Scilab Textbook Companion for
Basic Electrical and Electronics Engineering-i
by S. K. Bhattacharya and Debashis De[1]

Created by
Mohd Arif
B.Tech
Electronics Engineering
Uttarakhand Technical University
College Teacher
None
Cross-Checked by
Spandana

July 31, 2019

Book Description

Title: Basic Electrical and Electronics Engineering-i

Author: S. K. Bhattacharya and Debashis De

Publisher: Dorling Kindersley, India

Edition: 1

Year: 2011

ISBN: 978-81-317-5604-1

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

7

8

Chapter 1

DC Networks and Network Theorems

Scilab code Exa 1.1 Convert Voltage source

```
1  //Example 1_1
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  Vs=20;//V
8  Rse=5;//ohm(Internal Resistance)
9  //Source Conversion
10 Is=Vs/Rse;//A
11 Rsh=Rse;//ohm(same)
12 disp(Is,"Equivalent current source(A)");
13 disp(Rsh,"Internal resistance in parallel(ohm)")
```

Scilab code Exa 1.2 Conversion of a Voltage source

```scilab
1  //Example 1_2
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  Is=100;//A
8  Rsh=10;//ohm
9  //Source Conversion
10 Vs=Is*Rsh;//V
11 disp(Vs,"Equivalent voltage source(V)");
12 Rse=Rsh;//ohm
13 disp(Rse,"Internal resistance in series(ohm)");
```

Scilab code Exa 1.3 Calculate the current

```scilab
1  //Example 1_3
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  Vs=12;//V
8  Req=2+4*(2+2)/(4+(2+2));//ohm
9  I=Vs/Req;//A
10 I1=I;//A(Current in first 2 ohm resistance)
11 disp(I1,"Current in first 2 ohm resistance(A)");
12 I2=I/2;//A(Current in 4 ohm resistance)
13 disp(I2,"Current in 4 ohm resistance(A)");
14 I3=I/2;//A(Current in remaining 2 ohm resistances)
15 disp(I3,"Current in remaining 2 ohm resistances(A)")
       ;
```

Scilab code Exa 1.4 `Calculate the current`

```
1  //Example 1_4
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  Vs=6;//V
8  //Point A & C, B & D are shorted
9  RAB=(4*4/(4+4));//ohm
10 RDC=(4*4/(4+4));//ohm
11 Req=RAB*RDC/(RAB+RDC);//ohm
12 Is=Vs/Req;//A
13 disp(Is,"Current supplied by the battery(A)");
```

Scilab code Exa 1.5 `Calculate the current`

```
1  //Example 1_5
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  //Point B & C are shorted
8  RAB=(4*4/(4+4));//ohm
9  RBD=(4*4/(4+4));//ohm
10 Req=RAB+RBD;//ohm
11 disp(Req,"Equivalent Resistance(ohm)");
```

Scilab code Exa 1.6 `Calculate the branch current`

```
1  //Example 1_6
```

```scilab
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  format('v',6);
8  I=2;//A
9  //3*I1+8*I2=6 from loop ABCA
10 //7*I1-5*I2=0 from loop ADCA
11 A=[3 8;7 -5];//coefiicient matrix
12 B=[6;0];//coefiicient matrix
13 X=A^-1*B;//Matrix multiplication
14 I1=X(1);//A
15 I2=X(2);//A
16 I3=I-I1-I2;//A
17 disp(I3,"Current in branch AB & BC(A)");
18 disp(I1,"Current in branch AD & DC(A)");
19 disp(I2,"Current in branch AC(A)");
```

Scilab code Exa 1.7 Calculate the current

```scilab
1  //Example 1_7
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  //11*I2+8*I3=4 from loop GDAG
8  //8*I2+11*I3=6 from loop HDAH
9  A=[11 8;8 11];//coefiicient matrix
10 B=[4;6];//coefiicient matrix
11 X=A^-1*B;//Matrix multiplication
12 I2=X(1);//A
13 I3=X(2);//A
14 I8=I2+I3;//A
```

```
15  disp(I8,"Current in 8 ohm resistor(A)");
```

Scilab code Exa 1.8 `Calculate the current`

```
1  //Example 1_8
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  //6*I1-3*I2=2 from mesh 1
8  //-6*I1+14*I2=4 from mesh 2
9  A=[6 -3;-6 14];//coefiicient matrix
10 B=[2;4];//coefiicient matrix
11 X=A^-1*B;//Matrix multiplication
12 I1=X(1);//A
13 I2=X(2);//A
14 disp(I1,"Current in 2ohm & 4ohm resistor(A)");
15 disp(I2,"Current in 3ohm & 5ohm resistor(A)");
16 I6ohm=I1-I2;//A(Current in 6ohm resistor)
17 disp(I6ohm,"Current in 6ohm resistor(A)");
```

Scilab code Exa 1.9 `Determine unknown voltage`

```
1  //Example 1_9
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  //9*I1-2*I2-3*I3=24-V from mesh 1
8  //I1-6*I2+3*I3=0 from mesh 2
9  //3*I1+6*I2-11*I3=-V from mesh 3
```

```
10  d=[9 -2 -3;1 -6 3;3 6 -11];
11  delta=det(d);//determinant
12  //d1=[24-V -2 -3;0 -6 3;-V 6 -11];
13  //delta1=det(d1);determinant
14  //Putting I1=delta1/delta=0
15  V=(24*(66-18))/((66-18)+(-6-18));//V
16  disp(V,"Unknown Voltage(V)");
```

Scilab code Exa 1.10 `Voltage at nodes`

```
 1  //Example 1_10
 2  clc;
 3  clear;
 4  close;
 5  format('v',5);
 6  //given data :
 7  VD=10;//V
 8  VE=6;//V
 9  R1=3;R2=4;R3=14;R4=8;R5=12;//ohm
10  //Ohm's current law
11  //I1=(VD-VB)/R1;I2=VB/R4;I3=(VK-VC)/R2;//A
12  //Where VK=VB-3;//V
13  //KCL at Node B  : 17*VB-6*VC=98
14  //KCL at Node C  : 21*VB-34*VC=27
15  A=[17 -6;21 -34];//Coefficient Matrix
16  B=[98;27];//Coefficient Matrix
17  X=A^-1*B;//solution
18  VB=X(1);//V
19  VC=X(2);//V
20  I2=VB/R4;//A
21  disp(I2,"Current through the 8 ohm resistor(A) : ");
```

Scilab code Exa 1.11 `Value of current`

15

```
1  //Example 1_11
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  VA=24;//V
8  VC=12;//V
9  R1=6;R2=6;R3=6;//ohm
10 //Considering VA only, making VC short circuit
11 I=VA/(R1+R2*R3/(R2+R3));//A//from source VA
12 I1A=I*R2/(R1+R2);//A//through BD from VA only
13 //Considering VC only, making VA short circuit
14 I=VC/(R3+R1*R2/(R1+R2));//A//from source VC
15 I1C=I*R2/(R1+R2);//A//through BD from VA only
16 IBD=I1A+I1C;//A
17 disp(IBD,"Current IBD in the Circuit(A) : ");
```

Scilab code Exa 1.12 Calculate the current

```
1  //Example 1_12
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  VA=75;//V
8  VB=64;//V
9  R1=5;R2=5;R3=4;R4=20;R5=12;//ohm
10 //Considering VA only, making VB short circuit
11 I=VA/(R1+(R3*R5/(R3+R5)+R2)*R4/(R4+R3*R5/(R3+R5)+R2)
       );//A//from source VA
12 I1A=I*R4/(R4+R2+R3*R5/(R3+R5));//A//through AB from
       VA only
13 //Considering VB only, making VA short circuit
```

```
14  I=VB/(R3+(R1*R4/(R1+R4)+R2)*R5/(R5+R1*R4/(R1+R4)+R2)
       );//A//from  source  VB
15  I1B=I*R5/(R5+(R1*R4/(R1+R4)+R2));//A//through  AB
       from  VB  only
16  IAB=I1A-I1B;//A//total  current  through  R2=5  ohm
17  disp(IAB,"Current  I  in  the  Circuit  is  equal  to  IAB(A
       )  :  ");
```

Scilab code Exa 1.13 Calculate the current

```
1  //Example  1_13
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given  data  :
7  V=20;//V
8  I=2;//V
9  R1=2;R2=4;R3=8;//ohm
10  //Considering  current  source  only ,  making  Voltage
        source  short  circuit
11  I1=I*R1/(R1+R3);//A//through  B  to  A
12  //Considering  Voltage  source  only ,  making  current
        source  open  circuit
13  I2=V/(R1+R3);//A//through  A  to  B
14  IAB=I2-I1;//A//total  current  through  R2=5  ohm
15  disp(IAB,"Current  through  8ohm  resistor(A)  :  ");
```

Scilab code Exa 1.14 Calculate the current

```
1  //Example  1_14
2  clc;
3  clear;
```

```
4  close;
5  format('v',5);
6  //given data :
7  V1=40;//V
8  V2=44;//V
9  R1=2;//ohm
10 R2=4;//ohm
11 R3=6;//ohm
12 I1=poly(0,'I1');
13 I2=poly(0,'I2');
14 //From Mesh ABEFA//eq1=V1-R1*I1+R2*I2-V2;
15 //-R1*I1+R2*I2=V2-V1;//eqn(1)
16 //From Mesh BCDED//eq2=-R2*I2-R3*(I1+I2)+V2;
17 //R3*I1+(R2+R3)*I2=V2;//eqn(2)
18 A=[-R1 R2;R3 (R2+R3)];//coefficient matrix
19 B=[V2-V1;V2];//coefficient matrix
20 X=A^-1*B;//
21 I1=X(1);//A
22 disp(I1,"Current I1(A)");
23 I2=X(2);//A
24 disp(I2,"Current I2(A)");
25 I=I1+I2;//A
26 disp(I,"Total Current I(A)");
```

Scilab code Exa 1.15 Calculate the current

```
1  //Example 1_15
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  V=2;//V
8  R1=1;//ohm
9  R2=2;//ohm
```

18

```
10  R3 =3; //ohm
11  R4 =2; //ohm
12  R5 =4; //ohm
13  //Mesh ABDA: −I1−R5∗I3+R4∗I2=0
14  //Mesh BCDB: −R2∗(I1−I3)+R3∗(I2+I3)+R5∗I3=0
15  //Mesh ABCA: −I1−R2∗(I1−I3)+V=0
16  A=[-R1 R4 -R5;-R2 R3 R3+R2+R5;-R3 0 R2]; //
        coefficient matrix
17  B=[0;0;-V]; //coefficient matrix
18  X=A^-1*B; //
19  I3=X(3); //A
20  disp(I3,"Current through galvanometer, I3(A)");
```

Scilab code Exa 1.16 Determine Current Is

```
 1  //Example 1_16
 2  clc;
 3  clear;
 4  close;
 5  format('v',5);
 6  //given data :
 7  R1 =4; //ohm
 8  R2 =6; //ohm
 9  R3 =8; //ohm
10  //I1=I2+IS//eqn(1)
11  //I2+I3=V1/4//eqn(2)
12  Vo =16; //V
13  //VAC+VAB=Vo : V1+R1∗I2=Vo///eqn(3)
14  //I1=V1/R2;//eqn(4)
15  I3=Vo/R3; //A
16  //V1/4−I2=I3//eqn(5)
17  //solving eqn(3) & eqn(5)
18  A=[1 R1;1/4 -1];
19  B=[Vo;I3];
20  X=A^-1*B;
```

```
21  V1=X(1);//V
22  I2=X(2);//A
23  I1=V1/6;//A
24  Is=I1-I2;//A
25  disp(Is,"Current Is(A)");
```

Scilab code Exa 1.17 Determine Load Current

```
1   //Example 1_17
2   clc;
3   clear;
4   close;
5   format('v',5);
6   //given data :
7   V1=12;//V
8   V2=10;//V
9   R1=2;//ohm
10  R2=1;//ohm
11  R3=10;//ohm
12  //Node A : I1=(V1-VA)/2
13  //Node B : I2=(V2-VB)/2
14  //IL=VB/R3;//A
15  //IL=I1+I2
16  VA=10;VB=10//V
17  I1=(V1-VA)/2;//A//from Node A
18  I2=(V2-VB)/2;//A//from Node B
19  IL=VB/R3;//A
20  disp(I1,"Current by Battery A, IA(A)");
21  disp(I2,"Current by Battery B, IA(A)");
22  disp(IL,"Load Current(A)");
```

Scilab code Exa 1.18 Voltage at nodes

```
1  //Example 1_18
2  clc;
3  clear;
4  close;
5  format('v',8);
6  //given data :
7  V1=10;//V
8  V2=3;//V
9  V3=6;//V
10 R1=3;//ohm
11 R2=4;//ohm
12 R3=14;//ohm
13 R4=8;//ohm
14 R5=12;//ohm
15 //Node B : (V1-VB)/R1=VB/R4+(VB-VC-V2)/R2
16 //VB(1/R4+1/R1+1/R2)+VC*(-1/R2)=V2/R2+V1/R1//eq(1)
17 A1=[(1/R4+1/R1+1/R2) (-1/R2)];//Coefficient Matrix
18 B1=[V2/R2+V1/R1];//Coefficient Matrix
19 //Node C: VC/R5=(VB-VC-V2)/R2+(V3-VC)/R3
20 //VB*(-1/R2)+VC(1/R2+1/R5+1/R3)=V3/R3-V2/R2//eq(2)
21 A2=[(-1/R2) (1/R2+1/R5+1/R3)];////Coefficient Matrix
22 B2=[V3/R3-V2/R2];////Coefficient Matrix
23 A=[A1;A2];B=[B1;B2];//Coefficient Matrix
24 X=A^-1*B;//solution of matrix
25 VB=X(1);//V
26 VC=X(2);//V
27 I2=VB/R4;//A
28 disp(I2,"Current through 8 ohm resistor(A)");
```

Scilab code Exa 1.19 Calculate the current

```
1  //Example 1_19
2  clc;
3  clear;
4  close;
```

21

```
 5  format ( 'v' ,5) ;
 6  // given data :
 7  E1 =2.05; //V
 8  E2 =2.15; //V
 9  V3 =6; //V
10  R1 =0.05; //ohm
11  R2 =0.04; //ohm
12  R3 =1; //ohm
13  // Considering E1 only , Make E2 short circuit
14  I1=E1/(R1+R2*R3/(R2+R3)); //A
15  disp (I1 ," Current supplied by battery1 (A)") ;
16  I1dash=I1*R2/(R2+R3); //A
17  format ( 'v' ,6) ;
18  // Considering E2 only , Make E1 short circuit
19  I2=E2/(R2+R1*R3/(R1+R3)); //A
20  disp (I2 ," Current supplied by battery2 (A)") ;
21  I2dash=I2*R1/(R1+R3); //A
22  I=I1dash+I2dash; //A
23  disp (I ," Current through 1ohm resistance , Load
        current (A)") ;
```

Scilab code Exa 1.20 `Determine Current`

```
 1  // Example 1_20
 2  clc ;
 3  clear ;
 4  close ;
 5  format ( 'v' ,5) ;
 6  // given data :
 7  V=20; //V
 8  I =2; //A
 9  V3 =6; //V
10  R1 =2; //ohm
11  R2 =4; //ohm
12  R3 =8; //ohm
```

```
13  //Considering current source only, Make Voltage
        source short circuit
14  I1dash=I*R1/(R1+R3);//A
15  //Considering Voltage source only, Make Current
        source opent circuit
16  I1dash2=V/(R1+R3);//A
17  I=I1dash2-I1dash;//A
18  disp(I,"Current through 8 ohm resistor from A to B(A
        )");
```

Scilab code Exa 1.21 Range of current

```
1   //Example 1_21
2   clc;
3   clear;
4   close;
5   format('v',5);
6   //given data :
7   V1=90;//V
8   V2=50;//V
9   V3=100;//V
10  R1=60;//ohm
11  R2=40;//ohm
12  R3=30;//ohm
13  R4=60;//ohm
14  R=6:36;//ohm
15  //Open circuit AB
16  I1=V1/(R1+R3);//A
17  I2=V3/(R2+R4);//A
18  //Potential of point A
19  VA=I1*R3+V2;//V
20  //Potential of point B
21  VB=I2*R4;//V
22  VOC=VA-VB;//V
23  Req=R1*R3/(R1+R3)+R2*R4/(R2+R4);//ohm
```

```
24  Imin=VOC/(Req+max(R));//A
25  Imax=VOC/(Req+min(R));//A
26  disp("The  current  through  resistor  R  will  vary  from
         "+string(Imin)+" A to "+string(Imax)+" A.");
```

Scilab code Exa 1.22 Calculate the current

```
 1  //Example 1_22
 2  clc;
 3  clear;
 4  close;
 5  format('v',6);
 6  //given data :
 7  V1=24;//V
 8  V2=12;//V
 9  R1=4;//ohm
10  R2=5;//ohm
11  R3=3;//ohm
12  R4=5;//ohm
13  R5=3;//ohm
14  RL=10;//ohm
15  //Open circuit AB
16  I=V1/(R1+R2+R3);//A
17  //Potential of point A
18  VBQ=0;//V//there is no current
19  VPS=0;//V//there is no current
20  VQP=I*(R2+R3);//V
21  VSA=V2;//V
22  //Potential of point A with respect to B
23  VAB=VBQ+VQP+VPS-VSA;//V
24  VOC=VAB;//V
25  Req=R1*(R2+R3)/(R1+R2+R3)+R4+R5;//ohm
26  //Thevenin equivalent current
27  I=VOC/(Req+RL);//A
28  disp(I,"Current flowing through load resistance(A)")
```

```
    ;
```

Scilab code Exa 1.23 Calculate the current

```
 1  //Example 1_23
 2  clc;
 3  clear;
 4  close;
 5  format('v',6);
 6  //given data :
 7  V1=12; //V
 8  I=2; //A
 9  R1=2; //ohm
10  R2=4; //ohm
11  R3=3; //ohm
12  R4=3; //ohm
13  R5=5; //ohm
14  //Converting current source into Voltage source
15  V2=I*R3; //V//Converted source
16  //writing KVL equation for the loop
17  I1=poly(0,'I1');
18  eqn=-R1*I1+V1-R2*I1-R3*I1-V2; //KVL equation
19  I1=roots(eqn); //A
20  VSR=V2+R3*I1; //V
21  VRA=0; //V//there is no current
22  //Potential of point A with respect to B
23  VAB=VSR+VRA; //V
24  VOC=VAB; //V
25  Req=(R1+R2)*R3/(R1+R2+R3)+R4; //ohm
26  //Thevenin equivalent current
27  I=VOC/(Req+R5); //A
28  disp(I,"Current flowing through 5 ohm Resistance(A)"
       );
```

Scilab code Exa 1.24 `Determine Current`

```scilab
1  //Example 1_24
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  V1=6;//V
8  V2=15;//V
9  R1=6;//ohm
10 R2=3;//ohm
11 R3=4;//ohm
12 R4=6;//ohm
13 //writing KVL equation for the loop
14 I=poly(0,'I');
15 eqn=V2-R2*I-R1*I-V1;//KVL equation
16 I=roots(eqn);//A
17 VCD=V2-R2*I;//V
18 //Potential of point A with respect to B
19 VAB=VCD;//V
20 VOC=VAB;//V
21 Req=R1*R2/(R1+R2)+R3;//ohm
22 //Thevenin equivalent current
23 I=VOC/(Req+R4);//A
24 disp(I,"Current flowing through terminal AB(A)");
```

Scilab code Exa 1.25 `Calculate the current`

```scilab
1  //Example 1_25
2  clc;
3  clear;
```

```
 4  close;
 5  format('v',6);
 6  //given data :
 7  V1=2; //V
 8  R1=10; //ohm
 9  R2=20; //ohm
10  R3=40; //ohm
11  R4=30; //ohm
12  R5=15; //ohm
13  //solution
14  VBC=R4/(R4+R1)*V1; //V
15  VDC=R5/(R2+R5)*V1; //V
16  VBD=VBC-VDC; //V
17  Vth=VBD; //V
18  Req=R1*R4/(R1+R4)+R2*R5/(R2+R5); //ohm
19  //Thevenin equivalent current
20  IL=Vth/(Req+R3); //A
21  IL=IL*1000; //mA
22  disp(IL,"Current through BD, from B to D(mA)");
```

Scilab code Exa 1.26 Calculate the branch current

```
 1  //Example 1_26
 2  clc;
 3  clear;
 4  close;
 5  format('v',5);
 6  //given data :
 7  E1=140; //V
 8  R1=30; //ohm
 9  R2=70; //ohm
10  E2=85; //V
11  RL=[5 15 50]; //ohm
12  //solution
13  //writing KVL equation for the loop
```

```
14  I=poly(0,'I');
15  eqn=E1-R1*I-R2*I-E2;//KVL equation
16  I=roots(eqn);//A
17  Vth=E1-I*R1;//V
18  Req=R1*R2/(R1+R2);//ohm
19  //Thevenin equivalent current
20  IL1=Vth/(Req+RL(1));//A//for RL=5 ohm
21  IL2=Vth/(Req+RL(2));//A//for RL=15 ohm
22  IL3=Vth/(Req+RL(3));//A//for RL=50 ohm
23  disp(IL1,"RL=5 ohm, branch current I2(A)");
24  disp(IL2,"RL=15 ohm, branch current I2(A)");
25  disp(IL3,"RL=50 ohm, branch current I2(A)");
```

