Scilab Textbook Companion for Semiconductor Circuit Approximations by Malvino[1]

Created by
Daud Ibrahim Saifi
B.Tech
Computer Engineering
H. N. B.Garhwal University
College Teacher
Mr. Ankit Jorawer
Cross-Checked by
Prathan Mehta

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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 4

2 Rectifier Diodes 5

3 Special Diodes 10

4 Diode Applications 22

5 Bipolar Transistor 27

6 Common Emitter Approximations 36

7 Common Collector Approximations 45

8 Common Base Approximations 53

9 Class A Power Amplifiers 57

10 Other Power Amplifiers 68

11 More Amplifier Theory 75

12 JFETS 78

14 Thyristors 81

16 Op Amp Negative Feedback 84

List of Scilab Codes

Exa 2.1	Output voltage	5
Exa 2.2	Output voltage	5
Exa 2.4	Maximum reverse voltage	6
Exa 2.5	Power dissipation of the diode	7
Exa 2.6	Peak forward current and PIV	7
Exa 2.7	Peak load voltage and peak inverse voltage	8
Exa 3.1	LED current	10
Exa 3.2	LED current	10
Exa 3.4	Tuning range	12
Exa 3.5	Minimum and maximum zener current	12
Exa 3.6	Minimum and maximum output voltage	13
Exa 3.7	Maximum current	14
Exa 3.8	Value of IS IL IZ	14
Exa 3.9	Values of all currents	15
Exa 3.10	Value of Change in output voltage	17
Exa 3.11	Value of IS IL IZ	18
Exa 3.12	Value of IS IL IZ	18
Exa 4.1	DC voltage across load resistance	22
Exa 4.2	DC current through each diode	23
Exa 4.3	Value of Vdc and PIV	23
Exa 4.6	DC load voltage	24
Exa 4.8	Zener current	25
Exa 4.9	Ripple across the load current	25
Exa 5.1	Value of VCE	27
Exa 5.2	DC load line	28
Exa 5.3	Value of IC and VCE	28
Exa 5.4	LED current	29
Exa 5.5	DC voltage	30

Exa 5.6	DC collector to ground voltage	30
Exa 5.7	Value of Vc	31
Exa 5.8	Minimum and maximum collector current	32
Exa 5.9	IC and VCE	33
Exa 5.10	IC and VCE	33
Exa 5.11	IC and VCE	34
Exa 5.12	DC voltage	35
Exa 6.2	Total voltage	36
Exa 6.3	Total current	36
Exa 6.4	Input impedence	37
Exa 6.5	Value of VB	38
Exa 6.6	Ac output voltage	39
Exa 6.7	Minimum and maximum voltage gain	39
Exa 6.8	Input impedance of the amplifier	40
Exa 6.9	Input impedance of each stage	41
Exa 6.10	Ac output voltage across the final load resistor	41
Exa 6.11	Ac voltage at the final output	43
Exa 7.1	DC load line and Q point	45
Exa 7.2	AC output voltage	46
Exa 7.3	Voltage gain	47
Exa 7.4	Power gain	47
Exa 7.5	AC output voltage	48
Exa 7.7	AC output voltage	48
Exa 7.9	re1 and re2	49
Exa 7.10	Input impedance	50
Exa 7.11	Zener current	51
Exa 8.1	Value of VCB	53
Exa 8.2	Value of VCB	53
Exa 8.3	Output voltage	54
Exa 8.4	Output voltage	55
Exa 9.1	DC and AC load line	57
Exa 9.2	Cut off value of VCE	58
Exa 9.3	cutt of value of VCE	59
Exa 9.4	AC compliance	60
Exa 9.5	Value of ICQrL	61
Exa 9.6	Voltage divider biased stage	62
Exa 9.7	AC compliance	63
Exa 9.9	New value of AC compliance	63

Exa 9.10	Maximum ac load power	65
Exa 9.11	Efficiency	65
Exa 9.12	Power rating	66
Exa 10.1	PDQ PDmax and PLmax	68
Exa 10.2	Efficiency of the amplifier with a maximum output signal	69
Exa 10.3	DC and AC load line	69
Exa 10.4	PDQ PDmax and PLmax	70
Exa 10.5	Voltage gain of the driver stage	71
Exa 10.6	Ideal value of PP and PLmax	71
Exa 10.7	Overall voltage gain	72
Exa 10.8	Minimum base current that produces saturation	72
Exa 10.9	Input voltage required	73
Exa 11.1	Closed loop voltage gain	75
Exa 11.2	Alpha bita rdeshe and rdeshc	75
Exa 11.3	Value of rdeshb	76
Exa 11.4	Voltage gain	76
Exa 12.1	Source voltage to ground	78
Exa 12.2	Transconductance	79
Exa 12.3	Output voltage	79
Exa 12.4	Voltage gain	80
Exa 14.1	Load current	81
Exa 14.2	Input voltage	81
Exa 14.6	Ideal emitter current	82
Exa 14.7	Value of emitter supply voltage	82
Exa 16.1	Output voltage and error voltage	84
Exa 16.2	ACL Vout and Verror	85
Exa 16.3	Closed loop input and output impedence	85
Exa 16.4	Closed loop voltage gain	86
Exa 16.5	Closed loop voltage gain	87
Exa 16.6	Value of FCL	88

Chapter 2

Rectifier Diodes

Scilab code Exa 2.1 Output voltage

```
// Example 2.1
clc;
clear;
close;
format('v',6)
// given data
Vin= 15;// in V
R_L= 10;// in k
// The output voltage
Vout= Vin ;// in V
// The current
I= Vout/R_L;// in mA
disp(Vout,"The output voltage in volts is : ");
disp(I,"The current in mA is : ");
```

Scilab code Exa 2.2 Output voltage

```
// Example 2.2
```

```
clc;
clear;
close;
format('v',6)
// given data
Vin= 15;// in V
I=0;
R_L= 10;// in  k
R_L= R_L*10^3;// in
// The output voltage
Vout= I*R_L;// in V
// The voltage across the diode
V_R= Vin-Vout;// in V
disp(Vout,"The output voltage in volts is : ");
disp(V_R,"The voltage across the diode in volts is :
    ");
```

Scilab code Exa 2.4 Maximum reverse voltage

```
// Example 2.4
format('v',6)
clc;
clear;
close;
// given data
Vin= 15;// in V
V_P= Vin;// in V
R_L= 10;// in  k
R_L= R_L*10^3;// in
Vout=0;
// The peak current through the diode
I_P= V_P/R_L;// in A
// The maximum reverse voltage
V_R= Vin-Vout;// in V
I_P= I_P*10^3;// in mA
```

```
disp(I_P,"The peak current through the diode in mA is : ");
disp(V_R,"The maximum reverse voltage in volts is : ")
```

Scilab code Exa 2.5 Power dissipation of the diode

```
// Example 2.5
format('v',6)
clc;
clear;
close;
// given data
Vin= 15;// in V
V_K= 0.7;// in V
R_L= 10;// in k
R_L= R_L*10^3;// in
// The output voltage
Vout= Vin-V_K;// in V
// The current
I= Vout/R_L;// in A
// The power dissipation of the diode
P= V_K*I;// in W
I=I*10^3;// in mA
P= round(P*10^3);// in mW
disp(Vout,"The output voltage in volts is : ");
disp(I,"The current in mA is : ");
disp(P,"The power dissipation of the diode in mW is : ")
```

Scilab code Exa 2.6 Peak forward current and PIV

```
// Example 2.6
```

```
format('v',6)
clc;
clear;
close;
// given data
Vin= 15;// in V
V_K= 0.7;// in V
Vout=0;// in V
R_L= 10;// in  k
R_L= R_L*10^3;// in
// The peak output voltage
V_P= Vin-V_K;// in V
// The maximum forward current
I_P= V_P/R_L;// in A
// The peak inverse voltage
PIV= Vin-Vout;// in V
I_P= I_P*10^3;// in mA
disp(V_P,"The peak output voltage in volts is : ");
disp(I_P,"The maximum forward current in mA is : ");
disp(PIV,"The peak inverse voltage in volts is : ")
```

Scilab code Exa 2.7 Peak load voltage and peak inverse voltage

```
// Example 2.7
clc;
clear;
close;
format('v',5)
// given data
Vin= 10;// in V
V_K= 0.7;// in V
Vout=0;// in V
R_L= 1000;// in  k
r_B= 20;// in
// The peak forward current ,
```

```
I_P= (Vin-V_K)/(R_L+r_B);// in A
// The peak voltage
V_P= I_P*R_L;// in V
// The peak inverse voltage
PIV= Vin-Vout;// in V
disp(V_P,"The peak voltage in volts is : ");
disp(PIV,"The peak inverse voltage in volts is : ")
```

Chapter 3

Special Diodes

Scilab code Exa 3.1 LED current

```
// Exa 3.1
format('v',5)
clc;
clear;
close;
// given data
Vin= 12;// in V
V_LED= 2;// in V
Rs= 470;// in
Vs= Vin-V_LED;// in V
// The LED current
I= Vs/Rs;// in A
I= I*10^3;// in mA
disp(I,"The LED current in mA is : ")
```

Scilab code Exa 3.2 LED current

```
// Exa 3.2
```

```
format('v',5)
clc;
clear;
close;
// given data
Vin= 5;// in V
V_LED= 2;// in V
Rs= 470;// in
Vs= Vin-V_LED;// in V
// When supply voltage is 5 V, the LED current
I= Vs/Rs;// in A
I= I*10^3;// in mA
disp(I,"When supply voltage is 5 V, the LED current
   in mA is : ")
Vin= 10;// in V
Vs= Vin-V_LED;// in V
// When supply voltage is 10 V, the LED current
I= Vs/Rs;// in A
I= I*10^3;// in mA
disp(I,"When supply voltage is 10 V, the LED current
    in mA is : ")
Vin= 15;// in V
Vs= Vin-V_LED;// in V
// When supply voltage is 15 V, the LED current
I= Vs/Rs;// in A
I= I*10^3;// in mA
disp(I,"When supply voltage is 15 V, the LED current
    in mA is : ")
Vin= 20;// in V
Vs= Vin-V_LED;// in V
// When supply voltage is 20 V, the LED current
I= Vs/Rs;// in A
I= I*10^3;// in mA
disp(I,"When supply voltage is 20 V, the LED current
    in mA is : ")
```

