1.0 V, the drain current in mA is
   ");
V_GS = -1.5;// in V
I_D = I_DSS*(1-(V_GS/V_GSoff))^2;// in mA
```

```
disp(I_D,"At V_GS=-1.5 V, the drain current in mA is ");
```

**Scilab code Exa 7.9** Drain current and the value of VDS

```
// Exa 7.9
clc;
clear;
close;
// Given data
I_DSS = 12;// in mA
I_DSS= I_DSS*10^-3;// in A
I_D = I_DSS;// in A
V_DD = 12;// in V
R_D = 470;// in ohm
V_DS = V_DD - (I_D*R_D);// in V
disp(I_D*10^3,"The circuit drain current in mA is : ")
disp(V_DS,"The drain source voltage in V is");
```

**Scilab code Exa 7.10** Value of rd Av and Vout

```
// Exa 7.10
clc;
clear;
close;
// Given data
I_D = 12;// in mA
I_D= I_D*10^-3;// in A
I_DSS = I_D;// in A
V_DS = 6.36;// in V
g_mo = 4000;// in  S
g_mo=g_mo*10^-6;// in S
```

```
g_m = g_mo;// in S
R_D = 470;// in ohm
R_L = 2;// in kohm
R_L = R_L * 10^3;// in ohm
r_d = (R_D*R_L)/(R_D+R_L);// in ohm
disp(r_d,"The value of r_d in     is : ")
A_v = g_m*r_d;
disp(A_v,"The value of A_v is : ")
V_in = 100;// in mV
V_in = V_in *10^-3;// in V
V_out = A_v*V_in;// in V
disp(V_out,"The value of Vout in V is");
```

**Scilab code Exa 7.11** Value of RDS

```
// Exa 7.11
clc;
clear;
close;
// Given data
V_DS = 0.1;// in V
I_D = 10;// in mA
I_D= I_D*10^-3;// in A
R_DS = V_DS/I_D;// in ohm
disp(R_DS,"Part (a) The value of R_DS(on) in ohm is"
    );
V_DS = 0.75;// in V
I_D = 100;// in mA
I_D= I_D*10^-3;// in A
R_DS = V_DS/I_D;// in ohm
disp(R_DS,"Part (b) The value of R_DS(on) in ohm is"
    );
```

**Scilab code Exa 7.12** Voltage across EMOSFET

```
// Exa 7.12
clc;
clear;
close;
// Given data
I_D = 500;// in mA
V_GS = 3;// in V
R_DS = 2;// in ohm
V_DD = 20;// in V
R1 = 1;// in kohm
R1 = R1 * 10^3;// in ohm
V_out = (R_DS/(R1+R_DS))*V_DD;// in V
disp(V_out,"The output voltage in V is");
```

# Chapter 8

# Operational Amplifiers

**Scilab code Exa 8.1** Value of Rf

```
// Exa 8.1
clc;
clear;
close;
// Given data
A_V = -100;
R1 = 2.2;// in kohm
R1 = R1*10^3;// in ohm
R_f =-( A_V*R1);// in ohm
R_f = R_f * 10^-3;// in kohm
disp(R_f,"The resistance value in k   is");
```

**Scilab code Exa 8.2** Output voltage

```
// Exa 8.2
clc;
clear;
close;
```

```
// Given data
R_f = 200;// in kohm
R1 = 2;// in kohm
A_V = - (R_f/R1);
V_in = 2.5;// in mV
V_in= V_in*10^-3;// in V
V_o = (A_V * V_in);// in V
disp(V_o,"The output voltage in V is");
```

**Scilab code Exa 8.3** Output voltage

```
// Exa 8.3
clc;
clear;
close;
// Given data
V1 = 2;// in V
R_f = 500;// in kohm
R_f = R_f*10^3;// in ohm
R1 = 100;// in kohm
R1 = R1 * 10^3;// in ohm
V_o = (1+(R_f/R1))*V1;// in V
disp(V_o,"The output voltage in V is");
```

**Scilab code Exa 8.4** Output voltage

```
// Exa 8.4
clc;
clear;
close;
// Given data
R_f = 1;// in Mohm
R_f = R_f * 10^6;// in ohm
```