Scilab code Exa 1.27 Calculate the current

```
1  //Example 1_27
2  clc;
3  clear;
4  close;
5  format('v',4);
6  //given data :
7  V1=20;//V
8  V2=4;//V
9  R1=500;//ohm
10  R2=1000;//ohm
11  R3=100;//ohm
12  R4=800;//ohm
13  RL=1000;//ohm
14  //solution
15  VCB=-R2/(R4+R2)*V1;//V
16  //writing KVL equation for the loop
17  I=poly(0,'I');
18  eqn=V1-R1*I-V2-R3*I;//KVL equation
19  I=roots(eqn);//A
20  VCA=-I*R1;//V
```

```
21 //Potential at point B with respect to A
22 VBA=VCB-VCA;//V
23 VOC=VBA;//V
24 Vth=VOC;//V
25 Req=R1*R3/(R1+R3)+R2*R4/(R2+R4);//ohm
26 //Thevenin equivalent current
27 IL=Vth/(Req+RL);//A
28 IL=IL*1000;//mA
29 disp(IL,"Current through 1000 ohm resistor(mA)");
```

Scilab code Exa 1.28 Calculate the current

```
 1 //Example 1_28
 2 clc;
 3 clear;
 4 close;
 5 format('v',5);
 6 //given data :
 7 V1=15;//V
 8 V2=4;//V
 9 R1=4;//ohm
10 R2=3;//ohm
11 R3=2;//ohm
12 R4=5;//ohm
13 I1=6;//A
14 RL=R4;//ohm
15 //solution
16 Req=R1*R3/(R1+R3)+R2;//ohm
17 //Converting current source into Voltage source
18 V2=I1*R3;//V//Converted source
19 //writing KVL equation for the loop
20 I=poly(0,'I');
21 eqn=V1-R1*I-R3*I-V2;//KVL equation
22 I=roots(eqn);//A
23 //Potential at point A with respect to B
```

```
24  VAB=V2+R3*I;//V
25  //Thevenin equivalent current
26  I=VAB/(Req+RL);//A
27  disp(I,"Current through 5 ohm resistor(A)");
```

Scilab code Exa 1.29 Calculate the current

```
 1  //Example 1_29
 2  clc;
 3  clear;
 4  close;
 5  format('v',5);
 6  //given data :
 7  V1=12;//V
 8  V2=24;//V
 9  R1=4;//ohm
10  R2=4;//ohm
11  R3=4;//ohm
12  RL=5;//ohm
13  //solution by Norton Theorem
14  //Short Circuit AB
15  I=V1/(R1*R3/(R1+R3));//A
16  ISC1=I*R3/(R1+R3);//A
17  ISC2=V2/R3;//A
18  ISC=ISC1+ISC2;//A
19  Req=R1*R3/(R1+R3);//ohm
20  //Norton equivalent current
21  IL=ISC*Req/(Req+RL);//A
22  disp(IL,"By Nortons theorem, Current through load
       resistance(A)");
23  //solution by Thevenin Theorem
24  Rth=Req;//ohm
25  //Loop PQRS, Applying KVL
26  //V1-I1*R1-I2*R1=0
27  A1=[-R1 -R1];//Coefficient Matrix
```

```
28  B1=[-V1];//Coefficient  Matrix
29  //Loop NTRS,  Applying KVL
30  //V2-I2*R3-R2*I2-R1*I1-R1*I2=0
31  A2=[-R3-R2-R1  -R1];//Coefficient  Matrix
32  B2=[-V2];//Coefficient  Matrix
33  A=[A1;A2];//Coefficient  Matrix
34  B=[B1;B2];//Coefficient  Matrix
35  X=A^-1*B;//soolution  matrix
36  I1=X(1);//A
37  I2=X(2);//A
38  VOC=V2-R3*I2;//A
39  IL=VOC/(Rth+RL);//A
40  disp(IL,"By Thevenins  theorem ,  Current  through  load
        resistance(A)");
```

Scilab code Exa 1.30 Determine Current

```
 1  //Example  1_30
 2  clc;
 3  clear;
 4  close;
 5  format('v',5);
 6  //given  data  :
 7  I1=10;//A
 8  V2=12;//V
 9  R1=2;//ohm
10  R2=2;//ohm
11  R3=6;//ohm
12  R4=6;//ohm
13  //solution  by  Norton  Theorem
14  RL=R4;//ohm
15  //Short  Circuit  AB
16  ISC1=I1*R1/(R1+R2);//A//by  current  source
17  ISC2=V2/R3;//A///by  voltage  source
18  ISC=ISC1+ISC2;//A
```

```
19  Req=(R1+R2)*R3/(R1+R2+R3);//ohm
20  //Norton equivalent current
21  I=ISC*Req/(Req+RL);//A
22  disp(I,"By Nortons theorem, Current through 6 ohm
        resistance connected across AB(A)");
23  //solution by Thevenin Theorem
24  Rth=Req;//ohm
25  //Converting current source into Voltage source
26  V1=I1*R1;//V//Converted source
27  //Applying KVL
28  I=poly(0,'I');//A
29  eqn=V1-R1*I-R2*I-R3*I-V2;//
30  I=roots(eqn);//A
31  VOC=V2+R3*I;//A
32  I=VOC/(Rth+RL);//A
33  disp(I,"By Thevenins theorem, Current through 6 ohm
        resistance connected across AB(A)");
34  //Unit of current is given wrong in the book.
```

Scilab code Exa 1.31 `Norton and Thevenin theorem`

```
 1  //Example 1_31
 2  clc;
 3  clear;
 4  close;
 5  format('v',5);
 6  //given data :
 7  V1=12;//V
 8  V2=6;//V
 9  V3=24;//V
10  R1=4;//ohm
11  R2=2;//ohm
12  R3=6;//ohm
13  R4=3;//ohm
14  R5=12;//ohm
```

```scilab
15  R6=16; //ohm
16  //solution by Norton Theorem
17  RL=R6; //ohm
18  //Thevenin theorem
19  //Loop 1 applying KVL
20  //V1-(R1+R2)*I1+V2-R3*(I1+I2);
21  A1=[-R1-R2-R3 -R3]; //Coefficient Matrix
22  B1=[-V1-V2]; //Coefficient Matrix
23  //Loop 2 applying KVL
24  //V3-R4*I2+V2-R3*(I1+I2)-R5*I2;
25  A2=[-R3 -R4-R3-R5]; //Coefficient Matrix
26  B2=[-V3-V2]; //Coefficient Matrix
27  A=[A1;A2]; //Coefficient Matrix
28  B=[B1;B2]; //Coefficient Matrix
29  X=A^-1*B; //soolution matrix
30  I1=X(1); //A
31  I2=X(2); //A
32  VOC=-R5*I2+V3; //V
33  Rth=((R1+R2)*R3/(R1+R2+R3)+R4)*R5/((R1+R2)*R3/(R1+R2
       +R3)+R4+R5); //ohm
34  I=VOC/(Rth+RL); //A
35  disp(I,"By Thevenin Theorem, current through 16 ohm
        resistor(A)");
36  //solution by Norton Theorem
37  //Converting Voltage sources into current sources
38  I1=V1/(R1+R2); //A
39  I2=V2/R3; //A
40  I3=V3/R5; //A
41  Req=Rth; //ohm
42  //Combining I1 & I2 | parallel & opposite
43  I1=I1-I2; //A
44  I2=0; //A
45  ISC1=I1/2; //A//considering I1 only
46  ISC2=I3; //A//considering I3 only
47  ISC=ISC1+ISC2; //A
48  //Norton equivalent current
49  I=ISC*Req/(Req+RL); //A
50  disp(I,"By Nortons theorem, current through 16 ohm
```

```
r e s i s t o r (A) ") ;
```

Scilab code Exa 1.32 `Value of maximum power`

```
 1  //Example 1_32
 2  clc ;
 3  clear ;
 4  close ;
 5  format ( 'v ' ,5) ;
 6  //given data :
 7  V =12; //V
 8  R1 =2; //ohm
 9  R2 =2; //ohm
10  R3 =2; //ohm
11  R4 =2; //ohm
12  R5 =2; //ohm
13  //calculating Open circuit voltage :
14  I =V /( R1+R2+R3 ) ; //V
15  VCD = I *R3 ; //V
16  VAB = VCD ; //V //Open circuit voltage
17  Req =(R1+R2) *R3 /( R1+R2+R3 ) +R4+R5 ; //ohm
18  RL = Req ; //ohm // For maximum Power transfer
19  disp (RL , " For maximum Power transfer , RL(ohm) ") ;
20  PLmax = VAB ^2/4/ RL ; //W
21  disp ( PLmax , " Value of maximum Power (W) ") ;
```

Scilab code Exa 1.33 `Value of load resistance`

```
 1  //Example 1_33
 2  clc ;
 3  clear ;
 4  close ;
 5  format ( 'v ' ,5) ;
```

34

```
6  //given data :
7  V1=12;//V
8  R1=3;//ohm
9  R2=3;//ohm
10 I2=6;//A
11 //Converting currrent sources into Voltage sources
12 V2=I2*R2;//V
13 //writing KVL equation for the loop
14 I=poly(0,'I');
15 eqn=V1-R1*I-R2*I-V2;//KVL equation
16 I=roots(eqn);//A
17 VOC=V2+R2*I;//V
18 Req=R1*R2/(R1+R2);//ohm
19 RL=Req;//ohm//For maximum Power transfer
20 disp(RL,"For maximum Power transfer , RL(ohm)");
21 I=VOC/(Req+RL);//A
22 PLmax=I^2*RL;//W
23 disp(PLmax,"Value of maximum Power(W)");
24 Ri=Req;//ohm
25 Eta=1/(1+Ri/RL)*100;//%
26 disp(Eta,"Power Transfer Efficiency(%)");
```

Scilab code Exa 1.34 Value of load resistance

```
1  //Example 1_34
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  V1=48;//V
8  R1=4;//ohm
9  R2=20;//ohm
10 R3=12;//ohm
11 R4=12;//ohm
```

```
12  V2=12; //V
13  //Open circuit AB
14  I1=V1/(R1+R2); //A
15  I2=V1/(R3+R4); //A
16  VR1=V1*R1/(R1+R2); //V// across 4 ohm resistance
17  VR2=V1*R2/(R1+R2); //V// across 20 ohm resistance
18  VR3=V1*R3/(R3+R4); //V// across 12 ohm resistance
19  VCE=VR2; //V
20  VCD=VR3; //V
21  VBC=V2+VR3; //V
22  //POtential of A wih respect to B
23  VOC=VCE-VBC; //V
24  Rth=R1*R2/(R1+R2)+R3*R4/(R3+R4); //ohm
25  Ri=Rth; //ohm
26  RL=Ri; //ohm// For maximum Power transfer
27  disp(RL,"For maximum Power transfer, RL(ohm)");
28  I=VOC/(Rth+RL); //A
29  PL=I^2*RL; //W
30  disp(PL,"Value of maximum Power(W)");
31  //Answer in the textbook is wrong.
```

Scilab code Exa 1.35 Value of load resistance

```
1  //Example 1_35
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  V=12; //V
8  R1=4; //ohm
9  R2=6; //ohm
10  R3=6; //ohm
11  R4=6; //ohm
12  //Current by the source while −AB open circuit
```

```
13  I=V/(R2*R3*R4/(R2*R3+R3*R4+R2*R4)+R1); //A
14  //Voltage across AB
15  VOC=I*(R2*R3*R4/(R2*R3+R3*R4+R2*R4)); //V\
16  //Thevenin equivalent Resistance
17  Rth=(R2*R3*R4/(R2*R3+R3*R4+R2*R4)*R1/(R2*
        R3+R3*R4+R2*R4)+R1)); //ohm
18  Ri=Rth; //ohm
19  RL=Ri; //ohm//For maximum Power transfer
20  disp(RL,"For maximum Power transfer, RL(ohm)");
21  I=VOC/(Rth+RL); //A
22  PL=I^2*RL; //W
23  disp(PL,"Value of maximum Power(W)");
24  Eta=RL/(RL+Ri)*100; //%
25  disp(Eta,"Power Transfer Efficiency(%)");
```

Scilab code Exa 1.36 `Calculate equivalent resistance`

```
1  //Example 1_36
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  R1=3; //ohm
8  R2=6; //ohm
9  R3=3; //ohm
10  R4=3; //ohm
11  R5=6; //ohm
12  R6=3; //ohm
13  R25=R2*R5/(R2+R5); //ohm
14  RBC=R25; //ohm
15  RAB=R4; //ohm
16  RAC=R6; //ohm
17  RA=RAB*RAC/(RAB+RAC+RBC); //ohm
18  RB=RAB*RBC/(RAB+RAC+RBC); //ohm
```

```
19  RC=RAC*RBC/(RAB+RAC+RBC);//ohm
20  RPQ=(R1+RB)*(R3+RA)/(R1+RB+R3+RA)+RC;//ohm
21  disp(RPQ,"Equivalent  Resistance  across  P & Q(ohm)");
```

Scilab code Exa 1.37 `Calculate the current`

```
 1  //Example 1_37
 2  clc;
 3  clear;
 4  close;
 5  format('v',5);
 6  //given data :
 7  V=12;//V
 8  RAB=3;//ohm
 9  RAC=3;//ohm
10  RBC=3;//ohm
11  RBD=3;//ohm
12  RCD=3;//ohm
13  RA=RAB*RAC/(RAB+RAC+RBC);//ohm
14  RB=RAB*RBC/(RAB+RAC+RBC);//ohm
15  RC=RAC*RBC/(RAB+RAC+RBC);//ohm
16  Req=RA+(RB+RBD)*(RC+RCD)/(RB+RBD+RC+RCD);//ohm
17  I=V/Req;//A
18  disp(I,"Current  I  supplied  by  the  battery(A)");
```

Scilab code Exa 1.40 `Find the voltage drop`

```
 1  //Example 1_40
 2  clc;
 3  clear;
 4  close;
 5  format('v',5);
 6  //given data :
```

```
 7  V =24; //V
 8  R1 =7; //ohm
 9  R2 =7; //ohm
10  R3 =7; //ohm
11  R4 =7; //ohm
12  R5 =8; //ohm
13  R6 =10; //ohm
14  RAB =( R5 * R6 /( R5 + R6 )+ R4 )*( R2 + R3 )/( R5 * R6 /( R5 + R6 )+ R4 + R2 +
        R3 )+ R1 ; //ohm
15  I =V/ RAB ; //A
16  I2 =I *( R2 + R3 )/( R2 + R3 + R5 * R6 /( R5 + R6 )+ R4 ); //A
17  VPQ = I2 *( R5 * R6 /( R5 + R6 )); //V
18  disp (VPQ ," Voltage  drop  across  the  10  ohm  resistor (V)
        ");
19  // Answer  in  the  book  is  not  accurate .
```

Scilab code Exa 1.41 Calculate equivalent resistance

```
 1  // Example  1 _41
 2  clc ;
 3  clear ;
 4  close ;
 5  format ('v ' ,5);
 6  // given  data  :
 7  R1 =5; //ohm
 8  R2 =5; //ohm
 9  R3 =10; //ohm
10  R4 =10; //ohm
11  RAB =( R1 + R3 )*( R2 + R4 )/( R1 + R3 + R2 + R4 ); //ohm
12  disp (RAB ," Equivalent  resistance (ohm )");
```

Scilab code Exa 1.42 Calculate the total current

```scilab
1  //Example 1_42
2  clc;
3  clear;
4  close;
5  format('v',4);
6  //given data :
7  V=24;//V
8  R1=2;//ohm
9  R2=3;//ohm
10 R3=5;//ohm
11 R4=8;//ohm
12 R5=2;//ohm
13 R6=5;//ohm
14 R7=3;//ohm
15 R8=6;//ohm
16 R57=R5+R7;//ohm//in series
17 RAB=R3;//ohm
18 RAC=R57;//ohm
19 RBC=R6;//ohm
20 RA=RAB*RAC/(RAB+RAC+RBC);//ohm
21 RB=RAB*RBC/(RAB+RAC+RBC);//ohm
22 RC=RAC*RBC/(RAB+RAC+RBC);//ohm
23 Req=R1+RA+(RC+R8)*(RB+R4)/(RC+R8+RB+R4)+R2;//ohm
24 I=V/Req;//A
25 disp(I,"Total current by the battery(A)");
```

Scilab code Exa 1.43 Required Voltage

```scilab
1  //Example 1_43
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  VAP=25;//V
```

```
 8  RAP =15; //ohm
 9  RAQ =5; //ohm
10  R3 =5; //ohm
11  RBP =10; //ohm
12  RBQ =20; //ohm
13  RAB = RAP * RAQ /( RAP + RAQ )+ RBP * RBQ /( RBP + RBQ ) ; //ohm
14  disp ( RAB ," Equivalent resistance across terminal AB(
       ohm )");
15  I = VAP /( RAP * RAQ /( RAP + RAQ ) ) ; //A
16  VBQ =( RBP * RBQ /( RBP + RBQ ) ) * I ; //V
17  V = VAP + VBQ ; ///V
18  disp (V ," Required Voltage (V)");
```

Scilab code Exa 1.45 Find the resistance

```
 1  //Example 1_45
 2  clc ;
 3  clear ;
 4  close ;
 5  format ('v' ,5) ;
 6  //given data :
 7  RAB =4; //ohm
 8  RAC =6; //ohm
 9  RBC =2; //ohm
10  RBD =10; //ohm
11  RCD =14; //ohm
12  RA = RAB * RAC /( RAB + RAC + RBC ) ; //ohm
13  RB = RAB * RBC /( RAB + RAC + RBC ) ; //ohm
14  RC = RAC * RBC /( RAB + RAC + RBC ) ; //ohm
15  Req = RA +( RB + RBD ) *( RC + RCD ) /( RB + RBD + RC + RCD ) ; //ohm
16  disp ( Req ," Total Resistance (ohm )");
```

Scilab code Exa 1.46 Find the resistance

```
1  //Example 1_46
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  RAD=20;//ohm
8  RAC=30;//ohm
9  RDC=50;//ohm
10 RDB=50;//ohm
11 RBC=45;//ohm
12 RAN=RAD*RAC/(RAD+RAC+RDC);//ohm
13 RDN=RAD*RDC/(RAD+RAC+RDC);//ohm
14 RCN=RAC*RDC/(RAD+RAC+RDC);//ohm
15 RAB=RAN+(RDN+RDB)*(RCN+RBC)/(RDN+RDB+RCN+RBC);//ohm
16 disp(RAB,"Total Resistance between terminal A & B(
      ohm)");
```

Scilab code Exa 1.47 Calculate the current

```
1  //Example 1_47
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  V1=6;//V
8  V2=5;//V
9  V3=8;//V
10 R1=2;//ohm
11 R2=2;//ohm
12 R3=5;//ohm
13 R4=4;//ohm
14 //Node A :
15 VA=poly(0,'VA');
```

```
16  I1=(V1-VA)/R1;//A
17  I2=(V2-VA)/R2;//A
18  I3=(V3+VA)/R3;//A
19  //KCL at Node A
20  eqn=I1+I2-I3;
21  VA=roots(eqn);//V
22  VB=-V3;//V
23  I3=(VA-VB)/R3;//A
24  disp(I3,"Current flowing through 5 ohm Resistance(A)
        ");
```

Scilab code Exa 1.48 Calculate the current

```
 1  //Example 1_48
 2  clc;
 3  clear;
 4  close;
 5  format('v',5);
 6  //given data :
 7  V1=12;//V
 8  V2=3;//V
 9  V3=6;//V
10  R1=2;//ohm
11  R2=8;//ohm
12  R3=4;//ohm
13  R4=10;//ohm
14  R5=12;//ohm
15  //Node A//I1=I2+I3
16  VA=poly(0,'VA');
17  VB=poly(0,'VB');
18  I1=(V1-VA)/R1;//A
19  VK=VA-V2;//V
20  //I2=(VK-VB)/R3;//A
21  I3=VA/R2;//A
22  //7*VA-2*VB=56//eqn(1)
```

```
23  A1 =[7  -2];// Coefficient  Matrix
24  B1 =[56];// Coefficient  Matrix
25  //Node B //I2+I5=I4
26  I5=(V3-VB)/R5;//A
27  I4=VB/R4;//A
28  //15*VA−26*VB=15//eqn(2)
29  A2 =[15  -26];// Coefficient  Matrix
30  B2 =[15];// Coefficient  Matrix
31  A=[A1;A2];// Coefficient  Matrix
32  B=[B1;B2];// Coefficient  Matrix
33  X=A^-1*B;// solution  Matrix
34  VA=X(1);//V
35  VB=X(2);//V
36  I3=VA/R2;//A
37  disp(I3,"Current  through  8 ohm  resistor(A)");
```