Scilab code Exa 3.4 Tuning range

```
// Exa 3.4
format('v',5)
clc;
clear;
close;
// given data
C1= 560;//transistor capacitance at 1V in pF
C2= 30;//transistor capacitance at 10V in pF
// The tuning range
tuningRange= C1/C2;
disp(tuningRange,"The tuning range is : ")
```

Scilab code Exa 3.5 Minimum and maximum zener current

```
// Exa 3.5
format('v',5)
clc;
clear;
close;
// given data
Vin_min= 20;// in V
Vin_max= 40;// in V
Vz= 10;// in V
Rs= 820;// in
// The minimum zener current ,
Iz_min= (Vin_min-Vz)/Rs;// in A
// The maximum zener current ,
Iz_max= (Vin_max-Vz)/Rs;// in A
// The output voltage ,
Vout= Vz;// in V
```

```
Iz_min= Iz_min*10^3;// in mA
Iz_max= Iz_max*10^3;// in mA
disp(Iz_min,"The minimum zener current in mA is : ");
disp(Iz_max,"The maximum zener current in mA is : ");
disp(Vout,"The output voltage in V is : ")
```

Scilab code Exa 3.6 Minimum and maximum output voltage

```
// Exa 3.6
format('v',5)
clc;
clear;
close;
// given data
Rs= 820;// in
Rz= 17;// in
R_T= Rs+Rz;// in
Vz= 10;// in V
Vin_min= 20;// in V
Vin_max= 40;// in V
// The minimum zener current
Iz_min= (Vin_min-Vz)/R_T;// in A
// The maximum zener current
Iz_max= (Vin_max-Vz)/R_T;// in A
// The minimum output voltage
Vout_min= Vz+Iz_min*Rz;// in V
// The maximum output voltage
Vout_max= Vz+Iz_max*Rz;// in V
Iz_min= Iz_min*10^3;// in mA
Iz_max= Iz_max*10^3;// in mA
disp(Iz_min,"The minimum zener current in mA is : ")
disp(Iz_max,"The maximum zener current in mA is : ")
disp(Vout_min,"The minimum output voltage in V is :
```

```
")
disp(Vout_max,"The maximum output voltage in V is : ")
```

Scilab code Exa 3.7 Maximum current

```
// Exa 3.7
format('v',5)
clc;
clear;
close;
// given data
P= 100;// power rating in mW
V= 6.2;// in V
// The maximum current rating
I_ZM= P/V;// in mA
disp(I_ZM,"The maximum current rating in mA is : ")
```

Scilab code Exa 3.8 Value of IS IL IZ

```
// Exa 3.8
format('v',5)
clc;
clear;
close;
// given data
Vz= 12;// in V
Vout= Vz;// in V
Vin= 25;// in V
R_S= 180;// in
R_L= 200;// in
// The value of I_S
I_S= (Vin-Vout)/R_S;// in A
```

```
// The value of I_L
I_L= Vout/R_L;// in A
// The value of I_Z
I_Z= I_S-I_L;// in A
I_S= I_S*10^3;// in mA
I_L= I_L*10^3;// in mA
I_Z= I_Z*10^3;// in mA
disp(I_S,"The value of I_S in mA is : ")
disp(I_L,"The value of I_L in mA is : ")
disp(I_Z,"The value of I_Z in mA is : ")
```

Scilab code Exa 3.9 Values of all currents

```
// Exa 3.9
format('v',5)
clc;
clear;
close;
// given data
disp("(i) For 200   load resistance");
R_L= 200;// in
Vz= 12;// in V
Vout= Vz;// in V
Vin= 25;// in V
R_S= 180;// in
// The value of I_S
I_S= (Vin-Vout)/R_S;// in A
// The value of I_L
I_L= Vout/R_L;// in A
// The value of I_Z
I_Z= I_S-I_L;// in A
I_S= I_S*10^3;// in mA
I_L= I_L*10^3;// in mA
I_Z= I_Z*10^3;// in mA
disp(I_S,"The value of I_S in mA is : ")
```

```
disp(I_L,"The value of I_L in mA is : ")
disp(I_Z,"The value of I_Z in mA is : ")
disp("(ii) For 400    load resistance");
R_L= 400;// in
// The value of I_S
I_S= (Vin-Vout)/R_S;// in A
// The value of I_L
I_L= Vout/R_L;// in A
// The value of I_Z
I_Z= I_S-I_L;// in A
I_S= I_S*10^3;// in mA
I_L= I_L*10^3;// in mA
I_Z= I_Z*10^3;// in mA
disp(I_S,"The value of I_S in mA is : ")
disp(I_L,"The value of I_L in mA is : ")
disp(I_Z,"The value of I_Z in mA is : ")
disp("(iii) For 600    load resistance");
R_L= 600;// in
// The value of I_S
I_S= (Vin-Vout)/R_S;// in A
// The value of I_L
I_L= Vout/R_L;// in A
// The value of I_Z
I_Z= I_S-I_L;// in A
I_S= I_S*10^3;// in mA
I_L= I_L*10^3;// in mA
I_Z= I_Z*10^3;// in mA
disp(I_S,"The value of I_S in mA is : ")
disp(I_L,"The value of I_L in mA is : ")
disp(I_Z,"The value of I_Z in mA is : ")
disp("(iv) For 800    load resistance");
R_L= 800;// in
// The value of I_S
I_S= (Vin-Vout)/R_S;// in A
// The value of I_L
I_L= Vout/R_L;// in A
// The value of I_Z
I_Z= I_S-I_L;// in A
```

```
I_S= I_S*10^3;// in mA
I_L= I_L*10^3;// in mA
I_Z= I_Z*10^3;// in mA
disp(I_S,"The value of I_S in mA is : ")
disp(I_L,"The value of I_L in mA is : ")
disp(I_Z,"The value of I_Z in mA is : ")
disp("(v) For 1 k  load resistance");
R_L= 1*10^3;// in
// The value of I_S
I_S= (Vin-Vout)/R_S;// in A
// The value of I_L
I_L= Vout/R_L;// in A
// The value of I_Z
I_Z= I_S-I_L;// in A
I_S= I_S*10^3;// in mA
I_L= I_L*10^3;// in mA
I_Z= I_Z*10^3;// in mA
disp(I_S,"The value of I_S in mA is : ")
disp(I_L,"The value of I_L in mA is : ")
disp(I_Z,"The value of I_Z in mA is : ")
```

Scilab code Exa 3.10 Value of Change in output voltage

```
// Exa 3.10
format('v',7)
clc;
clear;
close;
// given data
R_Z= 7;// in
I_Z1=12.2;// in mA
I_Z2=60.2;// in mA
deltaV_Z=(I_Z2-I_Z1)*R_Z;// in mV
deltaV_Z= deltaV_Z*10^-3;// in V
Vz= 12;// in V
```

```
// The output voltage ,
Vout= Vz+deltaV_Z;// in V
disp(Vout,"The output voltage in V is : ");
```

Scilab code Exa 3.11 Value of IS IL IZ

```
// Exa 3.11
format('v',6)
clc;
clear;
close;
// given data
Vz= 12;// in V
Vin= 15;// in V
R_S= 200;// in
R_L= 1*10^3;// in
// The value of I_S
I_S= (Vin-Vz)/R_S;// in A
// The value of I_L
I_L= Vz/R_L;// in A
// The value of I_Z
I_Z= I_S-I_L;// in A
I_S= I_S*10^3;// in mA
I_L= I_L*10^3;// in mA
I_Z= I_Z*10^3;// in mA
disp(I_S,"The value of I_S in mA is : ")
disp(I_L,"The value of I_L in mA is : ")
disp(I_Z,"The value of I_Z in mA is : ")
```

Scilab code Exa 3.12 Value of IS IL IZ

```
// Exa 3.12
format('v',6)
```

```
clc;
clear;
close;
// given data
disp("(i) For 15 V input voltage");
Vin= 15;// in V
Vz= 12;// in V
R_S= 200;// in
R_L= 1*10^3;// in
// The value of I_S
I_S= (Vin-Vz)/R_S;// in A
// The value of I_L
I_L= Vz/R_L;// in A
// The value of I_Z
I_Z= I_S-I_L;// in A
I_S= I_S*10^3;// in mA
I_L= I_L*10^3;// in mA
I_Z= I_Z*10^3;// in mA
disp(I_S,"The value of I_S in mA is : ")
disp(I_L,"The value of I_L in mA is : ")
disp(I_Z,"The value of I_Z in mA is : ")
disp("(ii) For 20 V input voltage");
Vin= 20;// in V
// The value of I_S
I_S= (Vin-Vz)/R_S;// in A
// The value of I_L
I_L= Vz/R_L;// in A
// The value of I_Z
I_Z= I_S-I_L;// in A
I_S= I_S*10^3;// in mA
I_L= I_L*10^3;// in mA
I_Z= I_Z*10^3;// in mA
disp(I_S,"The value of I_S in mA is : ")
disp(I_L,"The value of I_L in mA is : ")
disp(I_Z,"The value of I_Z in mA is : ")
disp("(iii) For 25 V input voltage");
Vin= 25;// in V
// The value of I_S
```

```
I_S= (Vin-Vz)/R_S;// in A
// The value of I_L
I_L= Vz/R_L;// in A
// The value of I_Z
I_Z= I_S-I_L;// in A
I_S= I_S*10^3;// in mA
I_L= I_L*10^3;// in mA
I_Z= I_Z*10^3;// in mA
disp(I_S,"The value of I_S in mA is : ")
disp(I_L,"The value of I_L in mA is : ")
disp(I_Z,"The value of I_Z in mA is : ")
disp("(iv) For 30 V input voltage");
Vin= 30;// in V
// The value of I_S
I_S= (Vin-Vz)/R_S;// in A
// The value of I_L
I_L= Vz/R_L;// in A
// The value of I_Z
I_Z= I_S-I_L;// in A
I_S= I_S*10^3;// in mA
I_L= I_L*10^3;// in mA
I_Z= I_Z*10^3;// in mA
disp(I_S,"The value of I_S in mA is : ")
disp(I_L,"The value of I_L in mA is : ")
disp(I_Z,"The value of I_Z in mA is : ")
disp("(v) For 35 V input voltage");
Vin= 35;// in V
// The value of I_S
I_S= (Vin-Vz)/R_S;// in A
// The value of I_L
I_L= Vz/R_L;// in A
// The value of I_Z
I_Z= I_S-I_L;// in A
I_S= I_S*10^3;// in mA
I_L= I_L*10^3;// in mA
I_Z= I_Z*10^3;// in mA
disp(I_S,"The value of I_S in mA is : ")
disp(I_L,"The value of I_L in mA is : ")
```

```
disp(I_Z,"The value of I_Z in mA is : ")
```