```
disp("Part (a)")
V1 = 1;// in V
V2 = 2;// in V
V3 = 3;// in V
R1 = 500;// in kohm
R1 = R1 * 10^3;// in ohm
R2 = 1;// in Mohm
R2 = R2 * 10^6;// in ohm
R3 = 1;// in Mohm
R3 = R3 * 10^6;// in ohm
V_o = -(R_f) * ( (V1/R1)+(V2/R2)+(V3/R3) );// in V
disp(V_o,"The output voltage in V is");

disp("Part (b)")
V1 = -2;// in V
V2 = 3;// in V
V3 = 1;// in V
R1 = 200;// in kohm
R1 = R1 * 10^3;// in ohm
R2 = 500;// in kohm
R2 = R2 * 10^3;// in ohm
R3 = 1;// in Mohm
R3 = R3 * 10^6;// in ohm
V_o = -(R_f) * ( (V1/R1)+(V2/R2)+(V3/R3) );// in V
disp(V_o,"The output voltage in V is");
```

**Scilab code Exa 8.6** Output voltage

```
// Exa 8.6
clc;
clear;
close;
// Given data
R_f = 0;// in V
R1 = 2;// in kohm
```

```
R1 = R1 * 10^3;// in ohm
A_vmin = (1+(R_f/R1));
disp(A_vmin,"The minimum closed loop voltage gain is ");
R_f1 = 100;// in kohm
R_f1 = R_f1 * 10^3;// in ohm
A_vmax = (1+(R_f1/R1));
disp(A_vmax,"The maximum closed loop voltage gain is ");
```

**Scilab code Exa 8.7** Output voltage

```
// Exa 8.7
clc;
clear;
close;
// Given data
V1 = 745;// in  V
V1 = V1 * 10^-6;// in V
V2 = 740;// in  V
V2 = V2 * 10^-6;// in V
Av = 5*10^5;
CMRR = 80;// in dB
// Formula CMRR in dB= 20*log(Av/Ac)
Ac= Av/(10^(CMRR/20));
disp(Ac,"The common mode gain is");
V_o = Av*(V1-V2)+Ac*((V1+V2)/2);// in V
disp(V_o,"The output voltage in V is");

// Note: In the book the calculation of finding the value of common mode gain  (i.e. Ac) is wrong, so the answer in the book is wrong
```

**Scilab code Exa 8.8** Voltage gain of the amplifier

```
// Exa 8.8
clc;
clear;
close;
// Given data
R_f = 1;// in Mohm
R_f = R_f * 10^6;// in ohm
Ri= 1*10^6;// in ohm
R1 = Ri;// in ohm
A_VF = -(R_f/R1);
disp(A_VF,"The Voltage gain is");
```

**Scilab code Exa 8.10** Output voltage

```
// Exa 8.10
clc;
clear;
close;
// Given data
R_F = 3;// in kohm
R1 = 1;// in  kohm
V1 = 2;// in V
V2 = 3;// in V
V_o1 = (1+(R_F/R1))*V1;// in V
V_o2 = (1+(R_F/R1))*V2;// in V
V_o = V_o1+V_o2;// in V
disp(V_o,"The output voltage in V is");
```

**Scilab code Exa 8.11** Range of voltage gain

```
// exa 8.11
```

```
clc;
clear;
close;
// Given data
R_i = 10;// in  k
R_im = 20;// in  k
R_f = 500;// in  k
A_vmin = -(R_f/R_i);
disp(A_vmin,"Closed loop voltage gain corresponding to minimum resistance is");
A_vmax = -(R_f/R_im);
disp(A_vmax,"Closed loop voltage gain corresponding to maximum resistance is");
```

**Scilab code Exa 8.12** Range of output voltage

```
// Exa 8.12
clc;
clear;
close;
// Given data
R_f = 200;// in  kohm
R1 = 20;// in kohm
A_v = -(R_f/R1);
V_i = 0.1;// in V
V_im = 0.5;// in V
V_omin = -10*V_i;// in V
disp(V_omin,"The minimum output voltage in V is");
V_omax = -10*V_im;// in V
disp(V_omax,"The maximum output voltage in V is");
disp("Output voltage ranges from "+string(V_omin)+" to "+string(V_omax))
```

**Scilab code Exa 8.13** Output waveform