Scilab code Exa 1.49 Current in various branches

```
 1  //Example 1_49
 2  clc;
 3  clear;
 4  close;
 5  format('v',5);
 6  //given data :
 7  I1=1;//A
 8  V3=12;//V
 9  I4=0.5;//A
10  R1=10;//ohm
11  R2=10;//ohm
12  R3=20;//ohm
13  R4=20;//ohm
14  R5=20;//ohm
15  //Node B//I1=I2+I3
16  VB=poly(0,'VB');
17  VC=poly(0,'VC');
```

```
18  VD=poly(0,'VD');
19  I2=(VB)/R1;//A
20  //I3=(VB–VC)/R1;//A
21  //2*VB–VC=10//eqn(1)
22  A1=[2 -1 0];//Coefficient Matrix
23  B1=[10];//Coefficient Matrix
24  //Node C //I3=I4+I5
25  I4=(VC-V3)/R3;//A
26  //I5=(VC–VD)/R4;//A
27  //2*VB–4*VC+VD=−12//eqn(2)
28  A2=[2 -4 1];//Coefficient Matrix
29  B2=[-12];//Coefficient Matrix
30  //Node D //I6=I5+I7
31  I6=VD/R5;//A
32  I7=I4;//A
33  //VC–2*VD=−10//eqn(3)
34  A3=[0 1 -2];//Coefficient Matrix
35  B3=[-10];//Coefficient Matrix
36  A=[A1;A2;A3];//Coefficient Matrix
37  B=[B1;B2;B3];//Coefficient Matrix
38  X=A^-1*B;//solution Matrix
39  VB=X(1);//V
40  VC=X(2);//V
41  VD=X(3);//V
42  I2=(VB)/R1;//A
43  I3=(VB-VC)/R1;//A
44  I5=(VC-VD)/R4;//A
45  I4=(-I3-I5);//A
46  I6=VD/R5;//A
47  disp("Current in various branches are : ");
48  disp(I2,"Current I2(A)");
49  disp(I3,"Current I3(A)");
50  disp(I4,"Current I4(A)");
51  disp(I5,"Current I5(A)");
52  disp(I6,"Current I6(A)");
```

Scilab code Exa 1.50 Calculate the current

```
1  //Example 1_50
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  I=8;//A
8  I4=6;//A
9  R1=3;//ohm
10 R2=2;//ohm
11 R3=4;//ohm
12 //Applying KCL//I=I1+I2
13 //I=V1/R1+V1/R2-V2/R2//eqn(1)
14 A1=[1/R1+1/R2 -1/R2];//Coefficient Matrix
15 B1=[I];//Coefficient Matrix
16 //Applying KCL//I2=I3+I4
17 //V1/R2-V2/R2-V2/R3=I4//eqn(2)
18 A2=[1/R2 -1/R2-1/R3];//Coefficient Matrix
19 B2=[I4];//Coefficient Matrix
20 A=[A1;A2];//Coefficient Matrix
21 B=[B1;B2];//Coefficient Matrix
22 X=A^-1*B;//solution Matrix
23 V1=X(1);//V
24 V2=X(2);//V
25 I1=V1/R1;//A
26 I2=V1/R2-V2/R2;//A
27 I3=(V2)/R3;//A
28 disp("Current in various branches are : ");
29 disp(I1,"Current I1(A)");
30 disp(I2,"Current I2(A)");
31 disp(I3,"Current I3(A)");
```

Chapter 2

Electromagnetism

Scilab code Exa 2.1 Inductance and coupling coefficient

```
1  //Ex_2_1
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  LTsc=1.6;//H(Series cumulative)
8  LTd=0.4;//H(differentially)
9  L1=0.6;//H
10 M=(LTsc-LTd)/4;//H(Mutual Inductance)
11 L2=LTsc-2*M-L1;//H
12 K=M/sqrt(L1*L2);//Coupling Coefficient
13 disp(M,"Mutual Inductance(H)");
14 disp(K,"Coupling Coefficient");
```

Scilab code Exa 2.2 Calculate the emf induced

```
1  //Ex_2_2
```

```
2 clc;
3 clear;
4 close;
5 format('v',6);
6 //given data :
7 l=0.5;//m
8 B=0.5;//Wb/m^2
9 I=50;//A
10 v=20;//m/s
11 F=B*l*I;//N
12 disp(F,"Force expereinced by the conductor(N)");
13 e=B*l*v;//V
14 disp(e,"emf induced(V)");
```

Scilab code Exa 2.3 Calculate Inductance and emf

```
1 //Ex_2_3
2 clc;
3 clear;
4 close;
5 format('v',6);
6 //given data :
7 N=100;//turns
8 l=0.5;//m
9 A=10/10000;//m^2
10 mur=2000;//relative permeability of iron
11 mu0=4*%pi*10^-7;//permeability
12 I=5;//A
13 t=10;//ms
14 L=mur*mu0*N^2*A/l*1000;//mH
15 disp(L,"Inductance of the coil(mH)");
16 E=L*2*I/t;//V
17 disp(E,"Induced emf in the coil(V)");
```

Scilab code Exa 2.4 Calculate Inductance and emf

```
1  //Ex_2_4
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  N1=500;//turns
8  N2=2000;//turns
9  K=50/100;//coefficient for 50% flux linked
10 diBYdt=10;//A/s
11 L1=200;//mH
12 fi1BYI1=L1/N1;
13 M=N2*fi1BYI1;//mH
14 e2=M*10^-3*diBYdt;//V
15 disp(M/1000,"Mutual Inductance of two coil(H)");
16 disp(e2,"Induced emf in the coil having 1000 turns(V
       )");
```

Scilab code Exa 2.5 Mutual and Self Inductance

```
1  //Ex_2_5
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  I1=5;//A
8  N1=500;//turns
9  fi1=1;//mWb
10 dt=10;//ms
```

```
11  e2 =50; //V
12  K=60/100; // coefficient of coupling
13  di1=2*(I1); //A(as current changes from +5A to -5A)
14  M=e2*dt*10^-3/di1; //H
15  L1=N1*fi1/1000/I1; //H
16  L2=L1*M^2/K^2; //H
17  disp(M,"Mutual Inductance of two coil(H)");
18  disp(L1,"Self inductance of coil 1(H)");
19  disp(L2,"Self inductance of coil 2(H)");
20  //Answer is wrong in the book.
```

Scilab code Exa 2.6 Determine L1 L2 M and K

```
1  //Ex_2_6
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  N1=1000; //turns
8  N2=400; //turns
9  K1=75/100; // coefficient of coupling
10 I1=6; //A
11 I2=6; //A
12 fi1=0.8; //mWb
13 fi2=0.5; //mWb
14 L1=N1*fi1*10^-3/I1; //H
15 L2=N2*fi2*10^-3/I2; //H
16 M=N2*K1*fi1*10^-3/I1; //H
17 K=M/sqrt(L1*L2);
18 disp(L1,"Self inductance of coil 1(H)");
19 disp(L2,"Self inductance of coil 2(H)");
20 disp(M,"Mutual Inductance of two coil(H)");
21 disp(K,"Coefficient of coupling");
```

Scilab code Exa 2.7 `Calculate flux density`

```
1  //Ex_2_7
2  clc;
3  clear;
4  close;
5  format('v',7);
6  //given data :
7  r=10;//cm
8  I=100;//A
9  d=5;//cm
10 mu0=4*%pi*10^-7;//permeability
11 Bc=mu0*I/2/(r/100);//Wb/m^2 or T
12 B=mu0*I*(r/100)^2/(2*((r/100)^2+(d/100)^2)^(3/2));//
       Wb/m^2
13 disp(Bc,"Flux density at the centre(Wb/m^2)");
14 disp(B,"Flux density in the plane(Wb/m^2)");
15 //Answer is wrong in the book.
```

Scilab code Exa 2.8 `MMF and current`

```
1  //Ex_2_8
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  D=0.5;//m(mean diameter)
8  A=0.01;//m^2
9  fi=10/1000;//Wb
10 N=100;//turns
11 mmf1=10;//A-turn//(for Ni alloy)
```

```
12  mmf2=50; //A−turn //( for  Si−steel  alloy )
13  l=%pi*D; //m( total  length )
14  lni=l/2; //m( length  of  Ni  alloy )
15  lsi=l/2; //m( length  of  Si−steel )
16  mmf=mmf1*lni+mmf2*lsi; //A−turn /// total  mmf
17  disp (mmf ,"mmf required (A−turn )");
18  I=mmf/N; //A
19  disp (I ,"Current (A)");
```

Scilab code Exa 2.9 Calculate the reluctance

```
1  // Ex_2_9
2  clc ;
3  clear ;
4  close ;
5  format ('e',9);
6  // given  data  :
7  l=20/100; //m
8  A=1.5/10000; //m^2
9  mur=2000; // relative  permeability
10 mu0=4*%pi*10^-7; // permeability
11 S=l/(mu0*mur*A); //AT/Wb
12 disp (S ,"Reluctance  of  silicon  steel (AT/Wb)");
```

Scilab code Exa 2.10 Calculate the amount of flux

```
1  // Ex_2_10
2  clc ;
3  clear ;
4  format ('v',6);
5  close ;
6  // given  data  :
7  D=25/100; //m
```

```
8  A=9/10000;//m^2
9  N=100;//turns
10 I=1.5;//A
11 l=%pi*D;//m
12 mur=2000;//relative permeability
13 mu0=4*%pi*10^-7;//permeability
14 fi=N*I/l*(mu0*mur*A);//Wb
15 disp(fi*1000,"Flux produced(mWb)");
```

Scilab code Exa 2.11 Calculate the current

```
1  //Ex_2_11
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  lg=0.01/100;//m(airgap)
8  li=39.99/100;//m(mean length)
9  mur=2000;//relative permeability
10 mu0=4*%pi*10^-7;//permeability
11 N=1000;//turns
12 A=9/10000;//m^2
13 fi=1;//mWb
14 S=li/(mu0*mur*A)+lg/(mu0*A);//AT/Wb
15 I=fi*10^-3*S/N;//A
16 disp(I,"Current required(A)");
```

Scilab code Exa 2.12 Calculate the current

```
1  //Ex_2_12
2  clc;
3  clear;
```

```
4  close ;
5  format ('v',7);
6  //given data :
7  Ac=10/10000; //m^2
8  Ao=5/10000; //m^2(outer limbs)
9  Lo=25; //cm(outer limbs)
10 Lc=16; //cm
11 N=1000; //turns
12 fic=1.2; //mWb
13 fio=1.2; //mWb
14 B=1.2; //Wb/m^2
15 mmf=750; //AT/m
16 Bc=fic*10^-3/Ac; //Wb/m^2
17 Bo=fio*10^-3/Ao; //Wb/m^2
18 mmf_total=mmf*Lo/100+mmf*Lc/100; //AT/m
19 I=mmf_total/N; //A
20 disp(I,"Current required(A)");
```

Scilab code Exa 2.13 Calculate the amount of flux

```
1  //Ex_2_13
2  clc ;
3  clear ;
4  close ;
5  format ('v',4);
6  //given data :
7  Ao=5/10000; //m^2(outer limbs)
8  li=100/100; //m(iron path)
9  A=10/10000; //m^2
10 lg=1/1000; //m(airgap)
11 I1=3; //A
12 I2=2; //A
13 N1=100; //turns
14 N2=50; //turns
15 mur=2000; //relative permeability
```

```
16  mu0 =4*%pi *10^-7;// permeability
17  mmf = N1 * I1 - N2 * I2 ;//AT
18  S =1/( mu0 * A )*[ li / mur + lg ];//AT/Wb
19  fi = mmf / S *1000;//mWb
20  disp ( fi ,"Flux  available (mWb)");
```

Scilab code Exa 2.14 Calculate the amount of flux

```
1  // Ex_2_14
2  clc ;
3  clear ;
4  close ;
5  format ('v',10);
6  // given  data :
7  N1 =100;// turns
8  N2 =80;// turns
9  I1 =10;//A
10  I2 =1.5;//A
11  li =40/100;//m
12  lg =1/1000;//m( airgap )
13  A =10/10000;//m^2
14  mur =2000;// relative  permeability
15  mu0 =4*%pi *10^-7;// permeability
16  mmf = N1 * I1 - N2 * I2 ;//AT
17  S =1/( mu0 * A )*[ li / mur + lg ];//AT/Wb
18  fi = mmf / S ;//Wb
19  disp ( fi ,"Flux  produced (Wb)");
```

Scilab code Exa 2.15 Calculate the current

```
1  // Ex_2_15
2  clc ;
3  clear ;
```

```
4  close ;
5  format ( 'v',5) ;
6  //given data :
7  N=2000; //turns
8  lg=2/1000; //m(airgap)
9  lc=20/100; //m(mean diameter)
10 Ac=10/10000; //m^2(cross section central limb)
11 Ao=5/10000; //m^2(cross section outer limb)
12 B=[1 1.1 1.2 1.3 1.4]; //Wb/m^2
13 H=[550 650.750 820 870]; //AT/m
14 fi=1.1/1000; //Wb
15 Bc=fi/Ac; //Wb/m^2(For central limb)
16 Bo=fi/Ao; //Wb/m^2(For outer limb)
17 for i=1:5
18     if Bc==B(i) then
19         H=H(i); //AT/m
20 B=B(i); //Wb/m^2
21         break ;
22     end ;
23 end ;
24 lo=%pi*lc/2; //m(outer limb , including airgap)
25 //H=NI/l
26 NIc=H*lc; //AT//NI for central limb
27 NIo=H*(lo-lg); //AT//NI for outer limb
28 mu0=4*%pi*10^-7; //permeability of air
29 Hg=B/mu0; //AT/m
30 NIag=Hg*lg; ////AT//NI for airgap
31 NI=NIc+NIo+NIag; //AT//Total AT required
32 I=NI/N; //A
33 disp(I,"Current I(A)") ;
```

Scilab code Exa 2.16 Calculate the flux

```
1  //Ex_2_16
2  clc ;
```

```
 3  clear;
 4  close;
 5  format('v',5);
 6  //given data :
 7  LA=75/100; ///m
 8  LB=25/100; ///m
 9  lg=2/100; //m(airgap)
10  mu_r1=1000; ///relative permeability
11  mu_r2=1500; ///relative permeability
12  mu0=4*%pi*10^-7; //permeability of air
13  A=10*10^-4; //m^2//Area of core
14  N=1000; //turns
15  I=5; //A
16  S=LA/(mu0*mu_r1*A)+LB/(mu0*mu_r2*A)+lg/(mu0*A); //Wb/
       m^2
17  fi=N*I/S*1000; //mWb
18  disp(fi,"Flux produced in the air-gap(mWb)");
```

Scilab code Exa 2.17 Calculate the magnetizing current

```
 1  //Ex_2_17
 2  clc;
 3  clear;
 4  close;
 5  format('v',5);
 6  //given data :
 7  CD=10/100; BE=10/100; AF=10/100; //m
 8  BC=8/100; ED=8/100; AB=8/100; EF=8/100; //m
 9  BCDE=BC+CD+ED; //m
10  BAFE=AB+BE+EF; //m
11  A=2*2*10^-4; //m^2
12  mu_r=1200; ///relative permeability
13  N=800; //turns
14  fi2=2*10^-3; //Wb
15  mu0=4*%pi*10^-7; //permeability of air
```

```
16  S2=BAFE/(mu0*mu_r*A);//Wb/m^2
17  S1=BE/(mu0*mu_r*A);//Wb/m^2
18  fi1=fi2*S2/S1;//Wb
19  fi=fi1+fi2;//Wb
20  AT2=fi*S2;//AT// for portion BAFE
21  AT1=fi1*S1;//AT// for portion BCDE
22  AT=AT1+AT2;//AT// Toal AT required
23  NI=AT;//AT
24  I=NI/N;//A
25  disp(I,"Magnetizing current(A)");
```

Scilab code Exa 2.18 Flux density and magnetic pull

```
 1  // Ex_2_18
 2  clc;
 3  clear;
 4  close;
 5  format('v',7);
 6  // given data :
 7  lg=1/1000;//m// air −gap
 8  li=20/100;//m// flux path
 9  mu0=4*%pi*10^-7;// permeability of air
10  mu_r=500;/// relative permeability
11  A=0.5*10^-4;//m^2// Area
12  I=50/1000;//A
13  N=8000;// turns
14  S=li/mu0/mu_r/A+2*lg/mu0/A;//AT/Wb
15  fi=N*I/S;//Wb
16  B=fi/A;//Wb/m^2
17  disp(B,"Flux Density(Wb/m^2)");
18  format('v',5);
19  F=B*A/2/mu0;//N
20  disp(F,"Magnetic Pull(N)");
```

Scilab code Exa 2.19 Calculate the magnetic field

```scilab
1  //Ex_2_19
2  clc;
3  clear;
4  close;
5  format('v',7);
6  //given data :
7  I=100;//A
8  r=1;//m
9  mu0=4*%pi*10^-7;//permeability of air
10 B=mu0*I/2/%pi/r;//Wb/m^2
11 disp(B,"Magnetic field produced(Wb/m^2)");
```

Scilab code Exa 2.20 Calculate the resultant force

```scilab
1  //Ex_2_20
2  clc;
3  clear;
4  close;
5  format('e',9);
6  //given data :
7  I1=100;//A
8  I2=10;//A
9  l=20/100;//m
10 r1=1/100;//m
11 r2=11/100;//m
12 mu0=4*%pi*10^-7;//permeability of air
13 //Force of attraction between Conductor & AB
14 F1=mu0*I1*I2*l/2/%pi/r1;//N
15 //Force of repulsion between Conductor & CD
16 F2=mu0*I1*I2*l/2/%pi/r2;//N
```

```
17  //Net Force
18  F=F1-F2;//N
19  disp(F,"Resultant force developed(N)");
```

Scilab code Exa 2.21 Value of exciting current

```
 1  //Ex_2_21
 2  clc;
 3  clear;
 4  close;
 5  format('v',4);
 6  //given data :
 7  N=500;//turns
 8  A=0.01;//m^2(Area of cross section of poles)
 9  l=0.5;//m(mean length)
10  mu0=4*%pi*10^-7;//permeability of air
11  mu_r=1000;///relative permeability
12  g=9.8;//gravitational acceleration
13  W=200;//kg
14  F=W/2;//kg
15  F=F*g;//N
16  B=sqrt(F*2*mu0/A);//Wb/m^2
17  H=B/mu0/mu_r;//Wb/m^2
18  I=H*l/N;//A
19  disp(I,"Exciting current(A)");
```

Chapter 3

AC Fundamentals

Scilab code Exa 3.1 rms value of current

```
1  // Example 3_1
2  clc ;
3  clear ;
4  close ;
5  format ( 'v' ,6) ;
6  // given  data  :
7  // v =100* sin (314* t )
8  R =20; // ohm
9  Vm =100; // V
10 omega =314; //
11 Vrms = Vm /2; // V
12 Irms = Vrms / R ; // A
13 disp ( Irms ," rms  value  of  current  (A)") ;
```

Scilab code Exa 3.2 Frequency of the supply

```
1  // Example 3_2
2  clc ;
```

```scilab
 3 clear ;
 4 close ;
 5 format ('v',5) ;
 6 //given data :
 7 //v=150* sin (100*%pi*t)
 8 R=50; //ohm
 9 Vm =150; //V
10 omega =100*%pi ; //
11 f= omega /2/%pi ; //Hz
12 Vrms = Vm /2; //V
13 Vav = Vm /%pi ; //V
14 Irms = Vm /2/ R; //A
15 disp ( Irms ,"rms value of current (A)");
16 Iav = Vm /%pi /R; //A
17 disp ( Iav ,"Average value of current (A)");
18 Kf = Irms / Iav ; //Form Factor
19 disp ( Kf ,"Form Factor")
```

Scilab code Exa 3.3 `Form factor`

```scilab
 1 // Example 3_3
 2 clc ;
 3 clear ;
 4 close ;
 5 format ('v',5) ;
 6 //given data :
 7 v =10; //V
 8 T =0.2; //second
 9 Vav =1/ T* integrate ('1* v','t',0,T/2) ; //V
10 Vrms = sqrt (1/ T* integrate ('v^2','t',0,T/2)) ; //V
11 disp ( Vrms ,"rms value of Voltage (V)");
12 disp ( Vav ,"Average value of Voltage (V)");
13 Kf = Vrms / Vav ; //Form Factor
14 disp ( Kf ,"Form Factor")
15 // Answer is not accurate in the book .
```

Scilab code Exa 3.4 `Rms and average value`

```scilab
1  //Example 3_4
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  //Let T=1 for calculation
8  T=1;
9  //i=5*t/T+5;//A
10 Iav=1/T*integrate('5*t/T+5','t',0,T);
11 disp(Iav,"Average value(A)");
12 Irms=sqrt(1/T*integrate('(5*t/T+5)^2','t',0,T));//V
13 disp(Irms,"rms value(A)");
14 //Answer is not accurate in the book.
```

Scilab code Exa 3.5 `Rms and average value and form factor`

```scilab
1  //Example 3_5
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  //Let T=1 for calculation
8  T=1;
9  //y=m*x, m=10/T & x=t
10 //i=10*t/T
11 Im=10;//A
12 Irms=sqrt(1/T*integrate('(10*t/T)^2','t',0,T));//V
```

```
13  disp(Irms,"rms value(A)");
14  Iav=Im/2;//A
15  disp(Iav,"Average value(A)");
16  Kf=Irms/Iav;//Form Factor
17  disp(Kf,"Form Factor")
```