Chapter 4

Diode Applications

Scilab code Exa 4.1 DC voltage across load resistance

```
// Example 4.1
format('v',5)
clc;
clear;
close;
// given data
V2rms= 40;// in V
R_L= 20;// in
V2peak= V2rms/0.707;// in V
Vout_peak= V2peak;// in V
// The dc voltage across the load resistor
Vdc=0.318*Vout_peak;// in V
//The peak inverse voltage across the diode
PIV= V2peak;// in V
Idc= Vdc/R_L;// in A
// The dc current through the diode
I_diode= Idc;// in A
disp(Vdc,"The dc voltage across the load resistor in
    volts is : ");
disp(PIV,"The peak inverse voltage across the diode
   in volts is : ");
```

```
disp(I_diode,"The dc current through the diode in A
   is : ")
```

Scilab code Exa 4.2 DC current through each diode

```
// Example 4.2
format('v',5)
clc;
clear;
close;
// given data
Vrms= 40;// in V
R_L= 20;// in
V2peak= Vrms/0.707;// in V
Vout_peak= V2peak/2;// in V
// The dc load voltage
Vdc=0.636*Vout_peak;// in V
// The peak inverse voltage across each diode
PIV= V2peak;// in V
Idc= Vdc/R_L;// in A
// The dc current through each diode
I_diode= Idc/2;// in A
disp(Vdc,"The dc load voltage in volts is : ");
disp(PIV,"The peak inverse voltage across each diode
    in volts is : ");
disp(I_diode,"The dc current through each diode in A
    is : ")
```

Scilab code Exa 4.3 Value of Vdc and PIV

```
// Example 4.3
format('v',5)
clc;
```

```
clear;
close;
// given data
Vrms= 40;// in V
R_L= 20;// in
V2peak= Vrms/0.707;// in V
Vout_peak= V2peak;// in V
// The value of Vdc
Vdc=0.636*Vout_peak;// in V
// The value of PIV
PIV= V2peak;// in V
Idc= Vdc/R_L;// in A
//The value of I_diode
I_diode= Idc/2;// in A
disp(Vdc,"The value of Vdc in volts is : ");
disp(PIV,"The value of PIV in volts is : ");
disp(I_diode,"The value of I_diode in A is : ")
```

Scilab code Exa 4.6 DC load voltage

```
// Example 4.6
format('v',5)
clc;
clear;
close;
// given data
Vdc= 56.6;// in V
R_L= 100;// in
f=120;// in Hz
C= 1000;// in  F
C= C*10^-6;// in F
V2peak= Vdc;// in V
Idc= Vdc/R_L;// in A
// The peak-to-peak ripple
Vrip= Idc/(f*C);// in V
```

```
// The dc load voltage
Vdc= V2peak-Vrip/2;// in V
disp(Vrip,"The peak-to-peak ripple in volts is : ");
disp(Vdc,"The dc load voltage in volts is : ")
```

Scilab code Exa 4.8 Zener current

```
// Example 4.8
format('v',5)
clc;
clear;
close;
// given data
V2rms= 12.6;// in V
V_Z= 6.8;// in V
V2peak= V2rms/0.707;// in V
Vin= V2peak;// in V
Vout= V_Z;// in V
R_L= 1.2;// in k
R_L= R_L*10^3;//in
Rs= 1;// in k
Rs= Rs*10^3;// in
Is= (Vin-Vout)/Rs;// in A
I_L= Vout/R_L;// in A
// The zener current
Iz= Is-I_L;// in A
Iz= Iz*10^3;// in mA
disp(Iz,"The zener current in mA is : ")

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

Scilab code Exa 4.9 Ripple across the load current

```
// Example 4.9
format('v',5)
clc;
clear;
close;
// given data
C= 100;//in   F
C= C*10^-6;// in F
Rz= 5;//in
Rs= 1*10^3;//in
Idc= 11*10^-3;//in A
f=120;//in Hz
Vin_rip= Idc/(f*C);// in V
// The ripple across the load resistance
Vout_rip= Rz*Vin_rip/(Rs+Rz);//in A
Vout_rip= Vout_rip*10^3;// in mV
disp(Vout_rip,"The ripple across the load resistance in mV is : ")
```

Chapter 5

Bipolar Transistor

Scilab code Exa 5.1 Value of VCE

```
// Example 5.1
format('v',5)
clc;
clear;
close;
// given data
V_BB= 10;//in V
V_BE= 0.7;//in V
V_CC= 20;// in V
R_B= 1.5;// in M
R_B= R_B*10^6;//in
R_C= 5*10^3;//in
bita= 125;// unit less
I_B= (V_BB-V_BE)/R_B;//in A
I_C= bita*I_B;//in A
// The dc voltage between the collector and emitter
V_CE= V_CC-I_C*R_C;//in V
disp(V_CE,"The dc voltage between the collector and
    emitter in volts is : ")
```

Scilab code Exa 5.2 DC load line

```
// Example 5.2
format('v',6)
clc;
clear;
close;
// given data
V_CC= 30;// in V
R_C= 1.5;//in  k
Ver_intercept= V_CC/R_C;//in mA
Hor_intercept= V_CC;// in V
V_CE= 0:0.1:Hor_intercept;// in V
I_C= (V_CC-V_CE)/R_C;// in mA
// DC load line
plot(V_CE,I_C)
xlabel("V_CE in volts");
ylabel("I_C in mA")
title("DC load line")
```

Scilab code Exa 5.3 Value of IC and VCE

```
// Example 5.3
format('v',4)
clc;
clear;
close;
// given data
V_BE= 0.7;//in V
V_CC= 30;// in V
R_B= 390;// in  k
R_B= R_B*10^3;//in
```

```
R_C= 1.5*10^3;//in
bita= 80;// unit less
I_B= (V_CC-V_BE)/R_B;//in A
// The collector current ,
I_C= bita*I_B;//in A
// The value of V_CE
V_CE= V_CC-I_C*R_C;//in V
I_C= I_C*10^3;// in mA
disp(I_C,"The value of I_C in mA is : ")
disp(V_CE,"The value of V_CE in volts is : ")
```

Scilab code Exa 5.4 LED current

```
// Example 5.4
format('v',6)
clc;
clear;
close;
// given data
V_BE= 0.7;// in V
V_LED= 2;//in V
V_CC= 20;// in V
R_B= 47;// in k
R_B= R_B*10^3;//in
R_C= 1*10^3;//in
bita= 150;// unit less
// The LED current
I_LED= (V_CC-V_LED)/R_C;// in A
I_Csat= I_LED;// in A
I_Bsat= I_Csat/bita;// in A
// The input voltage ,
V_IN= I_Bsat*R_B+V_BE;//in V
I_LED= I_LED*10^3;// in mA
disp(I_LED,"The LED current in mA is : ");
disp(V_IN,"The value of Vin in volts is : ")
```

Scilab code Exa 5.5 DC voltage

```
// Example 5.5
format('v',5)
clc;
clear;
close;
// given data
Vz= 10;// in V
V_BE= 0.7;// in V
V_CC= 30;// in V
R_E= 5;// in k
R_E= R_E*10^3;//in
R_C= 4;// in k
R_C= R_C*10^3;//in
V_E= Vz-V_BE;// in V
I_E= V_E/R_E;// in A
I_C= I_E;// in A
// The collector voltage
V_C= V_CC-I_C*R_C;// in V
disp(V_C,"The collector voltage in volts is : ")
```

Scilab code Exa 5.6 DC collector to ground voltage

```
// Example 5.6
format('v',6)
clc;
clear;
close;
// given data
V_BE= 0.7;// in V
```

```
R2= 1*10^3;//in
R1= 3.9*10^3;//in
R_E= 100;// in
R_C= 150;// in  k
V_CC= 25;// in V
Vz= R2*V_CC/(R1+R2);// in V
V_E= Vz-V_BE;// in V
I_E= V_E/R_E;// in A
I_C= I_E;// in A
// The collector voltage
V_C= V_CC-I_C*R_C;// in V
disp(V_C,"The collector voltage in volts is : ")
```

Scilab code Exa 5.7 Value of Vc

```
// Example 5.7
format('v',5)
clc;
clear;
close;
// given data
R_E= 2*10^3;// in
R_C= 1*10^3;// in  k
V_E= 4.3;//in V
V_CC= 15;// in V
I_E= V_E/R_E;// in A
I_C= I_E;//in A
// In the first stage the collector voltage
V_C= V_CC-I_C*R_C;// in A
disp(V_C,"In the first stage the collector voltage
   in volts is : ");
// Second stage
V_E= 2.3;// in V
R_E= 220;// in
R_C= 470;// in
```

```
I_E= V_E/R_E;// in A
I_C= I_E;//in A
// In the second stage the collector voltage
V_C= V_CC-I_C*R_C;// in A
disp(V_C,"In the second stage the collector voltage in volts is : ");

// Note : In the book, the calculated value of collector voltage in first stage is not accurate.
```

Scilab code Exa 5.8 Minimum and maximum collector current