```
// exa 8.13
clc;
clear;
close;
// Given data
R = 133;// in kohm
R = R *10^3;// in ohm
C = 0.1;// in   F
C = 0.1 * 10^-6;// in F
Vi= 1.5;// in V
t=0:0.1:1;
subplot(2,1,1)
plot(t,Vi);
ylabel("Vi in volts")
xlabel("t")
title("Input voltage");
t= 0:0.1:1;
Vo= -1/(R*C)*t;
subplot(2,1,2)
plot(t,Vo)
xlabel("t");
ylabel("Vo in volts");
title("Output voltage")
```

---

**Scilab code Exa 8.14** Value of R1 and R2

```
// Exa 8.14
clc;
clear;
close;
// Given data
Rf = 250;// in kohm
Vo= '-5*Va+3*Vb';// given expression
```

```
// But output voltage of difference amplifier is
// Vo= -Rf/R1*Va+(R2/(R1+R2))*(1+Rf/R1)*Vb      (i)
// By comparing (i) with given expression
R1 = Rf/5;// in kohm
disp(R1,"The value of R1 in k  is : ");
// (R2/(R1+R2))*(1+Rf/R1)= 3
R2= 3*R1^2/(R1+Rf-3*R1);// in k
disp(R2,"The value of R2 in k  is : ")

// Note: There is calculation error to find the value of R2 in the book.
```

**Scilab code Exa 8.15** Output voltage

```
// Exa 8.15
clc;
clear;
close;
// Given data
V_i1 = 150;// in  V
V_i2 = 140;// in  V
V_d = V_i1-V_i2;// in  V
V_C = (1/2)*(V_i1+V_i2);// in  V
disp("Part (i)")
CMRR = 100;
A_d = 4000;
V_o = (A_d * V_d)*(1+(1/CMRR)*(V_C/V_d));// in  V
V_o = V_o * 10^-3;// in mV
disp(V_o,"The output voltage in mV is");
disp("Part(ii)")
CMRR = 10^5;
V_o = (A_d * V_d)*(1+(1/CMRR)*(V_C/V_d));// in  V
V_o = V_o * 10^-3;// in mV
disp(V_o,"The output voltage in mV is");
```

**Scilab code Exa 8.16** Output voltage

```
// Exa 8.16
clc;
clear;
close;
// Given data
R_f = 470;// in k
R1 = 4.3;// in k
R2 = 33;// in k
R3 = R2;// in k
A1 = (1+R_f/R1);
A2 = -(R_f/R2);
A3 = -(R_f/R3);
A = A1*A2*A3;
V_i = 80;// in V
V_i= 80*10^-6;// in V
V_o = A*V_i;
disp(V_o,"The output voltage in V is")
```

**Scilab code Exa 8.18** Output voltage

```
// Exa 8.18
clc;
clear;
close;
// Given data
R4 = 300;// in k
R2 = 150;// in k
R3 = 10;// in k
R1 = 10;// in k
V1 = 1;// in V
```

```
V2 = 2;// in V
V_o = ( (1+(R4/R2))*((R3/(R1+R3))*V1)-((R4/R2)*V2) )
    ;// in V
disp(V_o,"The output voltage in V is");
```

**Scilab code Exa 8.19** Input voltage

```
// Exa 8.19
clc;
clear;
close;
// Given data
V_o = 2;// in V
R_i = 20;// in k
R_f = 1;// in M
V_i = -((V_o*R_i)/R_f);// in mV
disp(V_i,"The input volatge in mV is");
```

**Scilab code Exa 8.20** Range of output voltage

```
// Exa 8.20
clc;
clear;
close;
// Given data
R_f = 200;// in k
R_i = 30;// in k
V_i = 0.1;// in V
V_im = 0.5;// in V
Vo_min = -((R_f/R_i)*V_i);// in V
disp(Vo_min,"The minimum output voltage in V is");
Vo_max = -((R_f/R_i)*V_im);// in V
disp(Vo_max,"The minimum output voltage in V is");
```