Scilab code Exa 3.6 `Voltage and current`

```
1  //Example 3_6
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  L=0.5;//H
8  V=230;//V
9  f=50;//Hz
10  Vm=sqrt(2)*V;//V
11  XL=2*%pi*f*L;//ohm
12  I=V/XL;//A
13  Im=sqrt(2)*I;//A
14  disp("Equations are : ");
15  disp("V="+string(Vm)+"*sin"+string(2*%pi*f)+"*t");
16  disp(" i="+string(Im)+"*sin("+string(2*%pi*f)+"*t-%pi
        /2)");
17  //Answer is not accurate in the book.
```

Scilab code Exa 3.7 `Instantaneous current`

```
1  //Example 3_7
2  clc;
3  clear;
4  close;
```

```
5  format('v',6);
6  //given data :
7  L=0.5;//H
8  C=100;// micro F
9  V=230;//V
10 f=50;//Hz
11 R=25;//ohm
12 Vm=sqrt(2)*V;//V
13 omega=2*%pi*f;//rad/s
14 disp("Voltage equation")
15 disp("V="+string(Vm)+"*sin"+string(omega)+"*t");
16 XL=omega*L;//ohm
17 XC=1/omega/(C*10^-6);///ohm
18 disp("Current through the resistor will be ");
19 disp("i="+string(Vm/R)+"*sin("+string(2*%pi*f)+"*t)"
      );
20 disp("Current through the inductor will be ");
21 disp("i="+string(Vm/XL)+"*sin("+string(2*%pi*f)+"*t
      -90)");
22 disp("Current through the capacitor will be ");
23 disp("i="+string(Vm/XC)+"*sin("+string(2*%pi*f)+"*t
      +90)");
24 //Answer is not accurate in the book.
```

Scilab code Exa 3.8 Calculate the current

```
1  //Example 3_8
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  V=100;//V
8  f=50;//Hz
9  R=10;//ohm
```

```
10  L=100;//mH
11  C=100;// micro F
12  XL=2*%pi*f*L*10^-3;//ohm
13  XC=1/2/%pi/f/(C*10^-6);//ohm
14  IR=V/R;//A
15  disp(IR,"Current through R(A)");
16  IL=V/XL;//A
17  disp(IL,"Current through L(A)");
18  IC=V/XC;//A
19  disp(IC,"Current through C(A)");
```

Scilab code Exa 3.9 Branch and Line current Power factor

```
 1  //Example 3_9
 2  clc;
 3  clear;
 4  close;
 5  format('v',5);
 6  // given data :
 7  V=230;//V
 8  f=50;//Hz
 9  R1=14;//ohm
10  L1=16;//mH
11  R2=18;//ohm
12  L2=32;//mH
13  XL1=2*%pi*f*L1*10^-3;//ohm
14  XL2=2*%pi*f*L2*10^-3;//ohm
15  Z1mag=sqrt(R1^2+XL1^2);//ohm
16  Z2mag=sqrt(R2^2+XL2^2);//ohm
17  fi1=atand(XL1/R1);// radian
18  fi2=atand(XL2/R2);// radian
19  Z1=Z1mag*expm(%i*fi1*%pi/180);//ohm
20  Z2=Z2mag*expm(%i*fi2*%pi/180);//ohm
21  Y1=1/Z1;//mho
22  Y2=1/Z2;//mho
```

```
23  I1=V*Y1;//A
24  I1mag=abs(I1);//A
25  I1ang=atand(imag(I1),real(I1));//degree
26  disp(I1ang,I1mag,"Branch Current I1, magnitude(A) &
        angle(degree) are: ");
27  I2=V*Y2;//A
28  I2mag=abs(I2);//A
29  I2ang=atand(imag(I2),real(I2));//degree
30  disp(I2ang,I2mag,"Branch Current I2, magnitude(A) &
        angle(degree) are: ");
31  I_cosfi=I1mag*cosd(fi1)+I2mag*cosd(fi1);
32  I_sinfi=I1mag*sind(fi1)+I2mag*sind(fi1);
33  tanfi=I_sinfi/I_cosfi;
34  fi=atand(tanfi);//degree
35  pf=cosd(fi);//Power Factor lagging
36  disp(pf,"Total Power Factor(lagging)");
37  I=sqrt(I_sinfi^2+I_cosfi^2);//A
38  disp(fi,-I,"Line Current I, magnitude(A) & angle(
        degree) are: ");
39  //Answer is not accurate in the book.
```

Scilab code Exa 3.10 Apparent Real and active power

```
1  //Example 3_10
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  V=200;//V
8  f=50;//Hz
9  R=40;//ohm
10 L=0.0637;//H
11 XL=2*%pi*f*L;//ohm
12 IR=V/R;//A
```

```
13  IL=V/XL;//A
14  I=sqrt(IR^2+IL^2);//A
15  disp(I,"(a) Current drawn from supply(A)");
16  S=V*I/1000;//kVA
17  disp(S,"(b) Apparent Power(kVA)");
18  P=V*IR/1000;//kW
19  disp(P,"(c) Real Power(kW)");
```

Scilab code Exa 3.11 `Current Power factor and power`

```
 1  //Example 3_11
 2  clc;
 3  clear;
 4  close;
 5  format('v',6);
 6  //given data :
 7  V=100;//V
 8  f=50;//Hz
 9  R1=8;//ohm
10  X1=6;//ohm
11  R2=6;//ohm
12  X2=-8;//ohm
13  Z1=R1+%i*X1;//ohm
14  Z2=R2+%i*X2;//ohm
15  I1=V/Z1;//A
16  I1mag=abs(I1);//A
17  I1ang=atand(imag(I1),real(I1));//degree
18  disp(I1ang,I1mag,"Branch Current I1, magnitude(A) &
        angle(degree) are: ");
19  I2=V/Z2;//A
20  I2mag=abs(I2);//A
21  I2ang=atand(imag(I2),real(I2));//degree
22  disp(I2ang,I2mag,"Branch Current I2, magnitude(A) &
        angle(degree) are: ");
23  I=I1+I2;//A
```

```
24 Imag=abs(I);//A
25 Iang=atand(imag(I),real(I));//degree
26 disp(Iang,Imag,"Total Current I, magnitude(A) &
      angle(degree) are: ");
27 fi=atand(imag(I),real(I));//degree
28 pf=cosd(fi);//Power Factor lagging
29 disp(pf,"Total Power Factor(lagging)");
30 P=V*Imag*cosd(fi);//W
31 disp(P,"Active Power(W)");
32 S=V*Imag*sind(fi);//VAR
33 disp(S,"Reactive Power(VAR)");
34 //Answer is not accurate in the book.
```

Scilab code Exa 3.12 `Current Power factor and power`

```
1 //Example 3_12
2 clc;
3 clear;
4 close;
5 format('v',6);
6 //given data :
7 V=230;//V
8 f=50;//Hz
9 R=5;//ohm
10 L=30;//mH
11 XL=2*%pi*f*L*10^-3;//ohm
12 Z=R+%i*XL;//ohm
13 I=V/Z;//A
14 Imag=abs(I);//A
15 disp(Imag,"Magnitude of current(A) : ");
16 fi=atand(imag(I),real(I));//degree
17 format('v',5);
18 pf=cosd(fi);//Power Factor
19 disp(pf,"Power Factor(lagging)");
20 P=V*Imag*cosd(fi);//W
```

```
21  disp(P,"Power  Consumed(W)  :  "  );
22  //Answer  is  not  accurate  in  the  book.
```

Scilab code Exa 3.13 `Current Power factor and power`

```
1   //Example  3_13
2   clc;
3   clear;
4   close;
5   format('v',6);
6   //given  data  :
7   V=230;//V
8   f=50;//Hz
9   R=15;//ohm
10  L=0.15;//H
11  C=100;//micro  F
12  XL=2*%pi*f*L;//ohm
13  XC=1/2/%pi/f/(C*10^-6);//ohm
14  Z=R+%i*(XL-XC);//ohm
15  I=V/Z;//A
16  Imag=abs(I);//A
17  fi=atand(imag(I),real(I));//degree
18  disp(Imag,"Magnitude  of  current(A)  :  ");
19  disp(fi,"Angle(lagging)  of  current(degree)  :  ");
20  format('v',7);
21  pf=cosd(fi);//Power  Factor
22  disp(pf,"Power  Factor(lagging)");
23  P=V*Imag*cosd(fi);//W
24  disp(P,"Power  Consumed(W)  :  "  );
25  //Answer  is  not  accurate  in  the  book.
```

Scilab code Exa 3.14 `Value of Z2`

```
1  //Example 3_14
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  V=230; //V
8  f=50; //Hz
9  V1=120*expm(%i*30*%pi/180); //V
10 Z1=15*expm(%i*40*%pi/180); //ohm
11 V2=V-V1; //V
12 I=V1/Z1; //A
13 Z2=V2/I; //ohm
14 R=real(Z2); //ohm
15 XC=imag(Z2); //ohm
16 C=-1/2/%pi/f/XC*10^6; //micro F
17 disp(Z2,"Value of Z2(ohm) : ");
18 disp(R,"Resistance(ohm)");
19 format('v',7);
20 disp(C,"Capacitance(micro F)");
21 //Answer is not accurate in the book.
```

Scilab code Exa 3.15 Impedence Power factor and Power

```
1  //Example 3_15
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  f=50; ///Hz
8  V=160+%i*170; //V
9  I=12-%i*5; //A
10 Z=V/I; //ohm
11 disp(Z,"Impedence Z(ohm)");
```

```
12  fi=atand(imag(Z)/real(Z));//degree
13  pf=cosd(fi);//Power Factor
14  disp(pf,"Power Factor(lagging)");
15  P=abs(V)*abs(I)*pf;//W
16  disp(P,"Power Consumed(W)");
17  XL=imag(Z);//ohm
18  L=XL/2/%pi/f*1000;//mH
19  disp(L,"Inductance L(mH)");
20  //Answer is not accurate in the book.
```

Scilab code Exa 3.16 Value of L and R

```
1   //Example 3_16
2   clc;
3   clear;
4   close;
5   format('v',5);
6   //given data :
7   //v=325*sin(314*t)
8   //i=14.14*sin(314*t-60)
9   Vm=325;//V
10  omega=314;//rad/s
11  V=Vm/sqrt(2);//V
12  f=omega/2/%pi;//Hz
13  Im=14.14;//A
14  I=Im/sqrt(2);//A
15  fi=60;//degree
16  pf=cosd(fi);//power factor
17  P=V*I*cosd(fi);//W
18  disp(P,"Powe Consumed(W)");
19  Z=V/(I*expm(%i*-fi*%pi/180));//ohm
20  R=real(Z);//ohm
21  disp(R,"Value of R(ohm)");
22  XL=imag(Z);//ohm
23  L=XL/2/%pi/f*1000;//mH
```

```
24  disp(L,"Value  of  L(mH)");
25  //Answer  is  not  accurate  in  the  book.
```

Scilab code Exa 3.17 Value of R

```
1  //Example  3_17
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given  data  :
7  L=100;//mH
8  f=50;//Hz
9  XL=2*%pi*f*L/1000;///ohm
10 //VL  should  be  equal  to  1/2*V
11 //equalting  :  VL=I*XL  &  1/2*V=1/2*I*Z=1/2*I*sqrt(R
       ^2+XL^2)
12 R=sqrt(3*XL^2);//ohm
13 disp(R,"Value  of  R(ohm)");
```

Scilab code Exa 3.18 Value of L and R

```
1  //Example  3_18
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given  data  :
7  //v=100*sin(314*t)
8  //i=10*sin(314*t-%pi/6)
9  Vm=100;//V
10 omega=314;//rad/s
11 V=Vm/sqrt(2);//V
```

```
12  f=omega/2/%pi;//Hz
13  Im=10;//A
14  I=Im/sqrt(2);//A
15  fi=%pi/6;//radian
16  pf=cos(fi);//power factor
17  disp(pf,"Power Factor(Lagging)");
18  P=V*I*cos(fi);//W
19  disp(P,"Powe Consumed(W)");
20  Z=V/(I*expm(%i*-fi));//ohm
21  R=real(Z);//ohm
22  disp(R,"Value of R(ohm)");
23  XL=imag(Z);//ohm
24  L=XL/2/%pi/f*1000;//mH
25  disp(L,"Value of L(mH)");
```

Scilab code Exa 3.19 `Power Impedence R and L`

```
1   //Example 3_19
2   clc;
3   clear;
4   close;
5   format('v',6);
6   //given data :
7   //v=200*sin(314*t+%pi/3)
8   //i=20*sin(314*t+%pi/6)
9   Vm=200;//V
10  omega=314;//rad/s
11  V=Vm/sqrt(2);//V
12  f=omega/2/%pi;//Hz
13  Im=20;//A
14  I=Im/sqrt(2);//A
15  fi=%pi/3-%pi/6;//radian
16  pf=cos(fi);//power factor
17  disp(pf,"(i) Power Factor(Lagging)");
18  P=V*I*cos(fi);//W
```

```
19  disp(P,"(ii) Average Power(W)");
20  Z=V/(I*expm(%i*-fi));//ohm
21  Zmag=abs(Z);//ohm
22  Zang=atand(imag(Z),real(Z));//degree
23  disp(Zang,Zmag,"(iii) Impedence in polar form,
        Magnitude(ohm) & angle(degree) are");
24  disp(Z,"(iii) Impedence in rectangular form(ohm)");
25  R=real(Z);//ohm
26  disp(R,"(iv)Value of R(ohm)");
27  XL=imag(Z);//ohm
28  L=XL/2/%pi/f*1000;//mH
29  disp(L,"(iv)Value of L(mH)");
```

Scilab code Exa 3.20 Voltage and power factor

```
 1  //Example 3_20
 2  clc;
 3  clear;
 4  close;
 5  format('v',4);
 6  //given data :
 7  VR=20;//V
 8  VL=60;//V
 9  VC=30;//V
10  V=sqrt(VR^2+(VL-VC)^2);//V
11  disp(V,"Magnitude of voltage(V)");
12  format('v',5);
13  fi=acosd(VR/V);//degree
14  disp(fi,"Power Factor angle(degree)");
15  pf=cosd(fi);//Power Factor
16  disp(pf,"Power Factor");
17  //Answer is not accurate in the book.
```

Scilab code Exa 3.21 Value of R and C

```
1  //Example 3_21
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  L=100;//mH
8  //i=14.148sin(314*t+%pi/6)
9  //v=325*sin(314*t)
10 Vm=325;//V
11 Im=14.14;//A
12 omega=314;//rad/s
13 V=Vm/sqrt(2);//V
14 I=Im/sqrt(2);//A
15 Z=V/(I*expm(%i*%pi/6));//ohm
16 R=real(Z);//ohm
17 disp(R,"Value of R(ohm)");
18 XCL=-imag(Z);//ohm//XCL=XC-XL
19 XC=XCL+omega*L/1000;//ohm
20 C=1/XC/omega;//F
21 C=C*10^6;//micro F
22 disp(C,"Value of C(micro F)");
23 //Answer is not accurate in the book.
```

Scilab code Exa 3.22 Current and power factor

```
1  //Example 3_22
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  L=100;//mH
```

```
 8  R=15;//ohm
 9  V=230;//V
10  f=50;//Hz
11  XL=2*%pi*f*L/1000;//ohm
12  IR=V/R;//A
13  disp(IR,"Branch Current IR(A)");
14  IL=V/XL;//A
15  format('v',5);
16  disp(IL,"Branch Current IL(A)");
17  I=sqrt(IR^2+IL^2);//A
18  disp(I,"Line Current I(A)");
19  pf=IR/I;//Power factor(lagging)
20  disp(pf,"Power Factor(lagging)");
21  fi=acosd(pf);//degree
22  P=V*I*cosd(fi);//W
23  disp(P,"Power Consumed(W)");
24  //Answer is not accurate in the book.
```

Scilab code Exa 3.23 `Current and power factor`

```
 1  //Example 3_23
 2  clc;
 3  clear;
 4  close;
 5  format('v',6);
 6  //given data :
 7  R1=5;//ohm
 8  L1=150;//mH
 9  R2=50;//ohm
10  L2=15;//mH
11  V=230;//V
12  f=50;//Hz
13  Z1=R1+%i*2*%pi*f*L1/1000;//ohm
14  Z2=R2+%i*2*%pi*f*L2/1000;//ohm
15  I1=V/Z1;//A
```

```
16  I2=V/Z2 ;//A
17  I=I1+I2 ;//A
18  Imag=abs (I) ;//A
19  Iang=atand ( imag (I)/ real (I) ) ;// degree
20  disp ( Iang , Imag ,"Total  current  drawn ,  magnitude (A) &
        Angle ( degree )  are") ;
21  pf=cosd ( Iang ) ;// Power  Factor ( lagging )
22  format ('v',4) ;
23  disp ( pf ,"Power  Factor ( lagging )") ;
24  P=V*Imag*pf ;//W
25  format ('v',5) ;
26  disp (P,"Power  Consumed (W)") ;
27  // Answer  is  not  accurate  in  the  book .
```

Scilab code Exa 3.24 `Current and Power`

```
1   // Example  3_24
2   clc ;
3   clear ;
4   close ;
5   format ('v',6) ;
6   // given  data :
7   Z1=10+%i*12 ;// ohm
8   Z2=12-%i*10 ;// ohm
9   V=230 ;//V
10  f=50 ;//Hz
11  Z=Z1*Z2/(Z1+Z2) ;// ohm
12  I=V/Z ;//A
13  Imag=abs (I) ;//A
14  Iang=atand ( imag (I)/ real (I) ) ;// degree
15  disp ( Iang , Imag ,"Total  current  drawn ,  magnitude (A) &
        Angle ( degree )  are") ;
16  pf=cosd ( Iang ) ;// Power  Factor ( lagging )
17  format ('v',6) ;
18  disp ( pf ,"Power  Factor ( lagging )") ;
```

```
19 P=V*Imag*pf;//W
20 P=P/1000;//kW
21 disp(P,"Power Consumed(kW)");
22 //Answer is not accurate in the book.
```

Scilab code Exa 3.25 Apparent and reactive power

```
1 //Example 3_25
2 clc;
3 clear;
4 close;
5 format('v',6);
6 //given data :
7 R1=12;//ohm
8 L=50;//mH
9 R2=50;//ohm
10 C=50;//micro F
11 V=200*expm(%i*30*%pi/180);//V
12 f=50;//Hz
13 XL=2*%pi*f*L/1000;//ohm
14 XC=1/2/%pi/f/(C*10^-6);//ohm
15 Z1=R1+%i*XL;//ohm
16 Z2=R2+%i*XC;//ohm
17 I1=V/Z1;//A
18 I2=V/Z2;//A
19 I=I1+I2;//A
20 Imag=abs(I);//A
21 Iang=atand(imag(I)/real(I));//degree
22 disp(Iang,Imag,"Total current drawn, magnitude(A) &
      Angle(degree) are");
23 pf=cosd(Iang);//Power Factor(lagging)
24 fi=acosd(pf);//degree
25 disp(pf,"Power Factor(lagging)");
26 P=abs(V)*Imag*pf;//W
27 P=P/1000;//kW
```

```
28  disp(P,"Power Consumed(kW)");
29  S=abs(V)*Imag*sind(fi);//VARs
30  S=S/1000;//kVARs
31  disp(S,"Reactive Power (kVARs)");
32  Pa=abs(V)*Imag/1000;//kVA
33  disp(Pa,"Apparent Power(kVA)");
34  //Answer is not accurate in the book.
```

Scilab code Exa 3.26 Admittance and power factor

```
1   //Example 3_26
2   clc;
3   clear;
4   close;
5   format('v',6);
6   //given data :
7   V=230;//V
8   f=50;//Hz
9   Z1=12*expm(%i*30*%pi/180);//ohm
10  Z2=8*expm(%i*-30*%pi/180);//ohm
11  Z3=10*expm(%i*60*%pi/180);//ohm
12  Y1=1/Z1;//mho
13  Y2=1/Z2;//mhob
14  Y3=1/Z3;//mho
15  Y=Y1+Y2+Y3;//mho
16  Ymag=abs(Y);//mho
17  Yang=atand(imag(Y)/real(Y));//degree
18  disp(Yang,Ymag,"Total admittance, magnitude(mho) &
        Angle(degree) are");
19  Z=1/Y;//ohm
20  Zmag=abs(Z);//ohm
21  Zang=atand(imag(Z)/real(Z));//degree
22  disp(Zang,Zmag,"Equivallent Impedance, magnitude(ohm
        ) & Angle(degree) are");
23  I=V/Z;//A
```

```
24  Imag=abs(I);//A
25  Iang=atand(imag(I)/real(I));//degree
26  disp(Iang,Imag,"Total current, magnitude(A) & Angle(
        degree) are");
27  pf=cosd(Iang);//Power Factor(lagging)
28  fi=acosd(pf);//degree
29  disp(pf,"Power Factor(lagging)");
30  format('v',7);
31  P=abs(V)*Imag*pf;//W
32  P=P/1000;//kW
33  disp(P,"Power Consumed(kW)");
34  //Answer is not accurate in the book.
```