```
// Example 5.8
format('v',6)
clc;
clear;
close;
// given data
V_BE= 0.7;//in V
V_CC= 30;// in V
R_B= 3*10^6;// in
bitamin= 100;// unit less
bitamax= 300;// unit less
I_B= (V_CC-V_BE)/R_B;// in A
// The minimum value of collector current
I_Cmin= bitamin*I_B;// in A
// The maximum value of collector current
I_Cmax= bitamax*I_B;// in A
I_Cmin= I_Cmin*10^3;// in mA
I_Cmax= I_Cmax*10^3;// in mA
disp(I_Cmin,"The minimum value of collector current in mA is : ");
disp(I_Cmax,"The maximum value of collector current in mA is : ");
```

Scilab code Exa 5.9 IC and VCE

```
// Example 5.9
format('v',5)
clc;
clear;
close;
// given data
V_BE= 0.7;//in V
V_CC= 15;// in V
R_E= 100;// in
R_C= 910;// in
R_B= 430*10^3;// in
bita= 300;// unit less
// The collector current,
I_C= (V_CC-V_BE)/(R_E+R_B/bita);// in A
I_C= I_C*10^3;// in mA
disp(I_C,"The value of I_C in mA is : ");
I_C= I_C*10^-3;// in A
// The collector to emitter voltage,
V_CE= V_CC-I_C*(R_C+R_E);// in V
disp(V_CE,"The value of V_CE in volts is : ")
```

Scilab code Exa 5.10 IC and VCE

```
// Example 5.10
format('v',6)
clc;
clear;
close;
// given data
V_BE= 0.7;//in V
```

```
V_CC= 15;// in V
R_C= 1*10^3;// in
R_B= 200*10^3;// in
bita= 300;// unit less
// The collector current,
I_C= (V_CC-V_BE)/(R_C+R_B/bita);// in A
I_C=I_C*10^3;// in mA
disp(I_C,"The value of I_C in mA is : ");
I_C=I_C*10^-3;// in A
// The collector to emitter voltage,
V_CE= V_CC-I_C*R_C;// in V
disp(V_CE,"The value of V_CE in volts is : ")
```

Scilab code Exa 5.11 IC and VCE

```
// Example 5.11
format('v',5)
clc;
clear;
close;
// given data
V_BE= 0.7;//in V
V_CC= 15;// in V
V_EE= 15;// in V
R_E= 10*10^3;// in
R_C= 5.1*10^3;// in
I_E= (V_EE-V_BE)/R_E;// in A
// The collector current,
I_C= I_E;// in A
V_C= V_CC-I_C*R_C;// in A
V_E= -V_BE;// in V
V_CE= V_C-V_E;// in V
// The collector to emitter voltage,
V_CE= V_CC+V_EE-I_C*(R_C+R_E)
I_C= I_C*10^3;// in mA
```

```
disp(I_C,"The value of I_C in mA is : ");
disp(V_CE,"The value of V_CE in volts is : ")
```

Scilab code Exa 5.12 DC voltage

```
// Example 5.12
format('v',5)
clc;
clear;
close;
// given data
V_BE= 0.7;//in V
V_CC= 30;// in V
Vz= 6;// in V
R_E= 3*10^3;// in
R_C= 4*10^3;// in
I_E= (Vz-V_BE)/R_E;// in A
I_C= I_E;// in A
// For first stage the collector voltage to ground
V_C= V_CC-I_C*R_C;// in v
disp(V_C,"For first stage the collector voltage to
    ground in volts is : ")
Vz= 10;// in V
R_E= 2*10^3;//in
R_C= 3*10^3;// in
I_E= (Vz-V_BE)/R_E;// in A
I_C= I_E;// in A
// For second stage the collector voltage to ground
V_C= I_C*R_C;// in v
disp(V_C,"For second stage the collector voltage to
    ground in volts is : ")
```

Chapter 6

Common Emitter Approximations

Scilab code Exa 6.2 Total voltage

```
// Example 6.2
format('v',4)
clc;
clear;
close;
// given data
R1= 10;// in
R2= 10010;// in
V1= 10;// in V
// The total voltage across the 10    resistance
V= R1/R2*V1;// in V
V= V*10^3;// in mV
disp(V,"The total voltage across the 10 resistance in mV is :");
```

Scilab code Exa 6.3 Total current

```
// Example 6.3
format('v',6)
clc;
clear;
close;
// given data
R= 10*10^3;// in
V_CC= 15;// in V
V_BE= 0.7;// in V
Vt= 25*10^-3;// in V
Vp= 1*10^-3;// in V
I= (V_CC-V_BE)/R;// in A
r_ac= Vt/I;// in
// The total current through diode
Ip= Vp/r_ac;// in A
Ip= Ip*10^6;// in  A
disp(Ip,"The total current through diode in  A is :")
```

Scilab code Exa 6.4 Input impedence

```
// Example 6.4
format('v',5)
clc;
clear;
close;
// given data
R1= 47*10^3;// in
R2= 15*10^3;// in
R_E= 8.2*10^3;// in
R_C= 10*10^3;// in
R3= 3.3*10^3;// in
bita= 200;
V_CC= 30;// in V
V_BE= 0.7;// in V
```

```
Vin= 5*10^-3;//in V
Vt= 25*10^-3;// in V
V2= R2*V_CC/(R1+R2);// in V
// DC voltage across emitter
V_E= V2-V_BE;// in V
// Emitter current
I_E= V_E/R_E;// in A
r_desh_e= Vt/I_E;// in
r_L= R_C*R3/(R_C+R3);//in
A= r_L/r_desh_e;
// The output voltage
Vout= A*Vin;// in V
Zin_base= bita*r_desh_e;// in
// The input impedance of amplifier
Zin= R1*R2*Zin_base/(R2*Zin_base+R1*Zin_base+R1*R2);// in
Vout= Vout*10^3;// in mV
Zin= Zin*10^-3;// in k ohm
disp(Vout,"The output voltage in mV is : ")
disp(Zin,"The input impedance of amplifier in k  is : ")
```

Scilab code Exa 6.5 Value of VB

```
// Example 6.5
format('v',5)
clc;
clear;
close;
// given data
R1= 10*10^3;// in
R2= 2.2*10^3;// in
R_C= 3.6*10^3;// in
V_CC= 10;// in V
I_C= 1.1*10^-3;// in A
```

```
// The base voltage
V_B= R2*V_CC/(R1+R2);// in V
// The collector voltage
V_C= V_CC-I_C*R_C;// in V
disp(V_B,"The base voltage in V is : ")
disp(V_C,"The collector voltage in V is : ")
```

Scilab code Exa 6.6 Ac output voltage

```
// Example 6.6
format('v',6)
clc;
clear;
close;
// given data
V2= 1.1;// in V
Vin= 1*10^-3;// in V
Vt= 25*10^-3;// in V
R2= 1*10^3;// in
R_C= 3.6*10^3;// in
I_E= V2/R2;// in A
// Emitter diode ac resistance
r_desh_e= Vt/I_E;// in
A= R_C/r_desh_e;
// The output voltage
Vout= A*Vin;// in V
Vout= Vout*10^3;// in mV
disp(Vout,"The output voltage in mV is : ")
```

Scilab code Exa 6.7 Minimum and maximum voltage gain

```
// Example 6.7
format('v',5)
```

```
clc;
clear;
close;
// given data
R_C= 10*10^3;// in
R_L= 82*10^3;// in
r_E= 1*10^3;// in
r_desh_e_min= 50;// in
r_desh_e_max= 100;// in
r_L= R_C*R_L/(R_C+R_L);// in
// The minimum voltage gain
A_min= r_L/r_desh_e_max;
// The maximum voltage gain
A_max= r_L/r_desh_e_min;
disp(A_min,"The minimum voltage gain is : ")
disp(A_max,"The maximum voltage gain is : ")
```

Scilab code Exa 6.8 Input impedance of the amplifier

```
// Example 6.8
format('v',5)
clc;
clear;
close;
// given data
bita= 200;
R1= 47*10^3;// in
R2= 15*10^3;// in
r_E=  1*10^3;// in
r_desh_e= 50;// in
Zin_base= bita*(r_E+r_desh_e);// in
// The input impedance of the amplifier
Zin= R1*R2*Zin_base/(R1*R2+R1*Zin_base+R2*Zin_base);
    // in
Zin= Zin*10^-3;// in k ohm
```

```
disp(Zin,"The input impedance of the amplifier in
    k   is : ")
```

Scilab code Exa 6.9 Input impedance of each stage

```
// Example 6.9
format('v',5)
clc;
clear;
close;
// given data
bita= 150;
R1= 10*10^3;// in
R2= 2.2*10^3;// in
R_E= 1*10^3;// in
V_CC= 10;// in V
V_BE= 0.7;// in V
Vt= 25*10^-3;// in V
V_B= R2*V_CC/(R1+R2);// in V
V_E= V_B-V_BE;// in V
// The emitter current ,
I_E= V_E/R_E;// in A
r_desh_e= Vt/I_E;// in
Zin_base= bita*r_desh_e;// in
// The input impedance of each stage
Zin= R1*R2*Zin_base/(R1*R2+R1*Zin_base+R2*Zin_base);
    // in
Zin= Zin*10^-3;// in k ohm
disp(Zin,"The input impedance of each stage in  k
    is : ")
```

Scilab code Exa 6.10 Ac output voltage across the final load resistor

```
// Example 6.10
format('v',5)
clc;
clear;
close;
// given data
bita= 150;
R1= 10*10^3;// in
R2= 2.2*10^3;// in
R_E= 1*10^3;// in
Rs= 1*10^3;// in
R_C= 3.6*10^3;// in
R_L= 1.5*10^3;// in
V_CC= 10;// in V
V_BE= 0.7;// in V
Vt= 25*10^-3;// in V
Vin= 1*10^-3;// in V
V_B= R2*V_CC/(R1+R2);// in V
V_E= V_B-V_BE;// in V
I_E= V_E/R_E;// in A
r_desh_e= Vt/I_E;// in
Zin_base= bita*r_desh_e;// in
Zin= R1*R2*Zin_base/(R1*R2+R1*Zin_base+R2*Zin_base);// in
Vb1= Zin*Vin/(Rs+Zin);// in V
r_L= R_C*Zin/(R_C+Zin);// in
V_B= R2*V_CC/(R1+R2);// in V
V_E= V_B-V_BE;// in V
I_E= V_E/R_E;// in A
r_desh_e= Vt/I_E;// in
A1= r_L/r_desh_e;
Vb2= A1*Vb1;// in V
r_L= R_C*R_L/(R_C+R_L);// in
A2= r_L/r_desh_e;
// The ac output voltage across the final load resistor
Vout= A2*Vb2;// in V
A= A1*A2;
```