```
disp("The output voltage range is : "+string(Vo_min)
   +" V to "+string(Vo_max)+" V")
```

**Scilab code Exa 8.21** Output voltage

```
// Exa 8.21
clc;
clear;
close;
// Given data
R_f = 360;// in kohm
R_i = 12;// in kohm
V1 = - 0.3;// in V
V_o = (1+(R_f/R_i))*V1;// in V
disp(V_o,"The output voltage in V is");
V_o1 = 2.4;// in V
V_i = V_o1/(1+(R_f/R_i));// in V
disp(V_i*10^3,"The input voltage in mV is");
```

**Scilab code Exa 8.22** Output voltage

```
// Exa 8.22
clc;
clear;
close;
// Given data
R_f = -68;// in kohm
R1 = 33;// in kohm
R2 = 22;// in kohm
R3 = 12;// in kohm
V1 = 0.2;// in V
V2 = - 0.5;// in V
V3 = 0.8;// in V
```

```
V_o = ((R_f/R1)*V1) + ((R_f/R2)*V2) + ((R_f/R3)*V3);
    // in V
disp(V_o,"The output voltage in V is");
```

**Scilab code Exa 8.23** Closed loop voltage gain and bandwidth

```
// Exa 8.23
clc;
clear;
close;
// Given data
R_f = 1.8;// in kohm
R_f = R_f * 10^3;// in ohm
R1 = 180;// in ohm
A_v = (R_f/R1);
disp(A_v,"Closed loop gain is");
F = 1;// in MHz
F = F * 10^6;// in Hz
f2 = F/A_v;// in Hz
disp(f2,"Closed loop bandwidth in Hz is");
V_in = 25;// in mV
V_in = V_in * 10^-3;// in V
V_o = A_v*V_in;// in V
disp(V_o,"The output voltage in V is");
```

**Scilab code Exa 8.24** Closed loop voltage gain and bandwidth and output voltage

```
// Exa 8.24
clc;
clear;
close;
// Given data
```

```
R_f = 3;// in K ohm
R_f = R_f * 10^3;// in ohm
R1 = 150;// in ohm
A_v = (R_f/R1) + 1;
disp(A_v,"Close loop gain for inverting amplifier is
   ");
f = 1;// in MHz
f = f * 10^6;// in Hz
f2 = f/A_v;// in Hz
f2 = f2 * 10^-3;// in KHz
disp(f2,"The closed loop bandwidth in KHz is");
```

# Chapter 9

# Electronic Instrumentation and Measurements

**Scilab code Exa 9.1** Peak to peak amplitude

```
// Exa 9.1
clc;
clear;
close;
// Given data
scale= 5;// in mV/cm
gh= 5.2;//amplitude of the graph in cm
PtoPamplitude= gh*scale;// in mV
disp(PtoPamplitude,"Peak-to-peak amplitude in mV is
    : ")
```

---

**Scilab code Exa 9.2** Amplitude of the pulse signal

```
// Exa 9.2
clc;
clear;
```

```
close;
// Given data
scale= 100;// in mV/cm
gh= 5.2;//amplitude of the graph in cm
PtoPamplitude= gh*scale;// in mV
disp(PtoPamplitude*10^-3,"Peak-to-peak amplitude in V is : ")
```

**Scilab code Exa 9.3** Period of the waveform

```
// Exa 9.3
clc;
clear;
close;
// Given data
scale= 20;// in  S /cm
gh= 3.2;//amplitude of the graph in cm
T= gh*scale;// in mV
disp(T,"The period of the waveform in  S is : ")
```

**Scilab code Exa 9.4** Pulse delay

```
// Exa 9.4
clc;
clear;
close;
// Given data
scale= 50;// in  S /cm
gh= 2;//amplitude of the graph in cm
T_PD= gh*scale;// in mV
disp(T_PD,"The pulse delay for the waveform in  s is : ")
```

**Scilab code Exa 9.5** Pulse width of the waveform

```
// Exa 9.5
clc;
clear;
close;
// Given data
scale= 2;// in  S /cm
gh= 4.6;//amplitude of the graph in cm
T_PQ= gh*scale;// in mV
disp(T_PQ,"The pulse width of the waveform in  s is
    : ")
```