Scilab code Exa 3.27 Calculate power and power factor

```
1   //Example 3_27
2   clc;
3   clear;
4   close;
5   format('v',6);
6   //given data :
7   V=230;//V
8   f=50;//Hz
9   R1=12;//ohm
10  XL1=12;//ohm
11  R2=8;//ohm
12  XL2=16;//ohm
13  Z1=R1+%i*XL1;//ohm
14  Z2=R2+%i*XL2;//ohm
15  Y1=1/Z1;//mho
16  Y2=1/Z2;//mhob
17  I1=V*Y1;//A
18  I1mag=abs(I1);//A
19  I1ang=atand(imag(I1)/real(I1));//degree
20  disp(I1ang,I1mag,"current I1, magnitude(A) & Angle(
```

```
            degree )  are " ) ;
21  I2 = V * Y2 ; //A
22  I2mag = abs ( I2 ) ; //A
23  I2ang = atand ( imag ( I2 ) / real ( I2 ) ) ; // degree
24  disp ( I2ang , I2mag , " Current  I2 ,  magnitude (A)  &  Angle (
            degree )  are " ) ;
25  I = I1 + I2 ; //A
26  Imag = abs ( I ) ; //A
27  Iang = atand ( imag ( I ) / real ( I ) ) ; // degree
28  disp ( Iang , Imag , " Total  current ,  magnitude (A)  &  Angle (
            degree )  are " ) ;
29  pf = cosd ( Iang ) ; // Power  Factor ( lagging )
30  fi = acosd ( pf ) ; // degree
31  disp ( pf , " Power  Factor ( lagging ) " ) ;
32  P = abs ( V ) * Imag * pf ; //W
33  P = P /1000 ; //kW
34  disp (P , " Power  Consumed (kW) " ) ;
35  // Answer  is  not  accurate  in  the  book .
```

Scilab code Exa 3.28 `Total Current drawn`

```
 1  // Example  3_28
 2  clc ;
 3  clear ;
 4  close ;
 5  format ( 'v' ,5 ) ;
 6  // given  data  :
 7  V =230 ; //V
 8  f =50 ; //Hz
 9  R1 =10 ; // ohm
10  L1 =0.0636 ; //H
11  R2 =8 ; // ohm
12  C =398 ; // micro  F
13  R3 =6 ; // ohm
14  L2 =0.0319 ; //H
```

```
15 Z1=R1+%i*2*%pi*f*L1;//ohm
16 Z2=R2-%i/2/%pi/f/(C*10^-6);//ohm
17 Z3=R3+%i*2*%pi*f*L2;//ohm
18 Z=Z1*Z2/(Z1+Z2)+Z3;//ohm
19 I=V/Z;//A
20 Imag=abs(I);//A
21 Iang=atand(imag(I)/real(I));//degree
22 disp(Iang,Imag,"Current, magnitude(A) & Angle(degree
       ) are");
23 disp(Imag,"Total Current(A)");
24 pf=cosd(Iang);//Power Factor(lagging)
25 fi=acosd(pf);//degree
26 disp(pf,"Power Factor(lagging)");
27 //Answer is not accurate in the book.
```

Scilab code Exa 3.29 Value of R

```
1 //Example 3_29
2 clc;
3 clear;
4 close;
5 format('v',4);
6 //given data :
7 V=230;//V
8 I=25;//A
9 f=50;//Hz
10 R1=5;//ohm
11 R2=10;//ohm
12 L2=50;//mH
13 Z1=R1;//ohm
14 Z2=R2+%i*2*%pi*f*L2/1000;//ohm
15 R=poly(0,'R');
16 Z3=R;//ohm
17 Z12=Z1*Z2/(Z1+Z2);//ohm
18 Z=V/I;//ohm//Zdash is Z durectly
```

83

```
19  R3=Z-Z12;//ohm
20  R3=real(R3);//ohm
21  disp(R3,"Value of R(ohm)");
```

Scilab code Exa 3.30 Current and power factor

```
 1  //Example 3_30
 2  clc;
 3  clear;
 4  close;
 5  format('v',5);
 6  //given data :
 7  V=200;//V
 8  f=50;//Hz
 9  ZA=4+%i*3;//ohm
10  ZB=10-%i*7;//ohm
11  ZC=6+%i*5;//ohm
12  Z=ZC+ZA*ZB/(ZA*ZB);//ohm
13  IC=V/Z;//A
14  ICmag=abs(IC);//A
15  ICang=atand(imag(IC)/real(IC));//degree
16  disp(ICang,ICmag,"Current IC, magnitude(A) & Angle(
        degree) are");
17  IA=IC*ZB/(ZA+ZB);//A
18  IAmag=abs(IA);//A
19  IAang=atand(imag(IA)/real(IA));//degree
20  disp(IAang,IAmag,"Current IA, magnitude(A) & Angle(
        degree) are");
21  IB=IC*ZA/(ZA+ZB);//A
22  IBmag=abs(IB);//A
23  IBang=atand(imag(IB)/real(IB));//degree
24  disp(IBang,IBmag,"Current IB, magnitude(A) & Angle(
        degree) are");
25  fi=ICang;//degree//angle of pf
26  pf=cosd(fi);//Power Factor(lagging)
```

```
27  disp(pf,"Power Factor(lagging)");
28  VC=IC*ZC;//V
29  VCmag=abs(VC);//A
30  VCang=atand(imag(VC)/real(VC));//degree
31  disp(VCang,VCmag,"Voltage VC, magnitude(V) & Angle(
       degree) are");
32  VA=IC*ZA*ZB/(ZA+ZB);//V
33  VAmag=abs(VA);//A
34  VAang=atand(imag(VA)/real(VA));//degree
35  disp(VAang,VAmag,"Voltage VA, magnitude(V) & Angle(
       degree) are");
36  VB=IC*ZA*ZB/(ZA+ZB);//V
37  VBmag=abs(VB);//A
38  VBang=atand(imag(VB)/real(VB));//degree
39  disp(VBang,VBmag,"Voltage VB, magnitude(V) & Angle(
       degree) are");
40  //Answer is not accurate in the book.
```

Scilab code Exa 3.31 `Determine the voltage`

```
1   //Example 3_31
2   clc;
3   clear;
4   close;
5   format('v',5);
6   //given data :
7   I2=10;//A
8   f=50;//Hz
9   R1=5;//ohm
10  L1=0.0191;//H
11  R2=7;//ohm
12  C2=398;//micro F
13  R3=8;//ohm
14  L3=0.0318;//H
15  Z1=R1+%i*2*%pi*f*L1;//ohm
```

```
16  Z2=R2-%i/2/%pi/f/(C2*10^-6);//ohm
17  Z3=R3+%i*2*%pi*f*L3;//ohm
18  VAC=I2*Z2;//V
19  I1=VAC/Z1;//A
20  I=I1+I2;//A
21  VCB=I*Z3;//V
22  VAB=VAC+VCB;//V
23  VABmag=abs(VAB);//A
24  VABang=atand(imag(VAB)/real(VAB));//degree
25  disp(VABang,VABmag,"Voltage AB, magnitude(V) & Angle
       (degree) are");
26  //Answer is not accurate in the book.
```

Scilab code Exa 3.32 Impedence Current and power

```
 1  //Example 3_32
 2  clc;
 3  clear;
 4  close;
 5  format('v',6);
 6  //given data :
 7  V=110;//V
 8  f=50;//Hz
 9  ZA=2;//ohm
10  ZB=3+%i*4;//ohm
11  ZC=2-%i*2;//ohm
12  ZAB=ZA*ZB/(ZA+ZB);//ohm
13  ZP=ZAB*ZC/(ZAB+ZC);//ohm
14  ZD=1+%i*1;//ohm
15  z=ZP+ZD;//ohm
16  zmag=abs(z);//A
17  zang=atand(imag(z)/real(z));//degree
18  disp(zang,zmag,"(a) Total impedence, magnitude(ohm)
       & Angle(degree) are");
19  I=V/abs(z);//A
```

```
20  format ('v',5);
21  disp(I,"(b) Current taken by circuit (A)");
22  format ('v',7);
23  ID=I; //A
24  RD=real(ZD); //ohm
25  PD=ID^2*RD; //W
26  disp(PD,"Power Consumed by branch D(W)");
27  //VPQ=I*ZP;
28  IA=I*abs(ZP)/abs(ZA); //A
29  RA=2; //ohm
30  PA=IA^2*RA; //W
31  disp(PA,"Power Consumed by branch A(W)");
32  IB=I*abs(ZP)/abs(ZB); //A
33  RB=3; //ohm
34  PB=IB^2*RB; //W
35  disp(PB,"Power Consumed by branch B(W)");
36  IC=I*abs(ZP)/abs(ZC); //A
37  RC=2; //ohm
38  PC=IC^2*RC; //W
39  disp(PC,"Power Consumed by branch C(W)");
40  P=PA+PB+PC+PD; //W
41  disp(P,"Total Power Consumed(W)");
42  //Answer is not accurate in the book.
```

Scilab code Exa 3.33 Frequency and Q factor

```
1  //Example 3_33
2  clc;
3  clear;
4  close;
5  format ('v',5);
6  //given data :
7  R=10; ///ohm
8  L=0.1; //H
9  C=8; //micro F
```

```
10  f0=1/2/%pi/sqrt(L*C*10^-6);//Hz
11  disp(f0,"(a) Resonant Frequency(Hz)");
12  Q=2*%pi*f0*L/R;//Q-factor
13  disp(Q,"(b) Q-factor");
14  f1=f0-R/4/%pi/L;//Hz
15  f2=f0+R/4/%pi/L;//Hz
16  disp(f2,f1,"(c) Half power frequencies, f1 & f2 in
       Hz are");
17  BW=f2-f1;//Hz
18  disp(BW,"Bandwidth(Hz)");
19  //Answer is not accurate in the book.
```

Scilab code Exa 3.34 Capacitance and Q factor

```
1  //Example 3_34
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  R=4;///ohm
8  L=0.5;//H
9  V=100;///V
10 f=50;//Hz
11 C=(1/2/%pi/f)^2/L*10^6;//micro F
12 disp(C,"(a) Capacitance at resonant Frequency(micro
      F)");
13 I0=V/R;//A
14 VC=I0/2/%pi/f/(C*10^-6);//V
15 disp(VC,"(b) Voltage across the capacitor at
      resonant(V)");
16 Q=VC/V;//Q-factor
17 disp(Q,"(b) Q-factor");
18 //Answer is not accurate in the book.
```

Scilab code Exa 3.35 Circuit parameters

```
1  //Example 3_35
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  V=230;///V
8  f=50;//Hz
9  Im=1.5;//A//Maximum current
10 VC=600;//V
11 VL=600;//V
12 R=V/Im;//ohm
13 XL=VL/Im;//ohm
14 L=XL/2/%pi/f;//H
15 XC=XL;//ohm
16 C=1/2/%pi/f/XC;//F
17 disp(R,"Resistance(ohm)");
18 format('v',5);
19 disp(L,"Inductance(H)");
20 format('v',11);
21 disp(C,"Capacitance(F)");
22 //Answer is not accurate in the book.
```

Scilab code Exa 3.36 Circuit parameters and Q factors

```
1  //Example 3_36
2  clc;
3  clear;
4  close;
5  format('v',6);
```

89

```
6  //given data :
7  f=100;//Hz
8  C=100;//micro F
9  Cdash=200;//micro F//When current is half of maximum
10 L=1/(2*%pi*f)^2/(C*10^-6);//H
11 disp(L,"Inductance(H)");
12 XL=2*%pi*f*L;//ohm
13 XC=1/2/%pi/f/(Cdash*10^-6);//ohm
14 //at I=Im/2   Z will be 2*R
15 //Im=V/R and I=V/Z=V/sqrt(R^2+(XL–XC)^2)
16 R=(XL-XC)/sqrt(3);//ohm
17 format('v',5);
18 disp(R,"Resistance(ohm)");
19 //Answer is not accurate in the book.
```

Scilab code Exa 3.37 `Voltage and Q factor`

```
1  //Example 3_37
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  R=10;//ohm
8  L=20;//mH
9  C=10;//micro F
10 V=50;//V
11 f0=1/2/%pi/sqrt(L/1000*C/10^6);//Hz
12 disp(f0,"Resonance frequency(Hz)");
13 I0=V/R;//A
14 XL=2*%pi*f0*L/1000;//ohm
15 VL=I0*XL;//V
16 disp(VL,"Voltage across inductance(V)");
17 VR=I0*R;//V
18 disp(VR,"Voltage across Resistance(V)");
```

```
19  XC=1/2/%pi/f0/(C*10^-6);//ohm
20  VC=I0*XC;//V
21  disp(VC,"Voltage across Capacitance(V)");
22  Q=VL/V;//Q-factor
23  disp(Q,"Q-factor");
24  //Answer is not accurate in the book.
```

Scilab code Exa 3.38 Value of C and voltage

```
1  //Example 3_38
2  clc;
3  clear;
4  close;
5  format('v',7);
6  //given data :
7  R=50;//ohm
8  L=1;//mH
9  Im=5;//A//Maximum current
10 f0=50;//Hz
11 C=1/(2*%pi*f0)^2/(L/1000);//F
12 disp(C,"Value of C(F)");
13 V=Im*R;///V
14 disp(V,"Applied Voltage(V)");
15 //Answer is not accurate in the book.
```

Scilab code Exa 3.39 Power factor Impedence and current

```
1  //Example 3_39
2  clc;
3  clear;
4  close;
5  format('v',10);
6  //given data :
```

```
 7  R=2.5;//ohm
 8  XL=25;//ohm
 9  V=200;//V
10  f0=50;//Hz
11  XC=XL;//ohm
12  C=1/(2*%pi*f0*XC);//F
13  disp(C,"For maximum current, Value of C(F)");
14  //At resonance Z=R
15  pf=1;//power factor
16  disp(pf,"Power Factor ");
17  Z=R;//ohm
18  disp(Z,"Impedence(ohm)");
19  Im=V/R;//A
20  disp(Im,"Current(A)");
21  //Answer is not accurate in the book.
```

Scilab code Exa 3.40 Frequency Q factor and current

```
 1  //Example 3_40
 2  clc;
 3  clear;
 4  close;
 5  format('v',7);
 6  //given data :
 7  R=10;//ohm
 8  L=100;//mH
 9  C=20;//micro F
10  V=100;//V
11  f0=1/2/%pi*sqrt(1/(L/1000*C*10^-6)-R^2/(L/1000)^2);
        //Hz
12  disp(f0,"Resonant frequency(Hz)");
13  Q=2*%pi*f0*L/1000/R;//Q-factor
14  disp(Q,"Q-factor");
15  Z0=L/1000/(C*10^-6)/R;//ohm
16  disp(Z0,"Dynamic Impedence(ohm)");
```

```
17 I0=V/Z0;//A
18 disp(I0,"Current at resonance(A)");
19 //Answer is not accurate in the book.
```

Scilab code Exa 3.41 Value of capacitor

```
1  //Example 3_41
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  R=5;//ohm
8  XL=10;//ohm
9  V=230;//V
10 f=50;//Hz
11 Z=R+%i*XL;//ohm
12 IL=V/Z;//A
13 fi_L=atand(imag(IL)/real(IL));//degree
14 IC=abs(IL)*sind(fi_L);//A
15 XC=-V/IC;//ohm
16 C=1/2/%pi/f/XC*10^6;//micro F
17 disp(C,"Value of capacitor(micro F)");
18 I=abs(IL)*cosd(fi_L);//A
19 format('v',3);
20 disp(I,"Magnitude of in-phase current(A)");
21 //Answer is not accurate in the book.
```

Scilab code Exa 3.42 Resonant current

```
1  //Example 3_42
2  clc;
3  clear;
```

```scilab
4  close;
5  format('v',7);
6  //given data :
7  R=4;//ohm
8  L=20;//mH
9  V=230;//V
10 f=50;//Hz
11 omega=2*%pi*f;//rad/s
12 ZL=R+%i*omega*L/1000;//ohm
13 IL=V/ZL;//A
14 fi_L=atand(imag(IL)/real(IL));//degree
15 IC=abs(IL)*sind(fi_L);//A
16 XC=-V/IC;//ohm
17 C=1/2/%pi/f/XC*10^6;//micro F
18 disp(C,"Value of capacitor(micro F)");
19 I0=abs(IL)*cosd(fi_L);//A
20 format('v',5);
21 disp(I0,"Magnitude of in-phase current(A)");
22 //Answer is not accurate in the book.
```

Scilab code Exa 3.43 Value of Ri

```scilab
1  //Example 3_43
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  XL1=6;//ohm
8  R2=10;//ohm
9  XC2=4;//ohm
10 R1=poly(0,'R1');
11 Z1=R1+%i*XL1;//ohm
12 Z2=R2-%i*XC2;//ohm
13 Z=Z1*Z2/(Z1+Z2);//ohm
```

```
14  //Imaginary part of Z will be zero
15  //For Calculation
16  eq=imag(numer(Z)*denom(Z'));//equaltion of imaginary
        part
17  R1=roots(eq);//ohm
18  R1=R1(1);//ohm//leaving -ve value
19  disp(R1,"Value of R1(ohm)");
```

Chapter 4

Semiconductor Fundamentals

Scilab code Exa 4.1 Value of wave vector

```
1  // Example 4_1
2  clc ;
3  clear ;
4  close ;
5  format ( 'v' ,9)
6  // given data :
7  E =2; // eV
8  c =3*10^8; // m/s // Speed of light
9  h =6.64*10^ -34; // Js // Planks Constant
10 E=E*1.6*10^ -19; // J
11 lambda = c*h/E ; // m
12 lambda = lambda /10^ -10; // Angstrum
13 disp ( lambda ," Wavelength ( Angstrum )") ;
14 k =2*%pi /( lambda *10^ -10) ; // m^ −1
15 disp (k ," k−vector (m^ −1) ") ;
```

Scilab code Exa 4.2 Identify the semicnductor

```
1  //Example 4_2
2  clc;
3  clear;
4  close;
5  format('v',7)
6  //given data :
7  c=3*10^8;//m/s//Speed of light
8  h=1.05*10^-34;//Js//Planks Constant
9  lambda=0.5;//micro m///or less
10 lambda=lambda/10^6;//m
11 Eg=2*%pi*h*c/lambda;//J
12 Eg=Eg/(1.6*10^-19);//eV
13 disp(Eg,"Bandgap Eg(eV)");
14 disp("Semiconductors Guess: C, BN, GaN & SiC");
```

Scilab code Exa 4.3 Calculate the energy of electron

```
1  //Example 4_3
2  clc;
3  clear;
4  close;
5  format('v',4)
6  //given data :
7  c=3*10^8;//m/s//Speed of light
8  h=1.05*10^-34;//Js//Planks Constant
9  mc=0.1;//mo
10 mc=mc*0.91*10^-30;//kg
11 k=0.3;///per Angstrum
12 E=h^2*(k/10^-10)^2/2/mc;//J
13 E=E/(1.6*10^-19);//eV
14 disp(E,"Energy of the electron(eV)");
```

Scilab code Exa 4.4 Calculate the energy of electron

```
1  //Example 4_4
2  clc;
3  clear;
4  close;
5  format('v',6)
6  //given data :
7  c=3*10^8;//m/s//Speed of light
8  h=1.05*10^-34;//Js//Planks Constant
9  mc_GaAs=0.067;//mo
10 mc_InAs=0.01;//mo
11 k=0.01;///per Angstrum
12 mc_GaAs=mc_GaAs*0.91*10^-30;//kg
13 mc_InAs=mc_InAs*0.91*10^-30;//kg
14 E_GaAs=h^2*(3*k*10^10)^2/2/mc_GaAs;//J
15 E_GaAs=E_GaAs/(1.6*10^-19)*1000;//meV
16 disp(E_GaAs,"Energy of the electron in GaAs(meV)");
17 E_InAs=h^2*(3*k*10^10)^2/2/mc_InAs;//J
18 E_InAs=E_InAs/(1.6*10^-19)*1000;//meV
19 disp(E_InAs,"Energy of the electron in InAs(meV)");
20 //Answer given in the textbook is wrong.
```

Scilab code Exa 4.5 Calculate the energy of electron

```
1  //Example 4_5
2  clc;
3  clear;
4  close;
5  format('v',6)
6  //given data :
7  c=3*10^8;//m/s//Speed of light
8  h=1.05*10^-34;//Js//Planks Constant
9  mc=0.067;//mo
10 k=[0.1 0.1 0 0];///per Angstrum
11 mc=mc*0.91*10^-30;//kg
12 E=h^2*((k(1)*10^10)^2+(k(2)*10^10)^2)/2/mc;//J
```

```
13  E=E/(1.6*10^-19);//eV
14  disp(E,"Energy of the electron in GaAs(eV)");
15  //Answer given in the textbook is wrong.
```

Scilab code Exa 4.6 Estimate smallest k vector

```
1  //Example 4_6
2  clc;
3  clear;
4  close;
5  format('v',8)
6  //given data :
7  c=3*10^8;//m/s//Speed of light
8  h=1.05*10^-34;//Js//Planks Constant
9  mc=0.067;//mo
10  mc=mc*0.91*10^-30;//kg
11  E=0.3;//eV
12  E=E*1.6*10^-19;//J
13  //Formula//E=3*h^2*kx^2/2/mc
14  kx=sqrt(2*mc*E/3/h^2);//m^-1
15  disp(kx,"Smallest k-vector along x-direction(m^-1)")
       ;
```