```
Vout= A*Vb1;// in V
disp(Vout,"The ac output voltage across the final
   load resistor in volts is : ")
```

Scilab code Exa 6.11 Ac voltage at the final output

```
// Example 6.11
format('v',6)
clc;
clear;
close;
// given data
bita= 150;
R1= 10*10^3;// in
R2= 2.2*10^3;// in
R_C= 3.6*10^3;// in
Rs= 1*10^3;// in
R_L= 1.5*10^3;// in
r_E= 180;// in
R_E= 1*10^3;// in
V_CC= 10;// in V
V_BE= 0.7;// in V
Vt= 25*10^-3;// in V
Vin= 1*10^-3;// in V
V_B= R2*V_CC/(R1+R2);// in V
V_E= V_B-V_BE;// in V
I_E= V_E/R_E;// in A
r_desh_e= Vt/I_E;// in
Zin_base= bita*(r_desh_e+r_E);// in
Zin= R1*R2*Zin_base/(R1*R2+R1*Zin_base+R2*Zin_base);
   // in
r_L= R_C*Zin/(R_C+Zin);// in
A1= r_L/(r_E+r_desh_e);
r_L= R_C*R_L/(R_C+R_L);// in
A2= r_L/(r_desh_e+r_E);
```

```
A= A1*A2;
Vb1= Zin*Vin/(Rs+Zin);// in V
// The ac voltage at the final output
Vout= A*Vb1;// in V
Vout= Vout*10^3;// in mV
disp(Vout,"The ac voltage at the final output in mV
   is : ")
```

Chapter 7

Common Collector Approximations

Scilab code Exa 7.1 DC load line and Q point

```
// Example 7.1
format('v',6)
clc;
clear;
close;
// given data
V_CC= 10;// in V
R_E= 430;// in
V_BE= 0.7;//in V
V_B= 5;//in V
// The collector saturation current,
I_Csat= V_CC/R_E;// in A
// The collector emitter voltage,
V_CEcutoff= V_CC;// in V
// The collector current,
I_C= (V_B-V_BE)/R_E;// in A
// The collector emitter voltage,
V_CE= V_CC-(V_B-V_BE);// in V
I_C= I_C*10^3;// in mA
```

```
disp("Q-point is : "+string(V_CE)+" V, "+string(I_C)
    +" mA");
disp("DC load line shown in figure")
I_C= I_C*10^-3;// in A
V_CE= 0:0.1:V_CEcutoff;// in V
I_C= (V_CC-V_CE)/R_E*10^3;// in mA
// The plot of DC load line
plot(V_CE,I_C);
xlabel("V_CE in volts");
ylabel("I_C in mA");
title("DC load line")
```

Scilab code Exa 7.2 AC output voltage

```
// Example 7.2
format('v',5)
clc;
clear;
close;
// given data
Vin= 100;// in mV
Vin= Vin*10^-3;// in V
R_E= 430;// in
R_L= 1*10^3;// in
r_e= 2.5;// in
// The ac load resistance ,
r_L= R_E*R_L/(R_E+R_L);// in
A= r_L/(r_L+r_e);// unit less
// The output voltage
Vout= A*Vin;// in V
Vout= Vout*10^3;// in mV
disp(Vout,"The output voltage in mV is : ")
```

Scilab code Exa 7.3 Voltage gain

```
// Example 7.3
format('v',5)
clc;
clear;
close;
// given data
R_E= 430;// in
R_L= 100;// in
R1= 10*10^3;// in
R2= 10*10^3;// in
bita= 200;// unit less
r_e= 2.5;// in
r_L= R_E*R_L/(R_E+R_L);// in
// The voltge gain
A= r_L/(r_L+r_e);
disp(A,"The voltge gain is : ")
Zin_base= bita*(r_L+r_e);// in
// The input impedence
Zin= R1*R2*Zin_base/(R1*R2+R2*Zin_base+Zin_base*R1);// in
Zin= Zin*10^-3;// in k ohm
disp(Zin,"The input impedence in k  is : ")
```

Scilab code Exa 7.4 Power gain

```
// Example 7.4
format('v',6)
clc;
clear;
close;
// given data
R_E= 430;// in
R_L= 100;// in
```

```
R1= 10*10^3;// in
R2= 10*10^3;// in
bita= 200;
r_e= 2.5;// in
// The load resistance
r_L= R_E*R_L/(R_E+R_L);// in
// The power gain
G= bita*r_L/(r_L+r_e);
disp(G,"The power gain is : ")
```

Scilab code Exa 7.5 AC output voltage

```
// Example 7.5
format('v',5)
clc;
clear;
close;
// given data
R_C= 5*10^3;// in
r_e= 25;// in
Vin= 1*10^-3;// in V
R_L= 1*10^3;// in
A= R_C/r_e;
// Thevenin voltage ,
V_TH= A*Vin;// in V
// The ac output voltage
Vout= R_L*V_TH/(R_C+R_L);// in V
Vout= Vout*10^3;// in mV
disp(Vout,"The ac output voltage in mV is : ")
```

Scilab code Exa 7.7 AC output voltage

```
// Example 7.7
```

```
format('v',5)
clc;
clear;
close;
// given data
V_B= 1.8;// in V
V_E= 1.1;// in V
V_TH= 200*10^-3;// in V
I_E= 1*10^-3;// in A
r_e= 2.5;//in
bita=200;
V_CC= 10;// in V
R_C= 5*10^3;// in
R_E= 430;// in
R_L= 1*10^3;//in
I_C= I_E;// in A
// The collector voltage,
V_C= V_CC-I_C*R_C;// in V
V_E= 4.3;// in V
// The emitter current,
I_E= V_E/R_E;// in A
// The base current,
I_B= I_E/bita;// in A
// The load resistance,
r_L= R_E*R_L/(R_E+R_L);// in
Zin= bita*(r_L+r_e);// in
Vin= Zin*V_TH/(R_C+Zin);// in V
// The ac output voltage
Vout= r_L*Vin/(r_L+r_e);//in V
Vout= Vout*10^3;// in mV
disp(Vout,"The ac output voltage in mV is : ")
```

Scilab code Exa 7.9 re1 and re2

```
// Example 7.9
```

```
format('v',6)
clc;
clear;
close;
// given data
R1= 100;//in  k
R2= 100;//in  k
R3= 360;//in
bita= 100;
V1= 5;// in V
v1= 1.4;// in V
v2= 25;// in mV
// Voltage at first base
V2= R1/R2*V1;// in V
// Emitter current in second transistor
I_E2= (V2-v1)/R3;// in A
I_E2= I_E2*10^3;// in mA
// Resistance of second emitter diode,
r_desh_e2= v2/I_E2;// in
// Base current
I_B2= I_E2/bita;// in mA
// Emitter current,
I_E1= I_B2;// in mA
// First emitter diode resistance
r_desh_e1= v2/I_E1;// in
disp(r_desh_e2,"The value of r''e2 in    is : ")
disp(r_desh_e1,"The value of r''e1 in    is : ")
```

Scilab code Exa 7.10 Input impedance

```
// Example 7.10
format('v',5)
clc;
clear;
close;
```

```
// given data
R_E= 360;// in
R_L= 1*10^3;// in
R1= 100*10^3;//in
R2= 100*10^3;//in
r_desh_e1= 250;// in
r_desh_e2= 2.5;// in
h_FE= 100;
h_fe= 100;
// The load resistance ,
r_L= R_E*R_L/(R_E+R_L);// in
Zin1= h_FE*h_fe*r_L;// in
Zin= R1*R2*Zin1/(R1*R2+R2*Zin1+Zin1*R1);// in
Zin2= h_FE*(r_L+r_desh_e2);// in
Zin1= h_FE*(Zin2+r_desh_e1);// in
// The input impedence
Zin= R1*R2*Zin1/(R1*R2+R2*Zin1+Zin1*R1);// in
Zin= Zin*10^-3;// in k ohm
disp(Zin,"The input impedence in k   is : ")
```

Scilab code Exa 7.11 Zener current

```
// Example 7.11
format('v',5)
clc;
clear;
close;
// given data
Vin= 20;// in V
Vz= 10;// in V
Rs= 680;// in
V_BE= 0.7;// in V
R_L= 15;// in
bita= 80;
Is= (Vin-Vz)/Rs;// in A
```

```
Vout= Vz-V_BE;// in V
I_E= Vout/R_L;// in A
I_L= I_E;// in A
I_B= I_E/bita;// in A
// The current through the zener diode
Iz= Is-I_B;// in A
V_CE= Vin-Vout;// in V
// The transistor power dissipation
Po= I_L*(Vin-Vout);// in W
Iz= Iz*10^3;// in mA
disp(Iz,"The current through the zener diode in mA
    is : ");
disp(Po,"The transistor power dissipation in watt is
    : ")
```

Chapter 8

Common Base Approximations

Scilab code Exa 8.1 Value of VCB

```
// Example 8.1
format('v',6)
clc;
clear;
close;
// given data
V_EE= 10;// in V
V_BE= 0.7;// in V
R_E= 20*10^3;// in
V_CC= 25;// in V
R_C= 10*10^3;// in
// The emitter current
I_E= (V_EE-V_BE)/R_E;// in A
I_C= I_E;// in A
// The collector to base voltage,
V_CB= V_CC-I_C*R_C;// in V
disp(V_CB,"The value of V_CB in volts is : ")
```

Scilab code Exa 8.2 Value of VCB