Scilab code Exa 4.7 Calculate the energy of electron

```
1  //Example 4_7
2  clc;
3  clear;
4  close;
5  format('v',6)
6  //given data :
7  c=3*10^8;//m/s//Speed of light
8  h=1.05*10^-34;//Js//Planks Constant
```

```
9   mc_GaAs=0.067;//mo
10  mc_InAs=0.01;//mo
11  k=[0.01 0.01 0.01];///per Angstrum
12  mc_GaAs=mc_GaAs*0.91*10^-30;//kg
13  mc_InAs=mc_InAs*0.91*10^-30;//kg
14  E_GaAs=h^2*(3*k(1)*10^10)^2/2/mc_GaAs;//J
15  E_GaAs=E_GaAs/(1.6*10^-19)*1000;//meV
16  disp(E_GaAs,"Energy of the electron in GaAs(meV)");
17  E_InAs=h^2*(3*k(1)*10^10)^2/2/mc_InAs;//J
18  E_InAs=E_InAs/(1.6*10^-19)*1000;//meV
19  disp(E_InAs,"Energy of the electron in InAs(meV)");
20  //Answer given in the textbook is wrong.
```

Scilab code Exa 4.8 Position of fermi level

```
1   //Example 4_8
2   clc;
3   clear;
4   close;
5   format('v',6)
6   //given data :
7   n0=6*10^17;//cm^-3
8   Nc=4.45*10^17;//cm^-3
9   kBT=0.026;//eV//at room temperature/T=300 K
10  EF=kBT*log(n0/Nc)*1000;//meV
11  disp(EF,"Position of fermi level(meV)");
```

Scilab code Exa 4.9 Position of fermi level

```
1   //Example 4_9
2   clc;
3   clear;
4   close;
```

```
5  format ('v',6)
6  //given data :
7  //me=2*mh
8  meBYmh=2;//ratio
9  T=300;//K
10 kT=0.026;//eV//at room temperature/T=300 K
11 //EF=3/4*kT*log(1/meBYmh)−EG/2
12 //position of fermi level below centre of forbidden
       gap
13 EF=-3/4*kT*log(1/meBYmh);//eV
14 disp(EF,"Position of fermi level below centre of
       forbidden gap by (eV) : ");
```

Scilab code Exa 4.10 Position of fermi level

```
1  //Example 4_10
2  clc;
3  clear;
4  close;
5  format ('v',7)
6  //given data :
7  h=1.05*10^-34;//Js//Planks Constant
8  mc=0.067;//mo
9  mc=mc*0.91*10^-30;//kg
10 n0=10^18;//cm^−3
11 n0=n0*10^6;//m^−3
12 EF=(h^2/2/mc)*(3*%pi^2*n0)^(2/3);//J
13 EF=EF/(1.6*10^-19);//eV
14 disp(EF,"Position of fermi level(eV)");
15 //Answer given in the textbook is wrong
```

Scilab code Exa 4.11 Calculate the time

```
1  //Example 4_11
2  clc;
3  clear;
4  close;
5  format('v',6)
6  //given data :
7  h=1.05*10^-34;//Js//Planks Constant
8  e=1.6*10^-19;//C///Charge on electron
9  E0=10^4;//V/cm
10 a=5.62*10^-8;//cm//lattice constant for n-GaAs
11 kB=2*%pi/a;//cm^-1///Brillouin Edge
12 tau=h*kB/e/E0*10^12;//ps
13 disp(tau,"Time taken by electron to reach Brillouin
       Zone(ps)");
14 //Answer given in the textbook is wrong
```

Scilab code Exa 4.12 Calculate the drift velocity

```
1  //Example 4_12
2  clc;
3  clear;
4  close;
5  format('e',9)
6  //given data :
7  h=1.05*10^-34;//Js//Planks Constant
8  e=1.6*10^-19;//C///Charge on electron
9  mc=0.067;//mo
10 mc=mc*0.91*10^-30;//kg
11 E0=1;//kV/cm
12 E0=E0*10^3/10^-2;//V/m
13 //Part (a)
14 tau_sc=10^-13;//s
15 v0=e*tau_sc*E0/mc;///m/s
16 v0=v0*100;//cm/s
17 disp(v0,"(a) Drift velocity(cm/s)");
```

```
18  //Part (b)
19  tau_sc=10^-12;//s
20  v0=e*tau_sc*E0/mc;///m/s
21  v0=v0*100;//cm/s
22  disp(v0,"(b) Drift velocity(cm/s)");
23  //Part (c)
24  tau_sc=10^-11;//s
25  v0=e*tau_sc*E0/mc;///m/s
26  v0=v0*100;//cm/s
27  disp(v0,"(c) Drift velocity(cm/s)");
```

Scilab code Exa 4.13 Conductivity and drift velocity

```
1   //Example 4_13
2   clc;
3   clear;
4   close;
5   format('v',9)
6   //given data :
7   n0=7.87*10^28;//m^-3
8   mu=35.2;//cm^2/vs
9   E0=30*10^2;//V/m
10  h=1.05*10^-34;//Js//Planks Constant
11  e=1.6*10^-19;//C///Charge on electron
12  //Part (a)
13  sigma=n0*e*mu*10^-4;//s/m
14  disp(sigma,"(a) Conductivity(s/m)");
15  //Part (b)
16  V0=E0*mu*10^-4;//m/s
17  disp(V0,"(b) Drift velocity of electron(m/s)");
18  J=sigma*E0;//A/m^3
19  disp(J,"(b) Current density(A/m^3)")
20  //Answer given in the textbook is not accurate.
```

Scilab code Exa 4.14 Calculate the drift velocity

```
1  //Example 4_14
2  clc;
3  clear;
4  close;
5  format('e',9)
6  //given data :
7  A=10^-5;//m^2
8  I=100;//A
9  n0=8.5*10^28;//m^-3
10 e=1.6*10^-19;//C///Charge on electron
11 //Formula : I=no*A*vd*e
12 vd=I/n0/A/e;//ms^-1
13 disp(vd,"Drift Velocity(ms^-1)")
```

Scilab code Exa 4.15 Calculate the drift velocity

```
1  //Example 4_15
2  clc;
3  clear;
4  close;
5  format('e',9)
6  //given data :
7  A=10^-5;//m^2
8  I=100;//A
9  n0=8.5*10^28;//m^-3
10 e=1.6*10^-19;//C///Charge on electron
11 //Formula : I=no*A*vd*e
12 vd=I/n0/A/e;//ms^-1
13 disp(vd,"Drift Velocity(ms^-1)")
```

Scilab code Exa 4.16 Calculate the drift velocity

```scilab
1  //Example 4_16
2  clc;
3  clear;
4  close;
5  format('v',7);
6  //given data :
7  V=1; //V
8  L=10; //m
9  tau=10^-14; //s
10 e=1.6*10^-19; //C///Charge on electron
11 m=0.02*9.1*10^-31; //kg//effective mass of electron
12 E0=V/L; //V/m
13 v0=e*E0*tau/m; //m/s
14 disp(v0,"Drift Velocity(ms^-1)")
```

Scilab code Exa 4.17 Equilibrium hole concentration

```scilab
1  //Example 4_17
2  clc;
3  clear;
4  close;
5  format('e',9);
6  //given data :
7  Nd=10^17; //atoms/cm^3
8  ni=1.5*10^10; //atoms/cm^3
9  n0=Nd; //atoms/cm^3(For Nd>>ni)
10 p0=ni^2/n0; //atoms/cm^3
11 disp(p0,"Equilibrium hole concentration(cm^-3)")
```

Scilab code Exa 4.18 Calculate the time

```scilab
1  //Example 4_18
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  h=1.05*10^-34;//Js//Planks Constant
8  e=1.6*10^-19;//C///Charge on electron
9  E0=10^4;//V/cm
10 a=5.62*10^-8;//cm//lattice constant for n-GaAs
11 kB=2*%pi/a;//cm^-1///Brillouin Edge
12 tau=h*kB/e/E0*10^12;//ps
13 disp(tau,"Time taken by electron to reach Brillouin
       Zone(ps)");
14 //Answer given in the textbook is wrong
```

Scilab code Exa 4.19 Estimate smallest k vector

```scilab
1  //Example 4_19
2  clc;
3  clear;
4  close;
5  format('v',8);
6  //given data :
7  c=3*10^8;//m/s//Speed of light
8  h=1.05*10^-34;//Js//Planks Constant
9  mc=0.067;//mo
10 mc=mc*0.91*10^-30;//kg
11 E=0.3;//eV
12 E=E*1.6*10^-19;//J
```

```
13  //Formula//E=3*h^2*kx^2/2/mc
14  kx=sqrt(2*mc*E/3/h^2);//m^-1
15  disp(kx,"Smallest  k-vector  along  x-direction(m^-1)")
      ;
```

Scilab code Exa 4.20 Electron and hole concentration

```
1   //Example 4_20
2   clc;
3   clear;
4   close;
5   format('e',9);
6   //given data :
7   ni=1.5*10^10;//cm^-3
8   mu_n=1350;//cm^2/V-s
9   mu_p=450;//cm^2/V-s
10  n0=ni*sqrt(mu_p/mu_n);//cm^-3
11  p0=ni*sqrt(mu_n/mu_p);//cm^-3
12  disp(n0,"Electron  concentration(cm^-3)")
13  disp(p0,"Hole  concentration(cm^-3)")
```

Scilab code Exa 4.21 Position of fermi level

```
1   //Example 4_21
2   clc;
3   clear;
4   close;
5   format('v',7);
6   //given data :
7   h=1.05*10^-34;//Js//Planks Constant
8   n0=6.02*10^23;//atom/mole
9   n0=n0/72.6;//atom/gram
10  n0=n0*5.32;//atom/cm^3
```

```
11  ND =1/10^7* n0 ; //cm^−3
12  T =300; //K
13  //mc=1/2∗mo
14  mcBYmo =1/2;
15  kBT =0.026; //eV//For T=300K
16  Nc = ND *( mcBYmo * T )^(3/2) ; //cm^−3
17  n0=ND; //cm^−3///Considering full ionization
18  EF = kBT * log ( n0 / Nc ) ; //eV
19  disp ( EF ," Position of fermi level (eV)")
```

Scilab code Exa 4.22 Mobility of free electron

```
1  //Example 4_22
2  clc ;
3  clear ;
4  close ;
5  format ('e' ,8) ;
6  //given data :
7  e =1.6*10^-19; //C/ electron
8  d =270; //g/cm^3
9  rho =3.44*10^-6; //ohm−cm
10 ne =3; // electrons / atom
11 me =26.97*1.66*10^ -27
12 n0=d/100* ne *10^ -3/ me *10^6; //m^−3
13 mu =1/ n0 / e / rho *10^2; //V−sec
14 disp ( mu ," Mobility of free electron (m^2/V−s ) ")
```

Scilab code Exa 4.23 Mobility of free electron

```
1  //Example 4_23
2  clc ;
3  clear ;
4  close ;
```

```
5  format('v',4);
6  //given data :
7  e=1.6*10^-19;//C/electron
8  Eg=1.21;//eV
9  ne=3;//electrons/atom
10 dniBYni=(1.5+Eg/0.052)*(1/ne/100)*100;//% per degree
11 disp(dniBYni,"100*dni/ni is ( % per degree)");
```

Scilab code Exa 4.24 Drift velocity mobility and conductivity

```
1  //Example 4_24
2  clc;
3  clear;
4  close;
5  format('e',9);
6  //given data :
7  d=1.03;//mm
8  R=6.51;//ohm per 1000 ft.
9  n0=8.4*10^27;//electrons/m^3
10 I=2;//A
11 A=%pi/4*d^2*10^-6;//m^2
12 J=I/A;//A/m^2
13 e=1.6*10^-19;//C/electron
14 v0=J/n0/e;//m/s
15 disp(v0,"(a) Drift Velocity(m/s)");
16 R=R/1000/0.304;//ohm/m
17 E0=I*R;//V/m
18 mu=v0/E0;//m^2/V-s
19 disp(mu,"(b) Mobility(m^2/V-s)");
20 sigma=n0*e*mu;//(ohm-m)^-1
21 disp(sigma,"(c) Conductivity((ohm-m)^-1)")
22 //Answer wrong in the book. calculation mistake.
```

Scilab code Exa 4.25 `Concentration of free electron`

```scilab
1  //Example 4_25
2  clc;
3  clear;
4  close;
5  format('v',9);
6  //given data :
7  T=300;//K
8  //Part (a)
9  ND=2*10^14;//cm^-3//Donor
10 NA=3*10^14;//cm^-3//Acceptor
11 ni=2.5*10^19;//m^-3//Intrinsic
12 ni=ni/10^6;//m^-3
13 n0=-(NA-ND)/2+sqrt([((NA-ND)/2)^2+ni^2]);//cm^-3
14 p0=-(ND-NA)/2+sqrt([((ND-NA)/2)^2+ni^2]);//cm^-3
15 disp(n0,"n0 is(cm^-3)");
16 disp(p0,"p0 is(cm^-3)");
17 if p0>n0 then
18     disp("(a) Since p0>n0, Sample is of p-type.");
19 end;
20 //Part (b)
21 format('v',4);
22 ND=10^15;//cm^-3
23 NA=10^15;//cm^-3
24 p0=poly(0,'p0');
25 n0=p0+ND-NA;//cm^-3
26 disp(n0,"(b) n0 is equal to ");
27 disp("It is Intrinsic Semiconductor")
28 //Part (c)
29 disp("Part(c) : ");
30 format('v',7);
31 ND=10^16;//cm^-3
32 NA=10^14;//cm^-3
33 n0=ND;//cm^-3(For NA<<ND)
34 p0=ni^2/ND;//cm^-3
35 disp(n0,"n0 is(cm^-3)");
36 format('v',9);
```

```
37  disp(p0,"p0 is (cm^-3)");
38  if p0<n0 then
39      disp("(c) Since p0<n0, Sample is of n-type.");
40  end;
```

Scilab code Exa 4.26 `Concentration of holes and electron`

```
1   //Example 4_26
2   clc;
3   clear;
4   close;
5   format('e',9);
6   //given data :
7   T=300;//K
8   e=1.6*10^-19;//C/electron
9   disp("Part(a) :");
10  sigma=100;//(ohm-cm)^-1
11  ni=2.5*10^13;//cm^-3//For Ge
12  mu_p=1800;//cm^2/V-s//For Ge
13  //sigma=p0*e*mu_p, since p0>>n0
14  p0=sigma/e/mu_p;//cm^-3
15  n0=ni^2/p0*10^6;//m^-3
16  disp(p0,"Concentration of holes(cm^-3)");
17  disp(n0,"Concentration of electrones(m^-3)");
18  disp("Part(b) :");
19  sigma=0.1;//(ohm-cm)^-1
20  ni=1.5*10^10;//cm^-3//For Si
21  mu_n=1300;//cm^2/V-s//For Si
22  //sigma=n0*e*mu_p, since n0>>p0
23  n0=sigma/e/mu_n;//cm^-3
24  p0=ni^2/n0*10^6;//m^-3
25  disp(n0,"Concentration of electrones(cm^-3)");
26  disp(p0,"Concentration of holes(m^-3)");
```

Scilab code Exa 4.27 Resistivity of intrinsic Ge

```
1 //Example 4_27
2 clc;
3 clear;
4 close;
5 format('v',5);
6 //data for intrinsic Ge
7 //n0=p0=ni;///for intrinsic
8 ni=2.5*10^13;//cm^-3
9 mu_n=3800;//cm^2/V-s
10 mu_p=1800;//cm^2/V-s
11 mu=mu_n+mu_p;//cm^2/V-s
12 e=1.6*10^-19;//C/electron
13 sigma=e*ni*(mu);//(s/cm)
14 rho=1/sigma;//ohm-cm
15 disp(rho,"Resistivity of intrinsic Ge(ohm-cm) : ");
```

Scilab code Exa 4.28 Conductivity of intrinsic Ge

```
1 //Example 4_28
2 clc;
3 clear;
4 close;
5 format('v',8);
6 //data for intrinsic Ge
7 //n0=p0=ni;///for intrinsic
8 ni=2.5*10^13;//cm^-3
9 mu_n=3800;//cm^2/V-s
10 mu_p=1800;//cm^2/V-s
11 mu=mu_n+mu_p;//cm^2/V-s
12 e=1.6*10^-19;//C/electron
```

```
13  sigma=e*ni*(mu);//(s/cm)
14  disp(sigma,"(a) Conductivity of intrinsic Ge(s/cm) :
        ");
15  format('v',5);
16  n=4.41*10^22;//cm^-3//Concentration of Ge atom
17  ND=n/10^7;//cm^-3
18  n0=ND;//cm^-3
19  p0=ni^2/ND;//cm^-3
20  sigma=n0*e*mu_n;//s/cm(n0<<p0, n0 neglected)
21  disp(sigma,"(b) Conductivity(s/cm)");
22  NA=n/10^7;//cm^-3
23  p0=NA;//cm^-3
24  n0=ni^2/NA;//cm^-3
25  sigma=p0*e*mu_p;//s/cm(p0<<n0, p0 neglected)
26  disp(sigma,"(c) Conductivity(s/cm)");
```

Chapter 5

Diode Fundamentals

Scilab code Exa 5.1 Height of potential barrier

```
1  //Example 5_1
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  rho_p=1.5; //ohm-cm
8  rho_n=1; //ohm-cm
9  e=1.6*10^-19; //C/electron
10 //For Ge diode
11 mu_p=1800; //cm^2/V-s//For Ge
12 mu_n=3800; //cm^2/V-s//For Si
13 VT=0.026; ///eV//at room temperature
14 ni=2.5*10^13; //cm^-3s
15 //rho=1/(NA*e*mu)
16 NA=1/(rho_p*e*mu_p); //cm^-3
17 ND=1/(rho_n*e*mu_n); //cm^-3
18 V0=VT*log(NA*ND/ni^2); //eV
19 disp(V0,"(a) Height of potential barrier(eV)");
20 //For Si diode
21 mu_p=500; //cm^2/V-s//For Ge
```

```
22  mu_n=1300;//cm^2/V-s//For Si
23  VT=0.026;///eV//at room temperature
24  ni=1.5*10^10;//cm^-3s
25  //rho=1/(NA*e*mu)
26  NA=1/(rho_p*e*mu_p);//cm^-3
27  ND=1/(rho_n*e*mu_n);//cm^-3
28  V0=VT*log(NA*ND/ni^2);//eV
29  disp(V0,"(b) Height of potential barrier(eV)");
30  ///Answer in the texbook is not accurate.
```

Scilab code Exa 5.2 Width of depletion zone

```
 1  //Example 5_2
 2  clc;
 3  clear;
 4  close;
 5  format('e',9);
 6  //given data :
 7  ND=10^16;//cm^-3
 8  A=4*10^-4;//cm^2
 9  NA=5*10^18;//cm^-3
10  T=300;//K
11  epsilon0=8.85*10^-14;//vaccum permittivity
12  epsilonr=11.8;//relative permittivity
13  e=1.6*10^-19;//C/electron
14  ni=1.5*10^10;//cm^-3
15  kBT=0.0259;//eV//at room temperture
16  V0=kBT*log(NA*ND/ni^2);//V
17  W=sqrt(2*epsilonr*epsilon0*V0/e*(1/NA+1/ND));//cm
18  disp(W,"Width of depletion zone(cm)");
19  ///Answer in the texbook is not accurate.Calculation
         mistake in W.
```

Scilab code Exa 5.3 Thermal and barrier voltage

```
1  //Example 5_3
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  ND=1.2*10^21;//cm^-3
8  NA=10^22;//cm^-3
9  T=(273+30);//K
10 kB=1.38*10^-23;//Boltzman constant
11 e=1.6*10^-19;//C/electron
12 VT=kB*T/e*1000;//mV//Thermal Voltage
13 disp(VT,"Thermal Voltage(mV)")
14 format('v',6);
15 ni=1.5*10^16;//cm^-3
16 V0=VT/1000*log(NA*ND/ni^2);//V
17 disp(V0,"Barrier Voltage(V)");
18 ///Answer in the texbook is not accurate.
```

Scilab code Exa 5.4 Calculate the barrier potential

```
1  //Example 5_4
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  t1=25;//degree C
8  t2=70;//degree C
9  VB1=0.7;//V
10 delV=-0.002*(t2-t1);//V
11 VB2=VB1+delV;//V//barrier potential
12 disp(VB2,"(a) Barrier potential at 70 degree C is (V
```

```
     )");
13 //Part (b)
14 t1=25;//degree C
15 t2=0;//degree C
16 VB1=0.7;//V
17 delV=-0.002*(t2-t1);//V
18 VB2=VB1+delV;//V//barrier potential
19 disp(VB2,"(b) Barrier potential at 0 degree C is (V)
     ");
```

Scilab code Exa 5.5 Find CT

```
1 //Example 5_5
2 clc;
3 clear;
4 close;
5 format('v',6);
6 //Part(a) Derivation
7 //Part(b)
8 //given data :
9 mu_p=500;//cm^2/V-s
10 q=1.6*10^-19;//C/electron
11 rho=3;//ohm-cm
12 V0=0.4;//V//Barrier Height
13 Vd=4.5;//V//Reverse Voltage
14 D=40;//mils
15 D=D*10^-3;//inch
16 D=D*2.54;//cm/in
17 A=%pi/4*D^2;//cm^2
18 NA=1/rho/mu_p/q;//cm^-3
19 W=sqrt((V0+Vd)/(14.13*10^10));//m^2
20 Vj=V0+Vd;//V
21 CT=2.9*10^-4*sqrt(NA/Vj)*A;///pF
22 disp(CT,"CT(pF) : ");
23 //Answer given in the textbook is not accurate.
```

Scilab code Exa 5.6 Compute the decrease in capacitance

```scilab
1  //Example 5_6
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  V=5;//V
8  CT=20;//pF
9  lambda=CT*sqrt(V);//pm
10 //increased V=V+1.5;//V
11 V=V+1.5;//V
12 CTnew=lambda/sqrt(V);//pF
13 dCT=CT-CTnew;//pF
14 disp(dCT,"Decrese in capacitance(pF)");
15 //Answer given in the textbook is not accurate.
```

Scilab code Exa 5.7 Calculate the barrier capacitance

```scilab
1  //Example 5_7
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  A=1.5*1.5;//mm^2
8  A=A/100;//cm^2
9  W=2*10^-4;//cm(Space charge thikness)
10 epsilon=16/(36*%pi*10^11);//F/cm(For Ge)
11 CT=epsilon*A/W*10^12;//pF
12 disp(CT,"Barrier capacitance(pF)");
```

Scilab code Exa 5.8 `Width of depletion layer`

```scilab
1  //Example 5_8
2  clc;
3  clear;
4  close;
5  format('v',4);
6  //given data :
7  e=1.6*10^-19; //C/electron
8  NA=2.5*10^20; //atoms/m^3
9  epsilon=16/(36*%pi*10^9); //F/m(For Ge)
10 Vd=0.2; //V//Barrier height
11 //Part(a)
12 V0=10; //V(reverse bias)
13 W=sqrt((V0+Vd)*2*epsilon/e/NA)*10^6; //micro m
14 disp(W,"(a) Width of depletion layer(micro m)");
15 format('v',5);
16 //Part(b)
17 V0=0.1; //V(reverse bias)
18 W=sqrt((V0+Vd)*2*epsilon/e/NA)*10^6; //micro m
19 disp(W,"(b) Width of depletion layer(micro m)");
20 //Part(c)
21 V0=0.1; //V(forward bias)
22 W=sqrt((Vd-V0)*2*epsilon/e/NA)*10^6; //micro m
23 disp(W,"(c) Width of depletion layer(micro m)");
24 //Part(d)
25 A=1; //mm^2//Cross section area
26 A=A/10^6; //m^2
27 format('v',6);
28 //For (a)
29 V0=10; //V(reverse bias)
30 W=sqrt((V0+Vd)*2*epsilon/e/NA)*10^6; //micro m
31 CT=epsilon*A/(W*10^-6)*10^12; //pF
32 disp(CT,"(d)(a) Space Charge capacitance(pF) ");
```

119

```
33  //For (b)
34  V0=0.1; //V( reverse  bias)
35  W=sqrt((V0+Vd)*2*epsilon/e/NA)*10^6; //micro m
36  CT=epsilon*A/(W*10^-6)*10^12; //pF
37  disp(CT,"(d)(b) Space Charge capacitance(pF) ");
38  //Answer given in the textbook is not accurate.
```

Scilab code Exa 5.10 Reverse saturation point

```
 1  //Example 5_10
 2  clc;
 3  clear;
 4  close;
 5  format('v',6);
 6  //given data :
 7  sigma_p=3; //(ohm-cm)^-1
 8  sigma_n=0.1; //(ohm-cm)^-1
 9  Ln=0.15; //cm
10  Lp=0.15; //cm
11  e=1.6*10^-19; //C/electron
12  mu_p=1800; //cm^2/V-s //For Ge
13  mu_n=3800; //cm^2/V-s //For Si
14  VT=0.026; ///eV//at T=27 degree C
15  A=1.5; //mm^2
16  A=A*10^-6; //m^2
17  b=mu_n/mu_p; //unitless
18  ni=2.5*10^15; //m^-3
19  sigma_i=(mu_n+mu_p)*ni*e; //(ohm-m)^-1
20  I0=A*VT*b*sigma_i^2/(1+b)^2*(1/Lp/sigma_p+1/Ln/
        sigma_n)*10^6; //micro A
21  disp(I0,"Reverse saturation point of current(micro A
        )");
```

Scilab code Exa 5.12 `Reverse saturation current`

```scilab
1  //Example 5_12
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  A=5;//mm^2
8  A=A*10^-2;//cm^2
9  Ln=0.01;//cm
10 Lp=0.01;//cm
11 sigma_p=0.01;//(ohm-cm)^-1
12 sigma_n=0.01;//(ohm-cm)^-1
13 mu_p=500;//cm^2/V-s//For Ge
14 mu_n=1300;//cm^2/V-s//For Si
15 e=1.6*10^-19;//C/electron
16 VT=0.026;///eV//at T=27 degree C
17 b=mu_n/mu_p;//unitless
18 ni=1.5*10^10;//m^-3
19 sigma_i=(mu_n+mu_p)*ni*e;//(ohm-m)^-1
20 I0=A*VT*b*sigma_i^2/(1+b)^2*(1/Lp/sigma_p+1/Ln/
      sigma_n)*10^12;//pA
21 disp(I0,"Reverse saturation current(pA)");
```

Scilab code Exa 5.13 `Ratio of reverse saturation current`

```scilab
1  //Example 5_13
2  clc;
3  clear;
4  close;
5  format('e',9);
6  //given data :
7  Ln=0.1;//cm
8  Lp=0.1;//cm
```

```
 9  e=1.6*10^-19; //C/ electron
10  // For Si
11  ni=1.5*10^10; //m^-3
12  sigma_p=0.01; // (ohm-cm)^-1
13  sigma_n=0.01; // (ohm-cm)^-1
14  mu_n=1300; //cm^2/V-s// For Si
15  mu_p=500; //cm^2/V-s// For Ge
16  b=mu_n/mu_p; // unitless
17  sigma_i=(mu_n+mu_p)*ni*e; // (ohm-m)^-1
18  YSi=b*sigma_i^2/(1+b)^2*(1/Lp/sigma_p+1/Ln/sigma_n);
        // (ohm-cm^2)^-1
19  // For Ge
20  ni=2.5*10^13; //m^-3
21  sigma_p=1; // (ohm-cm)^-1
22  sigma_n=1; // (ohm-cm)^-1
23  mu_n=3800; //cm^2/V-s// For Si
24  mu_p=1800; //cm^2/V-s// For Ge
25  b=mu_n/mu_p; // unitless
26  sigma_i=(mu_n+mu_p)*ni*e; // (ohm-m)^-1
27  YGe=b*sigma_i^2/(1+b)^2*(1/Lp/sigma_p+1/Ln/sigma_n);
        // (ohm-cm^2)^-1
28  ratio=YGe/YSi;
29  disp(ratio,"Ratio of reverse saturation current in
        Ge to that in Si");
30  //Answer given in the book is not accurate.
```

Scilab code Exa 5.14 Calculate the current

```
1  //Example 5_14
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  I0=9*10^-7; //A
```

```
8  VF=0.1;//V
9  I=I0*(exp(40*VF)-1)*10^6;//micro A
10 disp(I,"Current flowing(micro A)");
11 //Answer given in the book is not accurate.
```

Scilab code Exa 5.15 Find the voltage

```
1  //Example 5_15
2  clc;
3  clear;
4  close;
5  format('v',7);
6  //given data :
7  e=1.6*10^-19;//C/electron
8  J0=500;//mA/m^2
9  J0=J0/1000;//A/m^2
10 T=350;//K
11 Eta=1;//For Ge
12 k=1.38*10^-23;//Boltzman constant
13 J=10^5;//Am^-2
14 //J=J0*(exp(e*V/Eta/kT-1)
15 V=(1+log(J/J0))/e*Eta*k*T;//V
16 disp(V,"Voltage to be applied at junction(V)");
17 //Answer given in the book is not accurate.
```

Scilab code Exa 5.16 Find the current

```
1  //Example 5_16
2  clc;
3  clear;
4  close;
5  format('v',7);
6  //given data :
```

```
 7  e=1.6*10^-19;//C/electron
 8  kB=1.38*10^-23;//Boltzman constant
 9  Is=0.15;//pA
10  Is=Is*10^-12;//A
11  V=0.55;//V(Forward Biased)
12  Eta=1;//Assumed
13  //At t=20 degee C
14  t=20;//degree C
15  T=t+273;//K
16  VT=kB*T/e;//V
17  I=Is*(exp(V/Eta/VT)-1)*1000;//mA
18  //At t=100 degee C
19  t=100;//degree C
20  T=t+273;//K
21  VT=kB*T/e;//V
22  //Is increased by factor 2^8
23  Is=Is*2^8;//A
24  I=Is*(exp(V/Eta/VT)-1);//A
25  disp(I,"Current in the diode(A)");
```

Scilab code Exa 5.17 Calculate the current and voltage

```
 1  //Example 5_17
 2  clc;
 3  clear;
 4  close;
 5  format('v',7);
 6  //given data :
 7  e=1.6*10^-19;//C/electron
 8  kB=1.38*10^-23;//Boltzman constant
 9  Eta=2;//For Si diode
10  I01=2;//micro A
11  I02=4;//micro A
12  Vz1=100;//V
13  Vz2=100;//V
```

```
14  VT=0.026;//V//Thermal temperature
15  disp("When V=90V : ");
16  V=90;//V
17  //V<Vz1 & Vz2; Breakdown will not occur
18  I1=I01/2;//micro A(For D1)
19  disp(I1,"For D1, Current is (micro A)");
20  I2=-I01/2;//micro A
21  disp(I2,"For D2, Current is (micro A)");
22  V2=Eta*VT*log(1-I01/I02);//V
23  V1=V+V2;//V
24  disp(V1,"Voltage V1(V) : ");
25  format('v',5);
26  V2=V2*1000;//mV
27  disp(V2,"Voltage V2(mV) : ");
28  disp("When V=110V : ");
29  V=110;//V
30  //V>Vz1 //D1 breakdown & D2 reverse biased
31  I=I01;//micro A
32  disp(I,"Current in the circuit is (micro A)");
33  V1=-Vz1;///V
34  V2=-(V-Vz2);//V
35  disp(V1,"Voltage V1(V) : ");
36  disp(V2,"Voltage V1(V) : ");
```

Scilab code Exa 5.18 Ratio of current

```
1  //Example 5_18
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  e=1.6*10^-19;//C/electron
8  VT=0.026;//V//Thermal Voltage
9  IBYI0=-90/100;//ratio
```

```
10  // Part (a)
11  // I=I0 *( exp (V/VT) -1)
12  V= log ( IBYI0 +1)* VT ; // V
13  disp (V ," (a) Required Voltage is (V)") ;
14  // Part (b)
15  format ( 'v' ,5) ;
16  V =0.05; // V( Forward bias )
17  ratio =( exp (V/VT ) -1) /( exp (-V/VT ) -1) ; // ratio
18  disp ( ratio ," (b) Current ratio ") ;
19  // Part (c)
20  format ( 'v' ,6) ;
21  I0 =15; // micro A
22  V =[0.1 0.2 0.3]*1000; // mV
23  VT = VT *1000; // mV
24  I1 = I0 *( exp (V(1) /VT ) -1) /1000; // mA
25  I2 = I0 *( exp (V(2) /VT ) -1) /1000; // mA
26  I3 = I0 *( exp (V(3) /VT ) -1) /10^6; // A
27  disp (" (c) Current for 0.1 V is "+ string (I1)+" mA ,
         for 0.2 V is "+ string (I2)+" mA & for 0.3 V is "+
         string (I3)+" A .") ;
28  // Answer given in the book is not accurate .
```

Scilab code Exa 5.19 Calculate the anticipated factor

```
1  // Example 5_19
2  clc ;
3  clear ;
4  close ;
5  format ( 'v' ,4) ;
6  // given data :
7  // Part (a)
8  t1 =25; // degree C
9  t2 =70; // degree C
10  I0t2BYI0t1 =2^(( t2 - t1 ) /10+1) ; // anticipated factor
11  disp ( I0t2BYI0t1 ," (a) Anticipated factor ") ;
```

```
12  disp("I0(70  degree  C)  =  "+string(I0t2BYI0t1)+"*I0(25
        degree  C)");
13  //Part  (b)
14  format('v',6)
15  t1 =25; //degree  C
16  t2 =150; //degree  C
17  I0t2BYI0t1 =2^((t2-t1)/10); //anticipated  factor
18  disp(I0t2BYI0t1 ,"(b)  Anticipated  factor");
19  disp("I0(150  degree  C)  =  "+string(I0t2BYI0t1)+"*I0
        (25  degree  C)");
20  //Answer  in  the  textbook  is  not  accurate.
```

Scilab code Exa 5.20 Leakage resistance

```
1  //Example  5_20
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given  data  :
7  I=5; //micro  A
8  V=10; //V
9  //1/I0*dI0/dT=0.15  &  1/I*dI0/dT=0.07
10  I0=I/(0.15/0.07); //micro  A
11  //I=I0+IR
12  IR=I-I0; //micro  A
13  R=V/IR; //Mohm
14  disp(R,"Leakage  Resistance(Mohm)");
```

Scilab code Exa 5.21 Maximum reverse bias voltage

```
1  //Example  5_21
2  clc;
```

```
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  Rt=0.15;//mW/degree C(Thermal resistance)
8  t1=25;//degree C
9  I0_t1=5;//micro A(at 25 degree C)
10 delt=10;//degree C
11 t2=t1+delt;//degree C
12 Pout=Rt*(t2-t1);//mW
13 //reverse current doubles at evry 10 degree C
14 I0_t2=2*I0_t1;//micro A
15 V=Pout/(I0_t2/1000);//V
16 disp(V,"Maximum reverse bias voltage(V)");
```

Scilab code Exa 5.22 Current multiplying factor

```
1  //Example 5_22
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  V=0.4;//V(Forward voltage)
8  t1=25;//degree C
9  t=150;//degree C
10 T=t+273;//K
11 T1=t1+273;//K
12 VT=T/11600;//V
13 //I0T=I01*2^((T-T1)/10)
14 I0TBYI0T1=2^((T-T1)/10);//ratio of current
15 Eta=2;//for Si
16 I2ByI0T=(exp(V/Eta/VT)-1);//ratio of current
17 //At 25 degree C
18 VT1=T1/11600;//V
```

```
19  I1ByI0T1=(exp(V/Eta/VT1)-1);//A///at 25 degree C
20  I2ByI1=I2ByI0T/I1ByI0T1*I0TBYI0T1;///ratio of I2 &
        I1
21  disp(I2ByI1,"Current multiplying factor is ");
22  //Note : Solution is complete in this code.
23  //In the textbook, extra lines are given for which
        data is not given.
```

Scilab code Exa 5.24 Diffusion Length

```
1  //Example 5_24
2  clc;
3  clear;
4  close;
5  format('e',10);
6  //given data :
7  I=1;///mA
8  CD=1.5;//micro F
9  Eta=2;//for Si
10 Dp=13;//for Si
11 VT=0.026;//V(Thermal voltage)
12 Lp=sqrt(CD/10^6*Dp*Eta*VT/(I*10^-3));//m
13 disp(Lp,"Diffusion Length(m)");
```

Scilab code Exa 5.25 Find the static resistance

```
1  //Example 5_25
2  clc;
3  clear;
4  close;
5  format('v',7);
6  //given data :
7  I0=20;///micro A
```

```
 8  VF=0.2;//V
 9  t=27;//degree C
10  T=t+273;//K
11  VT=T/11600;//V(Thermal voltage)
12  Eta=1;//for Ge
13  I=I0*10^-6*[exp(VF/Eta/VT)-1]*1000;//mA
14  rdc=VT/(I0*10^-6)*exp(VF/Eta/VT)/10^6;//Mohm
15  disp(rdc,"Static Resistance(Mohm) : ");
16  //Note : Answer & Solution in the textbook is wrong
        as they calculated rdc for the values given in
        next example.
17  //I0 taken 80micro A instead 20 micro A & VT taken
        for 125 degree C instead 25 degree C.
```

Scilab code Exa 5.26 Find the dynamic resistance

```
 1  //Example 5_26
 2  clc;
 3  clear;
 4  close;
 5  format('v',6);
 6  //given data :
 7  I0=80;///micro A
 8  t=125;//degree C
 9  T=t+273;//K
10  Eta=1;//for Ge
11  VF=0.2;//V
12  VT=T/11600;//V(Volt equivalent of temperature)
13  ///Part(a) In forward direction
14  Rac=VT/(I0*10^-6)*exp(-VF/Eta/VT);//ohm
15  disp(Rac,"(a) Dynamic Resistance in forward diection
        (ohm) :  ");
16  ///Part(b) In reverse direction
17  format('v',8);
18  Rac=VT/(I0*10^-6)*exp(VF/Eta/VT)/10^6;//Mohm
```

```
19  disp(Rac,"(b) Dynamic Resistance in reverse diection
       (Mohm) :   ");
20  //Answer in the textbook is not accurate.
```

Scilab code Exa 5.27 Determine ac resistance

```
1  //Example 5_27
2  clc;
3  clear;
4  close;
5  format('v',7);
6  //given data :
7  I0=1.5;///micro A
8  T=300;//K
9  VF=150;//mV
10 kB=8.62*10^-5;//Boltzman Constant
11 VT=T/11600;//V(Volt equivalent of temperature)
12 rac=1/(I0*10^-6/kB/T*exp(VF/1000/VT));
13 disp(rac,"Ac resistance(ohm)")
14 //Answer and unit in the textbok is wrong.
```

Scilab code Exa 5.28 Maximum allowable current

```
1  //Example 5_28
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  Pmax=2.5;//W
8  Vf=900;//mV
9  If_max=Pmax/(Vf/1000);//A
```

```
10  disp ( If_max , " ( a ) Maximum allowable forward current (A
        ) : " ) ;
11  Rf = Pmax / If_max ^2; //ohm
12  format ( 'v' ,7) ;
13  disp ( Rf , " ( b ) Forward Diode Resistance ( ohm ) " )
14  //Answer in the textbok is wrong .
```

Scilab code Exa 5.29 Height of potential barrier

```
1  //Example 5_29
2  clc ;
3  clear ;
4  close ;
5  format ( 'v' ,5) ;
6  //given data :
7  //for Ge diode
8  rho_p =2; //ohm−cm ( p−side resistivity )
9  rho_n =1; //ohm−cm ( n−side resistivity )
10  e =1.6*10^ -19; //C/ electron
11  mu_p =1800; //m^2/V−s
12  mu_n =3800; //m^2/V−s
13  VT =0.026; //V( Thermal Voltage )
14  ni =2.5*10^13; // per cm^3( intrinsic concentration )
15  NA =1/( rho_p * e * mu_p ) ; // per cm^3
16  ND =1/( rho_n * e * mu_n ) ; // per cm^3
17  V0 = VT * log ( ND * NA / ni ^2) ; //eV
18  disp ( V0 , " ( a ) Height of potential barrier ( eV ) : " ) ;
19  //for Si diode
20  format ( 'v' ,6) ;
21  mu_p =500; //m^2/V−s
22  mu_n =1300; //m^2/V−s
23  ni =1.5*10^10; // per cm^3( intrinsic concentration )
24  NA =1/( rho_p * e * mu_p ) ; // per cm^3
25  ND =1/( rho_n * e * mu_n ) ; // per cm^3
26  V0 = VT * log ( ND * NA / ni ^2) ; //eV
```

```
27  disp(V0,"(b) Height of potential barrier(eV) : ");
```

Scilab code Exa 5.30 Find the dynamic resistance

```
1  //Example 5_30
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  t=125;//degree C
8  T=t+273;//K
9  Eta=1;//for Ge
10 VF=0.2;//V
11 VT=T/11600;//V(Volt equivalent of temperature)
12 I0=35;//micro A
13 //Part(a) Forward Direction
14 r=VT/(I0*10^-6)/exp(VF/VT);//ohm
15 disp(r,"(a) Dynamic Resistance in forward direcion(
     ohm) : ");
16 //Part(b) Reverse Direction
17 r=VT/(I0*10^-6)/exp(-VF/VT);//ohm
18 r=r/10^6;//Mohm
19 disp(r,"(b) Dynamic Resistance in reverse direcion(
     Mohm) : ");
20 ///Answer in the textbook is not accurate.
```

Scilab code Exa 5.31 Maximum and minimum zener current

```
1  //Example 5_31
2  clc;
3  clear;
4  close;
```

```
5  format('v',6);
6  //given  data :
7  Vz=10; //V
8  Rs=1; //kohm
9  RL=10; //kohm
10  IL=5; //mA(Assumed)
11  Vi=25:40; //V
12  RLmin=Rs; //kohm
13  Iz=(max(Vi)-Vz)/RLmin-IL; //mA
14  disp(Iz,"(a) Maximum value of zener current(mA) : ")
      ;
15  Iz_min=(min(Vi)-Vz)/Rs-IL; //mA
16  disp(Iz_min,"(b) Minimum value of zener current(mA)
      : ");
```