```
// Example 8.2
format('v',5)
clc;
clear;
close;
// given data
V_EE= 12;// in V
V_BE= 0.7;// in V
R_E= 5.6*10^3;// in
V_CC= 15;// in V
R_C= 6.8*10^3;// in
// The emitter current,
I_E= (V_EE-V_BE)/R_E;// in A
I_C= I_E;// in A
// The collector to base voltage
V_CB= V_CC-I_C*R_C;// in V
disp(V_CB,"The value of V_CB in volts is : ")

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

Scilab code Exa 8.3 Output voltage

```
// Example 8.3
format('v',6)
clc;
clear;
close;
// given data
V_EE= 15;// in V
V_BE= 0.7;// in V
R_E= 22*10^3;// in
Vin= 2*10^-3;// in V
V= 25*10^-3;// in V
R1= 10*10^3;// in
R2= 30*10^3;// in
```

```
I_E= (V_EE-V_BE)/R_E;// in A
// The ac resistance of emitter diode,
r_desh_e= V/I_E;// in
r_L= R1*R2/(R1+R2);// in
// The voltage gain
A= r_L/r_desh_e;
// The output voltage
Vout= A*Vin;// in V
Vout= Vout*10^3;// in mV
disp(Vout,"The output voltage in mV is : ")
```

Scilab code Exa 8.4 Output voltage

```
// Example 8.4
format('v',5)
clc;
clear;
close;
// given data
V_EE= 10;// in V
V_BE= 0.7;// in V
R_E= 6.8*10^3;// in
Rs= 100;// in
R1= 3.3*10^3;// in
R2= 1.5*10^3;// in
V= 25*10^-3;// in V
Vs= 1*10^-3;// in V
I_E= (V_EE-V_BE)/R_E;// in A
r_desh_e= V/I_E;// in
Zin= r_desh_e;// in
// The input voltage to the emitter,
Vin= Zin*Vs/(Rs+Zin);// in V
r_L= R1*R2/(R1+R2);// in
// The voltage gain,
A= r_L/r_desh_e;
```

```
// The output voltage
Vout= A*Vin;// in V
Vout= Vout*10^3;// in mV
disp(Vout,"The output voltage in mV is : ")
```

Chapter 9

Class A Power Amplifiers

Scilab code Exa 9.1 DC and AC load line

```
// Example 9.1
format('v',6)
clc;
clear;
close;
// given data
V_CC= 10;// in V
V_BE= 0.7;// in V
R1= 2.2;// in k
R2= 10;// in k
R_E= 1;// in k
R_C= 3.6;// in k
R= 1.5;// in k
// The base voltage
V_B= R1*V_CC/(R1+R2);// in V
// The emitter current ,
I_E= (V_B-V_BE)/R_E;// in mA
// The collector current ,
I_CQ= I_E;// in mA
// The collector emitter voltage ,
V_CE= V_CC-I_E*(R_C+R_E);// in V
```

```
V_CEQ= V_CE;// in V
// The saturation current ,
I_Csat= V_CC/(R_C+R_E);// in mA
V_CEcutoff= V_CC;// in V
V_CE= 0:0.1:V_CEcutoff;// in V
I_C= (V_CC-V_CE)/(R_C+R_E);// in mA
// The dc and ac load line
subplot(121)
plot(V_CE,I_C)
xlabel("V_CE in volts")
ylabel("I_C in mA");
title("DC load line")
r_L= R_C*R/(R_C+R);// in k
I_Csat= I_CQ+V_CEQ/r_L;// in mA
Vce_cutoff= V_CEQ+I_CQ*r_L;// in V
x=[0 Vce_cutoff];
y=[I_Csat 0]
subplot(122)
plot(x,y)
xlabel("V_CE in volts")
ylabel("I_C in mA");
title("AC load line")
disp("DC and AC load line shown in figure.")
```

Scilab code Exa 9.2 Cut off value of VCE

```
// Example 9.2
format('v',5)
clc;
clear;
close;
// given data
V_BE= 0.7;// in V
V_CC= 30;// in V
R_E= 8.2;// in
```

```
R1= 22;// in
R2= 47;// in
R_C= 10;// in
R_L= 30;//in
// The base to ground voltage ,
V_B= R1*V_CC/(R1+R2);// in V
// The emitter current ,
I_E= (V_B-V_BE)/R_E;// in A
// The collector current ,
I_CQ= I_E;// in A
// The collector emitter voltage ,
V_CEQ= V_CC-I_E*(R_E+R_C);// in V
// The load resistance ,
r_L= R_C*R_L/(R_C+R_L);// in
I_Csat= I_E+V_CEQ/r_L;// in A
Vce_cutoff= V_CEQ+I_CQ*r_L;// in V
disp(Vce_cutoff,"The cut off value of V_CE in volts
    is : ")
```

Scilab code Exa 9.3 cutt of value of VCE

```
// Example 9.3
format('v',6)
clc;
clear;
close;
// given data
V_BE= 0.7;// in V
V_CC= 20;// in V
V_B= 10;// in V
R_E= 50;// in
// The collector current ,
I_CQ= (V_B-V_BE)/R_E;// in A
// The collector emitter voltage ,
V_CEQ= V_CC-I_CQ*R_E;// in V
```

```
R1= 50;// in
R2= 50;// in
// The load resistance ,
r_L= R1*R2/(R1+R2);// in
I_Csat= I_CQ+V_CEQ/r_L;// in A
Vce_cutoff= V_CEQ+I_CQ*r_L;// in V
disp(Vce_cutoff,"The cut off value of V_CE in volts is : ")
```

Scilab code Exa 9.4 AC compliance

```
// Example 9.4
format('v',5)
clc;
clear;
close;
// given data
V_E= 1;// in V
R_E=1*10^3;// in
V_CC= 10;// in V
R_C= 4*10^3;// in
R_L= 10*10^3;// in
// The collector current ,
I_CQ= V_E/R_E;// in A
I_C= I_CQ;// in A
// The collector emitter voltage ,
V_CEQ= V_CC-I_C*(R_C+R_E);// in V
// The load resistance ,
r_L= R_L*R_C/(R_L+R_C);// in
//The ac compliance ,
PP= 2*I_CQ*r_L;// in V
disp(PP,"The ac compliance in volts is : ")
```

Scilab code Exa 9.5 Value of ICQrL

```
// Example 9.5
format('v',5)
clc;
clear;
close;
// given data
V_E= 1;// in V
R_E=1*10^3;// in
R_C= 4*10^3;// in
V_CC= 10;// in V
I_CQ= V_E/R_E;// in A
I_C= I_CQ;// in A
V_CEQ= V_CC-I_C*(R_C+R_E);// in V
// (i) when R_L = 1 M , the value of 2I_CQrL
R_L= 1*10^6;// in
r_L= R_L*R_C/(R_L+R_C);// in
I_CQrL= I_CQ*r_L;//in A
disp(2*I_CQrL,"When R_L = 1 M , the value of 2 I_CQrL in volts is : ")
// (ii) when R_L = 100 k , the value of 2I_CQrL
R_L= 100*10^3;// in
r_L= R_L*R_C/(R_L+R_C);// in
I_CQrL= I_CQ*r_L;//in A
disp(2*I_CQrL,"When R_L = 100 k , the value of 2 I_CQrL in volts is : ")
// (iii) when R_L = 10 k , the value of 2I_CQrL
R_L= 10*10^3;// in
r_L= R_L*R_C/(R_L+R_C);// in
I_CQrL= I_CQ*r_L;//in A
disp(2*I_CQrL,"When R_L = 10 k , the value of 2 I_CQrL in volts is : ")
// (iv) when R_L = 1 k , the value of 2I_CQrL
R_L= 1*10^3;// in
r_L= R_L*R_C/(R_L+R_C);// in
I_CQrL= I_CQ*r_L;//in A
disp(2*I_CQrL,"When R_L = 1 k , the value of 2
```

```
    I_CQrL in volts is : ")
// (v) when R_L = 100    , the value of 2I_CQrL
R_L= 100;// in
r_L= R_L*R_C/(R_L+R_C);// in
I_CQrL= I_CQ*r_L;//in A
disp(2*I_CQrL,"When R_L = 100    , the value of 2
    I_CQrL in volts is : ")
```

Scilab code Exa 9.6 Voltage divider biased stage

```
// Example 9.6
format('v',6)
clc;
clear;
close;
// given data
V_CC= 12;// in V
V_BE= 0.7;// in V
I_CQ= 5*10^-3;// in A
bita= 200;// unit less
// The emitter voltage,
V_E= 0.1*V_CC;// in V
// The emitter current,
I_E= I_CQ;// in A
// The emitter resistance,
R_E= V_E/I_E;// in
// The collector resistance,
R_C= 4*R_E;// in
// The base voltage,
V_B= V_E+V_BE;// in V
I_C= I_CQ;// in A
I_B= I_C/bita;// in A
R= V_CC/(10*I_B);// in
R2= V_B/(10*I_B);// in
R1= R-R2;// in
```

```
R1= R1*10^-3;// in k ohm
R2= R2*10^-3;// in k ohm
R_C= R_C*10^-3;// in k ohm
disp("The value of R1 is     : "+string(R1)+"  k    (
    standard value : 39  k  )")
disp("The value of R2 is     : "+string(R2)+"  k    (
    standard value : 7.5  k  )")
disp("The value of R_E is    : "+string(R_E)+"      (
    standard value : 240    )")
disp("The value of R_C is    : "+string(R_C)+"  k    (
    standard value : 1  k  )")
```

Scilab code Exa 9.7 AC compliance

```
// Example 9.7
format('v',6)
clc;
clear;
close;
// given data
I_CQ= 5*10^-3;// in A
R_C= 1*10^3;// in
R_L= 1*10^3;// in
// The load resistance
r_L= R_C*R_L/(R_C+R_L);// in
// The ac compliance ,
PP= 2*I_CQ*r_L;// in V
I_CQ= 5.15*10^-3;// in A
PP= 2*I_CQ*r_L;// in V
disp(PP,"The ac compliance in volts is : ")
```

Scilab code Exa 9.9 New value of AC compliance

```
// Example 9.9
format('v',6)
clc;
clear;
close;
// given data
V_CC= 12;// in V
V_BE= 0.7;// in V
R_C= 1*10^3;// in
R_E= 240;// in
r_L= 500;// in
bita= 200;// unit less
// The required collector current,
I_CQ= V_CC/(R_C+R_E+r_L);// in A
// The emitter voltage,
V_E= I_CQ*R_E;// in V
// The base voltage,
V_B= V_E+V_BE;// in V
I_C= I_CQ;// in A
I_B= I_C/bita;// in A
// The total resistance of the voltage divider,
R= V_CC/(10*I_B);// in
R2= V_B/(10*I_B);// in
R1= R-R2;// in
R1= R1*10^-3;// in k ohm
R2= R2*10^-3;// in k ohm
R_C= R_C*10^-3;// in k ohm
disp("The value of R1 is    : "+string(R1)+" k    (standard value : 27 k )")
disp("The value of R2 is    : "+string(R2)+" k    (standard value : 6.8 k )")
disp("The value of R_E is   : "+string(R_E)+"     (standard value : 240   )")
disp("The value of R_C is   : "+string(R_C)+" k    (standard value : 1 k )")
```

Scilab code Exa 9.10 Maximum ac load power

```
// Example 9.10
format('v',6)
clc;
clear;
close;
// given data
R_C= 3.6;// in  k
R_L= 1.5;// in  k
V_CEQ= 4.94;// in V
I_CQ= 1.1;// in mA
// The quiescent power dissipation of the transistor
   ,
P_DQ= V_CEQ*I_CQ;// in mW
r_L= R_C*R_L/(R_C+R_L);// in  k
PP= 2*I_CQ*r_L;// in V
// The maximum ac load power,
P_Lmax= PP^2/(8*R_L);// in mW
disp(P_Lmax,"The maximum ac load power in mW is : ")
```

Scilab code Exa 9.11 Efficiency

```
// Example 9.11
format('v',6)
clc;
clear;
close;
// given data
V_E= 1.71;// in V
R_E= 240;// in
V_CC= 12;// in V
```

```
R_C= 1*10^3;// in
R_L= 1*10^3;// in
I= 0.355*10^-3;// in A
I_CQ= V_E/R_E;// in A
I_C= I_CQ;// in A
// The collector emitter voltage,
V_CEQ= V_CC-I_C*(R_C+R_E);// in V
r_L= R_C*R_L/(R_C+R_L);// in
PP= 2*V_CEQ;// in V
// The maximum ac load power,
P_Lmax= PP^2/(8*R_L);// in W
I_CC= I_C+I;// in A
P_CC= V_CC*I_CC;// in W
// The efficiency
Eta= P_Lmax/P_CC*100;// in %
disp(Eta,"The efficiency in % is : ")
```

Scilab code Exa 9.12 Power rating

```
// Example 9.12
format('v',6)
clc;
clear;
close;
// given data
Ta= 70;// ambient temperature in  C
P= 30;// in power dissipation in W
theta_CS= 0.5;// in  C/W
theta_SA= 1.5;// in  C/W
// The case temperature
Tc= Ta+P*(theta_CS+theta_SA);// in  C
// The power rating
P_Dmax= 60;// in W
disp(Tc,"The case temperature in  C is : ");
disp(P_Dmax,"The power rating in watt is : ")
```

Chapter 10

Other Power Amplifiers

Scilab code Exa 10.1 PDQ PDmax and PLmax

```
// Example 10.1
format('v',6)
clc;
clear;
close;
// given data
V_CEQ= 7.5;// in V
R_L= 50;// in
I_Csat= V_CEQ/R_L;// in A
I_CQ= 0.01*I_Csat;// in A
P_DQ= V_CEQ*I_CQ;// in W
PP= 2*V_CEQ;// in V
P_Dmax= PP^2/(40*R_L);// in W
P_Lmax= PP^2/(8*R_L);// in W
// The value of P_DQ
P_DQ= P_DQ*10^3;// in mW
// The value of P_Dmax
P_Dmax= P_Dmax*10^3;// in mW
// The value of P_Lmax
P_Lmax= P_Lmax*10^3;// in mW
disp(P_DQ,"The value of P_DQ in mW is : ")
```

```
disp(P_Dmax,"The value of P_Dmax in mW is : ")
disp(P_Lmax,"The value of P_Lmax in mW is : ")
```

Scilab code Exa 10.2 Efficiency of the amplifier with a maximum output signal

```
// Example 10.2
format('v',6)
clc;
clear;
close;
// given data
V_CC= 15;// in V
I_Csat= 150;// in mA
P_Lmax= 563;// in mW
I= 0.02*I_Csat;// in mA
Idc= 0.318*I_Csat;// in mA
I_CC= I+Idc;// in mA
P_CC= V_CC*I_CC;// in mW
// The efficiency of amplifier
Eta= P_Lmax/P_CC*100;// in %
disp(Eta,"The efficiency of amplifier in % is : ");

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

Scilab code Exa 10.3 DC and AC load line

```
// Example 10.3
format('v',6)
clc;
clear;
close;
// given data
```

```
V_CC= 40;// in V
V_CEQ= 20;// in V
R_L= 10;// in
I_Csat= V_CEQ/R_L;// in A
V_CEcutoff= V_CEQ;// in V
V_CE= 0:0.1:V_CEcutoff;// in V
I_C= (V_CEQ-V_CE)/R_L;// in A
// The plot of ac load line,
plot(V_CE,I_C)
xlabel("V_CE in volts")
ylabel("I_C in A")
title("AC load line")
disp("AC load line shown in figure")
```

Scilab code Exa 10.4 PDQ PDmax and PLmax

```
// Example 10.4
format('v',6)
clc;
clear;
close;
// given data
V_CC= 40;// in V
V_BE= 0.7;// in V
R= 1*10^3;// in
R_L= 10;// in
V_CEQ= 20;// in V
I_CQ= (V_CC-2*V_BE)/(2*R);// in A
// The value of P_DQ
P_DQ= V_CEQ*I_CQ;// in W
disp(P_DQ,"The value of P_DQ in W is : ")
PP= 2*V_CEQ;// in V
// The value of P_Lmax
P_Lmax= PP^2/(8*R_L);// in W
// The value of P_Dmax
```

```
P_Dmax= PP^2/(40*R_L);// in W
disp(P_Lmax,"The value of P_Lmax in W is : ")
disp(P_Dmax,"The value of P_Dmax in W is : ")
```

Scilab code Exa 10.5 Voltage gain of the driver stage

```
// Example 10.5
format('v',6)
clc;
clear;
close;
// given data
V_E= 1.43;// in V
R_E= 100;// in
R_L= 100;// in
R_C= 1*10^3;// in
bita= 200;
Vt= 25*10^-3;// in V
I_E= V_E/R_E;// in A
I_CQ= I_E;// in A
Zin= bita*R_L;// in
r_desh_e= Vt/I_CQ;// in
// The voltage gain of the driver stage
A= (R_C*Zin/(R_C+Zin))/(R_E+r_desh_e);
disp(A,"The voltage gain of the driver stage is : ")
// On ignoring Zin and r_desh_e ,
A= R_C/R_E;
disp(A,"On ignoring the value of Zin and r''e, the
   voltage gain is : ")
```

Scilab code Exa 10.6 Ideal value of PP and PLmax

```
// Example 10.6
```

```
format('v',6)
clc;
clear;
close;
// given data
V_CC= 30;// in V
PP= V_CC;// in V
R_L= 100;// in
// The value of P_Lmax
P_Lmax= PP^2/(8*R_L);// in W
disp(PP,"The value of PP in volts is : ")
disp(P_Lmax,"The value of P_Lmax in W is : ")
```

Scilab code Exa 10.7 Overall voltage gain

```
// Example 10.7
format('v',6)
clc;
clear;
close;
// given data
R_C= 1*10^3;// in
r_desh_e= 2.5;//in
Zin= 1*10^3;// in
A2= 10;// unit less
A3= 1;// unit less
A1= (R_C*Zin/(R_C+Zin))/r_desh_e;// unit less
// The overall voltage gain
A= A1*A2*A3;
disp(A,"The overall voltage gain is : ")
```

Scilab code Exa 10.8 Minimum base current that produces saturation

```
// Example 10.8
format('v',5)
clc;
clear;
close;
// given data
V_CC= 50;// in V
V_CEsat= 1;// in V
R_L= 5;// in
bita_dc= 90;// unit less
I_Csat= (V_CC-V_CEsat)/R_L;// in A
// The minimum base current that produces saturation
I_Bsat= I_Csat/bita_dc;// in A
I_Bsat= I_Bsat*10^3;// in mA
disp(I_Bsat,"The minimum base current that produces saturation in mA is : ")
```

Scilab code Exa 10.9 Input voltage required

```
// Example 10.9
format('v',5)
clc;
clear;
close;
// given data
I_Csat= 109*10^-3;// in A
bita_dc= 200;
R_B= 1*10^3;// in
V_BE1= 0.7;// in V
V_BE2= 1.6;// in V
// The base current ,
I_Bsat= I_Csat/bita_dc;// in A
// The input voltage
Vin= I_Bsat*R_B+V_BE1+V_BE2;// in V
disp(Vin,"The input voltage in volts is : ")
```

Chapter 11

More Amplifier Theory

Scilab code Exa 11.1 Closed loop voltage gain

```
// Example 11.1
format('v',5)
clc;
clear;
close;
// given data
r_F= 220;// in
r_E= 4.7;//in
// The closed loop voltage gain
A_CL= r_F/r_E+1;
disp(A_CL,"The closed loop voltage gain is : ")
```

Scilab code Exa 11.2 Alpha bita rdeshe and rdeshc

```
// Example 11.2
format('v',6)
clc;
clear;
```

```
close;
// given data
h_ie= 3.5*10^3;//in
h_fe= 120;
h_re= 1.3*10^-4;
h_oe= 8.5*10^-6;// in S
bita= h_fe;// unit less
// The value of alpha
alpha= h_fe/(h_fe+1);
disp(alpha,"The value of alpha is : ")
// The value of r'e
r_desh_e= h_ie/h_fe;// in
r_desh_c= h_fe/h_oe;// in
disp(r_desh_e,"The value of r''e in    is : ")
// The value of r'c
r_desh_c= r_desh_c*10^-6;// in Mohm
disp(r_desh_c,"The value of r''c in M   is : ")
```

Scilab code Exa 11.3 Value of rdeshb

```
// Example 11.3
format('v',6)
clc;
clear;
close;
// given data
h_rb= 1.75*10^-4;
h_ob= 10^-6;// in S
r_desh_b= h_rb/h_ob;// in
disp(r_desh_b,"The value of r''b in    is : ")
```

Scilab code Exa 11.4 Voltage gain

```
// Example 11.4
format('v',5)
clc;
clear;
close;
// given data
h_fe= 120;// unit less
h_ie= 3.5*10^3;//in
r_L= 2*10^3;// in
h_oe= 8.5*10^-6;// in S
h_re= 1.3*10^-4;// unit less
// The voltage gain
A= h_fe*r_L/(h_ie*(1+h_oe*r_L)-h_re*h_fe*r_L)
disp(A,"The voltage gain is : ")
```

Chapter 12

JFETS

Scilab code Exa 12.1 Source voltage to ground

```
// Example 12.1
format('v',5)
clc;
clear;
close;
// given data
R1= 20;// in k
R2= 10;// in k
R_E= 10;// in k
R_D= 8.2;// in k
V_G= 10;// in V
V_BE= 0.7;// in V
V_GS= -2;// in V
V_DD= 30;// in V
V_B= R2*V_DD/(R1+R2);// in V
I_E= (V_B-V_BE)/R_E;// in mA
I_D= I_E;// in mA
// The dc voltage from the drain to ground
V_D= V_DD-I_D*R_D;// in V
// The source voltage to ground
Vs= V_G-V_GS;// in V
```

```
disp(V_D,"The dc voltage from the drain to ground in
    volts is : ");
disp(Vs,"The source voltage to ground in volts is :
   ")
```

Scilab code Exa 12.2 Transconductance

```
// Example 12.2
format('v',6)
clc;
clear;
close;
// given data
gmo= 3000;// in  mhoS
V_GSoff= -4;// in V
I_DSS= 10;// in mA
disp("Part (i) When V_GS= −1");
V_GS= -1;// in V
// The value of gm
gm= gmo*(1-V_GS/V_GSoff);// in  S
disp(gm,"The value of gm in  S is : ")
disp("Part (ii) When I_D= 2.5 mA")
I_D= 2.5;// in mA
// The value of gm
gm= gmo*2*I_D/I_DSS;// in  S
disp(gm,"The value of gm in  S is : ")
```

Scilab code Exa 12.3 Output voltage

```
// Example 12.3
format('v',6)
clc;
clear;
```

```
close;
// given data
gm= 2000;// in   S
gm=gm*10^-6;// in S
R_D= 4.7;// in  k
Vin= 2;// in mV
R_L= 10;// in  k
r_D= R_D*R_L/(R_D+R_L);// in  k
r_D= r_D*10^3;// in
A= gm*r_D;// unit less
// The output voltage
Vout= A*Vin;// in mV
disp(Vout,"The output voltage in mV is : ")

// Note: The calculated value of A in the book is
   wrong. Correct value of A is : 6.39, So the
   answer in the book is wrong.
```

Scilab code Exa 12.4 Voltage gain

```
// Example 12.4
format('v',6)
clc;
clear;
close;
// given data
R_D= 7.5;// in  k
R_L= 3;// in  k
r_s= R_D*R_L/(R_D+R_L);// in  k
r_s= r_s*10^3;// in
gm= 2500*10^-6;// in S
// The voltage gain
A= gm*r_s/(1+gm*r_s);// unit less
disp(A,"The voltage gain is : ")
```

Chapter 14

Thyristors

Scilab code Exa 14.1 Load current

```
// Example 14.1
format('v',6)
clc;
clear;
close;
// given data
V1=15;// in V
V2=1;// in V
R= 100;// in
// The load current
I= (V1-V2)/R;// in A
I= I*10^3;// in mA
disp(I,"The load current in mA is : ")
```

Scilab code Exa 14.2 Input voltage

```
// Example 14.2
format('v',6)
```

```
clc;
clear;
close;
// given data
I= 4;// in mA
I=I*10^-3;// in A
V1=0.5;// voltage across diode in V
R=100;// in
// The input voltage
V= V1+I*R;// in V
disp(V,"The input voltage in volts is : ")
```

Scilab code Exa 14.6 Ideal emitter current

```
// Example 14.6
format('v',6)
clc;
clear;
close;
// given data
Eta= 0.85;
V= 10;// in V
V1= Eta*V;// in V
V= 20;// in V
R= 400;// in
// The emitter current
I_E= V/R;// in A
I_E= I_E*10^3;// in mA
disp(I_E,"The emitter current in mA is : ")
```

Scilab code Exa 14.7 Value of emitter supply voltage

```
// Example 14.7
```

```
format('v',6)
clc;
clear;
close;
// given data
V_E= 1;// in V
R= 400;// in
I= 7*10^-3;// in A
// The emitter supply voltage
V= V_E+I*R;// in V
disp(V,"The emitter supply voltage in volts is : ")
```

Chapter 16

Op Amp Negative Feedback

Scilab code Exa 16.1 Output voltage and error voltage

```
// Example 16.1
format('v',5)
clc;
clear;
close;
// given data
A=100000;//unit less
R1= 98*10^3;// in
R2= 2*10^3;// in
Vin= 1*10^-3;// in V
B= R2/(R1+R2);// unit less
A_CL= 1/B;// unit less
A_CL= A/(1+A*B);// unit less
// The output voltage
Vout= Vin*A_CL;// in V
// The error voltage
Verror= Vout/A;// in V
Vout= Vout*10^3;// in mV
Verror= Verror*10^6;// in  V
disp(Vout,"The output voltage in mV is : ")
disp(Verror,"The error voltage in  V is : ")
```

Scilab code Exa 16.2 ACL Vout and Verror

```
// Example 16.2
format('v',6)
clc;
clear;
close;
// given data
A=20000;
B= 0.02;
Vin= 1;// in mV
Vin= Vin*10^-3;// in V
// The closed loop voltage gain,
A_CL= A/(1+A*B);
// The output voltage,
Vout= Vin*A_CL;// in V
// The error voltage,
Verror= Vout/A;// in V
Vout= Vout*10^3;// in mV
Verror= Verror*10^6;// in  V
disp(A_CL,"The value of A_CL is : ");
disp(Vout,"The value of Vout in mV is : ")
disp(Verror,"The value of Verror in  V is : ")
```

Scilab code Exa 16.3 Closed loop input and output impedence

```
// Example 16.3
format('v',6)
clc;
clear;
close;
```

```
// given data
A=100000;
R1= 100*10^3;// in
R2= 100;// in
r_in= 2*10^6;// in
r_out= 75;// in
B= R2/(R1+R2);// unit less
// The closed loop input impedence
r_in_CL= (1+A*B)*r_in;// in
// The closed loop output impedence
r_out_CL= r_out/(1+A*B);// in
r_in_CL=r_in_CL*10^-6;// in Mohm
disp(r_in_CL,"The closed loop input impedence in M
    is : ")
disp(r_out_CL,"The closed loop output  impedence in
      is : ")
```

Scilab code Exa 16.4 Closed loop voltage gain

```
// Example 16.4
format('v',6)
clc;
clear;
close;
// given data
A=100;
R_B= 39*10^3;// in
r_in= 2*10^6;// in
r_out= 75;// in
Vin_off= 2*10^-3;// in V
I_B1= 90*10^-9;// in A
I_in_off= 20*10^-9;// in A
// The closed loop voltage gain
B=1;// unit less
// The closed-loop input impedance
```

```
r_in_CL= (1+A*B)*r_in;// in
r_in_CL= r_in_CL*10^-6;// in Mohm
disp(B,"The closed loop voltage gain is : ")
disp(r_in_CL,"The closed-loop input impedance in M
    is : ")
A=100000;
// The closed-loop output impedance
r_out_CL= r_out/A;// in
disp(r_out_CL,"The closed-loop output impedance in
    is : ")
//Let V= V1-V2 = Vin_off+I_B1*R_B
V= Vin_off+I_B1*R_B;// in A
// The output offset voltage
Voo_CL= A*V/A;// in V
Voo_CL= Voo_CL*10^3;// in mV
disp(Voo_CL,"The output offset voltage in mV is : ")
```

Scilab code Exa 16.5 Closed loop voltage gain

```
// Example 16.5
format('v',6)
clc;
clear;
close;
// given data
R_F= 22*10^3;// in
R_S= 1*10^3;// in
A= 100000;// unit less
// The closed-loop voltage gain
A_CL= R_F/R_S;
// The desensitivity
desensitivity= A/A_CL;
disp(A_CL,"The closed-loop voltage gain is : ")
disp(desensitivity,"The desensitivity is : ")
```

Scilab code Exa 16.6 Value of FCL

```
// Example 16.6
format('v',6)
clc;
clear;
close;
// given data
f_unity= 1*10^6;// in Hz
// For A_CL= 1000, The value of f_CL
A_CL= 1000;
f_CL= f_unity/A_CL;// in Hz
f_CL= f_CL*10^-3;// in kHz
disp(f_CL,"For A_CL= 1000, The value of f_CL in kHz
    is : ")
// For A_CL= 100, The value of f_CL
A_CL= 100;
f_CL= f_unity/A_CL;// in Hz
f_CL= f_CL*10^-3;// in kHz
disp(f_CL,"For A_CL= 100, The value of f_CL in kHz
    is : ")
// For A_CL= 10, The value of f_CL
A_CL= 10;
f_CL= f_unity/A_CL;// in Hz
f_CL= f_CL*10^-3;// in kHz
disp(f_CL,"For A_CL= 10, The value of f_CL in kHz is
    : ")
// For A_CL= 1, The value of f_CL
A_CL= 1;
f_CL= f_unity/A_CL;// in Hz
f_CL= f_CL*10^-6;// in MHz
disp(f_CL,"For A_CL= 1, The value of f_CL in MHz is
    : ")
```