Scilab code Exa 5.32 Find the range of R

```
1  //Example 5_32
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given  data :
7  Vz=5; //V
8  Pmax=250; //mW
9  Vs=15; //V(Supply voltage)
10  PL=50; //W(Load)
11  Imax=Pmax/Vz; //mA(Maximum permissible current)
12  //Minimum current to maintain constant voltage
13  Imin=Imax-Imax*10/100; //mA
14  Rmin=Vs/Imax; //kohm
15  Rmax=Vs/Imin; //kohm
16  disp("For maintainng constant voltage, Range of R is
      "+string(Rmin)+" kohm to "+string(Rmax)+" kohm."
      );
```

```
17  //Diode loaded with 50W load
18  Imax=PL/Vz;//mA(Maximum permissible current)
19  //Minimum current to maintain constant voltage
20  Imin=Imax-Imax*10/100;//mA
21  Rmin=Vs/Imax;//kohm
22  Rmax=Vs/Imin;//kohm
23  disp("New range of R is "+string(Rmin)+" kohm to "+
        string(Rmax)+" kohm.");
24  //Solution is not complete in the textbook.
```

Scilab code Exa 5.33 Find out breakdown voltage

```
1   //Example 5_33
2   clc;
3   clear;
4   close;
5   format('v',6);
6   //given data :
7   ND=2*10^15;//cm^-3
8   Ep=1.5*10^5;//V/cm
9   epsilon=8.854*10^-14;//Permittivity
10  e=1.6*10^-19;//C/electron
11  //Width of depletion region
12  W=Ep*11.9*epsilon/e/ND;
13  VBR=W*Ep/2;//V
14  disp(VBR,"Breakdown Voltage(V) : ");
```

Scilab code Exa 5.35 Breakdown Voltage

```
1   //Example 5_35
2   clc;
3   clear;
4   close;
```

```
5  format('v',4);
6  //given data :
7  Ez=2*10^7;///V/m
8  //Vz=epsilon*Ez^2/(2*e*NA)
9  //e*NA=sigp/mu_p; as sigp=NA*e*mu_p
10 epsilon=16/(36*%pi*10^9);//F/m
11 mu_p=1800;//cm^2/V-s
12 sigp=poly(0,'sigp');//Notation : sigp=sigma_p
13 Vz=epsilon*Ez^2/2*mu_p*10^-6/sigp;//V
14 disp(Vz,"(a) Breakdown Voltage calculated and proved
       as ");
15 format('v',6);
16 sigma_i=1/45;//(ohm-cm)^-1
17 sigma_p=sigma_i;//(ohm-cm)^-1//as p-material is
       intrinsic
18 Vz=51/sigma_p;//V
19 disp(Vz,"(b) Vz(V) : ");
20 sigma_p=1/3.9;//(ohm-cm)^-1
21 Vz=51/sigma_p;//V
22 disp(Vz,"(c) Vz(V) : ");
23 //Part (d)
24 Vz=1.5;///V
25 sigma_p=51/Vz;//V
26 disp(sigma_p,"(d) Resistivity(ohm-cm)^-1 : ");
27 //Note : Part(b) answer wrong in the book & part(d)
       not complete.
28 //Note : sigp is used instead sigma_p as poly
       support only less than 5 character.
```

Scilab code Exa 5.36 Voltage across junction

```
1 //Example 5_36
2 clc;
3 clear;
4 close;
```

```
5  format ('v',5);
6  //given data :
7  Eta=1;//for Ge
8  T=300;//K
9  VT=0.026;//V(Thermal Voltage)
10 VF=5;///V
11 //I=I0;///given
12 IByI0=1;//ratio
13 //Using I=I0*(exp(V/VT)-1)
14 V=log(IByI0+1)*VT;//V
15 V2=VF-V;//V(Voltage across 2nd diode)
16 disp(V2,"(a) Voltage across each junction(V) : ");
17 //Part (b)
18 format ('v',6);
19 Vz=4.9;//V
20 Vrb=Vz;//V(Across reverse biased diode)
21 V2=VF-Vrb;//V
22 I0=6;//micro A
23 I=I0*(exp(V2/VT)-1);//micro A
24 disp(I,"(b) Current in the circuit(micro A) : ");
25 //Note : Answer in the textbook is not accurate.
```

Scilab code Exa 5.37 Find out ideality factor

```
1  //Example 5_37
2  clc;
3  clear;
4  close;
5  format ('v',5);
6  //given data :
7  I1=0.5;//mA
8  V1=340;//mV
9  I2=15;//mA
10 V2=465;//mV
11 kBTBye=25;//mV(It is kB*T/e)
```

```
12  //I=Is*(exp(V/Eta/kBTBye)-1)
13  Eta=(V2/kBTBye-V1/kBTBye)/log(I2/I1);//neglecting 1
        as exp(V/Eta/kBTBye)>>1
14  disp(Eta,"Ideality Factor(Eta) : ");
```

Scilab code Exa 5.38 `Temperature coefficient`

```
1  //Example 5_38
2  clc;
3  clear;
4  close;
5  format('v',7);
6  //given data :
7  Vd=12;//V
8  TC1=-1.7;//mV/degree C(Temperatre Coefficient of Si
        diode)
9  //For series combination to have TC=0
10 TC2=-TC1;//mV/degree C(Temperatre Coefficient of
        Avalanche diode)
11 //In percentage
12 TC2=TC2*10^-3/Vd*100;//%/degree C
13 disp(TC2,"Required temperature coefficient(%/degree
        C) : ");
```

Scilab code Exa 5.39 `Calculate R`

```
1  //Example 5_39
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  //For IL=0;//A
```

138

```
8  V0 =60; //V
9  V =200; //V( Supply  Voltage )
10 ID =5:40; //mA
11 R=(V-V0)/max(ID);//kohm(R is >= this value)
12 //For IL=ILmax;//A
13 IT=max(ID);//mA
14 ID=min(ID)///mA(ID<=this value)
15 Imax=IT-ID;///mA
16 disp(Imax,"(a) Imax(mA) : ");
17 //Part (b)
18 IL =25; //mA
19 ID =5:40; //mA
20 //Taking minimum current for good regulation
21 IT=min(ID)+IL;///mA
22 Vmax1=IT*R+V0;//V
23 //Taking maximum current for good regulation
24 IT=max(ID)+IL;///mA
25 Vmax2=IT*R+V0;//V
26 disp("(b) Without loss of regulation, V may vary
      from "+string(Vmax1)+" V to "+string(Vmax2)+" V."
      );
```

Chapter 6

Diode Circuits

Scilab code Exa 6.1 Find the current

```
 1 //Example 6_1
 2 clc;
 3 clear;
 4 close;
 5 format('v',5);
 6 //given data :
 7 I0=10;//micro A
 8 Vz=100;//V
 9 R=1.5;//kohm
10 V=45;//V
11 ///Part(a)
12 I=V/R;//mA(neglecting diode threshold voltage)
13 //I=I0*(exp(38.4*V)-1)//Diode Current Equation
14 Vd=(log(I*10^-3/(I0*10^-6)+1))/38.4;//V(Diode
      Voltage)
15 //Now calculating I again
16 I=(V-Vd)/R;//mA
17 disp(I,"(a) If diode is forward biased, Current(mA)"
      );
18 //Part(b)
19 Vd=-V;//V(for reverse polarity of battery)
```

```
20  I=-I0;//micro A
21  //Voltage drop across resistor neglected
22  disp(I,"(b) If battery inserted with reverse
        polarity , Current(micro A)");
23  //Part(c)
24  Vz=10;//V
25  //in forward direction behaviour will remain same
26  I=V/R;//mA(neglecting diode threshold voltage)
27  //I=I0*(exp(38.4*V)-1)//Diode Current Equation
28  Vd=(log(I*10^-3/(I0*10^-6)+1))/38.4;//V(Diode
        Voltage)
29  //Now calculating I again
30  I=(V-Vd)/R;//mA
31  disp(I,"(c) If diode is forward biased , Current(mA)"
        );
32  //reverse direction
33  //load line dataV=30;//
34  V=30;//V
35  I=-30;//mA
36  V1=20;//V//from Load Line
37  Idash=I*V1/V;///A
38  disp(Idash,"(c) If battery inserted with reverse
        polarity , Current(mA)");
39  //Answer in the book is not accurate ,
```

Scilab code Exa 6.2 Find the current

```
1  //Example 6_2
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  V=100;//V
8  //For diode D1
```

```scilab
 9  V1gamma =0.2; //V
10  r1 =20; //ohm
11  // For  diode  D2
12  V2gamma =0.6; //V
13  r2 =15; //ohm
14  // Part (a)
15  // Assume  D1 &  D2  are  ON
16  R=10; //kohm
17  // Writing  loop  equations
18  //V=(R+r1/1000)*I1+R*I2+V1gamma;(eqn(1))
19  A1 =[(R+r1/1000)  R]; // Coefficient  matrix
20  B1 =[V-V1gamma]; // Coefficient  matrix
21  //V=(R+r2/1000)*I2+R*I1+V2gamma;(eqn(2))
22  A2 =[R  (R+r2/1000)]; // Coefficient  matrix
23  B2 =[V-V2gamma]; // Coefficient  matrix
24  A=[A1;A2]; // Coefficient  matrix
25  B=[B1;B2]; // Coefficient  matrix
26  X=A^-1*B; // solution  matrix
27  I1=X(1); ///mA
28  I2=X(2); ///mA
29  if  I2 <0  then
30      disp("I2 <0,  Assumption  D2  is  ON,  not  valid .")
31  // Assume  D1  is  ON &  D2  is  OFF
32  I2=0; //A
33  I1=(V-V1gamma)/(R+r1/1000); //mA
34  disp(I2,I1,"(a)  Diode  current  I1 &  I2  in  mA  are  :  ")
       ;
35  end;
36  // Part (b)
37  format ('v',7);
38  // Assume  D1 &  D2  are  ON
39  R=1.5; //kohm
40  // Writing  loop  equations
41  //V=(R+r1/1000)*I1+R*I2+V1gamma;(eqn(1))
42  A1 =[(R+r1/1000)  R]; // Coefficient  matrix
43  B1 =[V-V1gamma]; // Coefficient  matrix
44  //V=(R+r2/1000)*I2+R*I1+V2gamma;(eqn(2))
45  A2 =[R  (R+r2/1000)]; // Coefficient  matrix
```

```
46  B2=[V-V2gamma];//Coefficient  matrix
47  A=[A1;A2];//Coefficient  matrix
48  B=[B1;B2];//Coefficient  matrix
49  X=A^-1*B;//solution  matrix
50  I1=X(1);///mA
51  I2=X(2);///mA
52  disp(I2,I1,"(b)  Diode  current  I1 & I2  in mA  are : ")
       ;
```

Scilab code Exa 6.3 Calculate the break region

```
1  //Example  6_3
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given  data :
7  r1BYr2=10000;//multipying  factor
8  //r=Eta*VT/I0*eps^(-V/Eta/VT)
9  //log(r1BYr2)=(-V1/Eta/VT)/(-V2/Eta/VT)=delV/Eta/VT
10 VT=26;//mV
11 Eta=2;//for  silicon
12 delV=log(r1BYr2)*Eta*VT;
13 disp(delV,"Break  region  for  Si(mV)");
14 Eta=1;//for  Germenium
15 delV=log(r1BYr2)*Eta*VT;
16 disp(delV,"Break  region  for  Ge(mV)");
17 //Answer  in  the  book  is  not  accurate.
```

Scilab code Exa 6.4 Peak and dc load current

```
1  //Example  6_4
2  clc;
```

143

```scilab
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  Rf=30; //ohm
8  RL=990; //ohm
9  Vrms=110; //V
10 //Part (a)
11 Vm=Vrms*sqrt(2); //V
12 Im=Vm/(Rf+RL)*1000; ///mA
13 disp(Im,"(a) Peak Load Current(mA)");
14 //Part (b)
15 format('v',5);
16 Idc=Im/%pi; //mA
17 disp(Idc,"(b) The dc Load Current(mA)");
18 //Part (c)
19 Irms=Im/2; //mA
20 disp(Irms,"(c) The ac Load Current(mA)");
21 //Part (d)
22 format('v',4);
23 Vdc=-Im*RL/1000/%pi; //mA
24 disp(Vdc,"(d) The dc diode Voltage(mV)");
25 //Part (e)
26 format('v',5);
27 Pi=(Irms*10^-3)^2*(Rf+RL); //W
28 disp(Pi,"(e) Total Input Power(W)");
29 //Part (f)
30 format('v',6);
31 VNL=Vm/%pi; //V
32 VFL=Idc*RL/1000; //V
33 Reg=(VNL-VFL)/VFL*100; //%(Regulation)
34 disp(Reg,"(f) % Regulation(%)");
35 //Answer not accurate in the book & unit of answer
       for part(d) is wrong.
```

Scilab code Exa 6.8 `dc load current and power`

```
1  //Example 6_8
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  Rf=500;//ohm
8  RL=2000;//ohm
9  Vrms=280;//V
10 Vm=Vrms*sqrt(2);//V
11 //Part (a)
12 Idc=2*Vm/%pi/(Rf+RL);//A
13 Idc=Idc*1000;//mA
14 disp(Idc,"(a) The dc load current(mA) : ");
15 //Part (b)
16 Idc_tube=Idc/2;///mA
17 disp(Idc_tube,"(b) Direct current in each tube(mA) :
       ");
18 //Part (c)
19 v2=Vm*Rf/(Rf+RL);//V
20 v1=-2*Vm+v2;//V
21 Vrms=sqrt(1/2/%pi*integrate('v2^2*(sin(alfa))^2','
       alfa',0,%pi)+1/2/%pi*integrate('v1^2*(sin(alfa))
       ^2','alfa',%pi,2*%pi));//V
22 Vrms=floor(Vrms);///V
23 disp(Vrms,"(c) The ac voltage across each diode(V) :
       ");
24 //Part (d)
25 Pdc=(Idc/1000)^2*RL;//W
26 disp(Pdc,"(d) The dc output power(W) : ");
27 //Part(e)
28 Reg=Rf/RL*100;//%
29 disp(Reg,"(e) % Regulation : ");
30 //Answer in the textbook is not accurate.
```

Scilab code Exa 6.10 `Full scale reading`

```
1  //Example 6_10
2  clc;
3  clear;
4  close;
5  format('v',4);
6  Rm=20;//ohm(meter resistance)
7  Rs=5;//kohm(series resistance)
8  Im=1;///mA
9  Idc=2*Im/%pi;//mA
10 RL=Rm+Rs*1000;//ohm
11 Vm=Idc/1000*%pi*RL/2;///V
12 v0_max=2*sqrt(2)*Vm;//V
13 disp(v0_max,"Full scale reading(V) : ");
```

Scilab code Exa 6.11 `dc output voltage and PIV`

```
1  //Example 6_11
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  V1=220;//V
8  N1ByN2=10/1;//turns ratio
9  V2=V1/N1ByN2;//V
10 Vm=sqrt(2)*V2;//V
11 Vdc=0.318*Vm;//V
12 disp(Vdc,"(a) dc output voltage(V) : " );
13 format('v',6);
14 PIV=Vm;//V
```

```
15 disp(PIV,"(b) PIV(V) : " );
```

Scilab code Exa 6.12 Maximum and average Power

```
1  //Example 6_12
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  V1=230;//V
8  N2ByN1=1/3;//turns ratio
9  RL=200;//ohm
10 V2=V1*N2ByN1;//V
11 Vm=sqrt(2)*V2;//V
12 Im=Vm/RL;//A
13 Pmax=Im^2*RL;//W
14 disp(Pmax,"Maximum load power(W) : ");
15 format('v',5);
16 Vdc=0.318*Vm;//V
17 Idc=Vdc/RL;//A
18 Pdc=Idc^2*RL;//W
19 disp(Pdc,"Average value of load power(W) : ");
20 //Answer in the textbook is not accurate.
```

Scilab code Exa 6.13 Maximum value of voltage

```
1  //Example 6_13
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
```

```
 7  Vdc=30; //V
 8  rf=25; //ohm
 9  RL=500; //ohm
10  Idc=Vdc/RL; //A
11  Im=%pi*Idc; //A
12  Vi_max=Im^2*(rf+RL); //V
13  disp(Vi_max,"Voltage required at input(V) : ");
14  //Answer in the textbook is not accurate.
```

Scilab code Exa 6.14 `AC voltage and efficiency`

```
 1  //Example 6_14
 2  clc;
 3  clear;
 4  close;
 5  format('v',7);
 6  //given data :
 7  Vdc=100; //V
 8  rf=20; //ohm
 9  RL=500; //ohm
10  Idc=Vdc/RL; //A
11  Im=%pi*Idc; //A
12  Vm=Im*(RL+rf); //V
13  disp(Vm,"(a) The ac voltage required(V) : ");
14  format('v',5);
15  Eta=0.406/(1+rf/RL)*100; //%( Rectification Efficiency
        )
16  disp(Eta,"Rectification Efficiency(%) : ");
```

Scilab code Exa 6.15 `dc output voltage`

```
 1  //Example 6_15
 2  clc;
```

```
3  clear ;
4  close ;
5  format ( 'v' ,4) ;
6  //given  data :
7  //v=50∗sin (100∗%pi∗t )
8  Vm=50; //V
9  f =50; //Hz
10  rf =20; //ohm
11  RL =5000; //ohm
12  Im=Vm/( rf+RL) ∗1000; //mA
13  disp (" ( a )  Current  is  "+string (Im)+"∗sin (100∗%pi∗t )
        for  %pi  <100∗%pi∗t<2∗%pi  &  it  will  be  zero  for  0
        <100∗%pi∗t<%pi " ) ;
14  format ( 'v' ,5) ;
15  Vdc=Im/1000/%pi∗RL ; //V
16  disp (" ( b )  Output  Voltage ,  Vo =  "+string (Vdc)+"∗sin
        (100∗%pi∗t )  for  %pi  <100∗%pi∗t<2∗%pi  &  it  will  be
         zero  for  0  <100∗%pi∗t<%pi  " ) ;
17  //Assuming  diode  is  ideal
18  disp (" ( c )  Voltage  across  diode ,  v =  "+string (Vdc)+"∗
        sin (100∗%pi∗t )  for  0  <100∗%pi∗t<%pi  &  it  will  be
        zero  for  %pi  <100∗%pi∗t<2∗%pi  " ) ;
```

Scilab code Exa 6.16 Value of capacitance

```
1  //Example  6_16
2  clc ;
3  clear ;
4  close ;
5  format ( 'v' ,5) ;
6  //given  data :
7  Vrms =230; //V
8  f =50; //Hz
9  Gamma =0:0.001:0.005; //Ripple  factor (Gamma<=0.005)
10  IL =0.5; //A
```

```
11  Gamma=Gamma(4);//Taken for the solution
12  Vm=sqrt(2)*Vrms;//V
13  Vdc=Vm/%pi;//V
14  Idc=IL;//A
15  RL=Vdc/Idc;//ohm
16  C=1/(2*sqrt(3)*f*RL*Gamma)*1000;//mF
17  disp(C,"Value of capacitance(mF) : ");
18  //Answer in the textbook is not accurate.
```

Scilab code Exa 6.17 calculate ripple factor

```
1   //Example 6_17
2   clc;
3   clear;
4   close;
5   format('v',5);
6   //given data :
7   RL=3.15;//kohm
8   rf=20;//ohm
9   //v=230*sin(314*t)
10  Vm=230;//V
11  f=50;//Hz
12  Irms=0.707*Vm/(rf+RL*1000);//A
13  Im=Vm/(rf+RL*1000);//A
14  Idc=0.637*Im
15  Gamma=sqrt((Irms/Idc)^2-1);//Ripple factor
16  disp(Gamma,"Ripple factor : ");
```

Scilab code Exa 6.18 dc output voltage and frequency

```
1   //Example 6_18
2   clc;
3   clear;
```

```
 4 close;
 5 format('v',4);
 6 //given data :
 7 Vp=230;//V
 8 fin=50;//Hz
 9 RL=200;//ohm
10 NsByNp=1/4;//turns ratio
11 Vs=Vp*NsByNp;//V
12 Vrms=Vs;//V
13 Vm=Vrms*sqrt(2);//V
14 Idc=2*Vm/%pi/RL;//A
15 RL=150;//ohm
16 Vdc=Idc*RL;//V
17 disp(Vdc,"dc output Voltage(V) : ");
18 //Because of two output pulses
19 fout=2*fin;///Hz
20 disp(fout,"Pulse frequency of the output(Hz) : ");
```

Scilab code Exa 6.19 `Maximum dc voltage`

```
 1 //Example 6_19
 2 clc;
 3 clear;
 4 close;
 5 format('v',5);
 6 //given data :
 7 Vp=220;//V
 8 fi=50;//Hz
 9 RL=1.5;//kohm
10 Np=1000;//turns
11 Ns=100;//turns
12 Vs=Vp*Ns/Np;//V
13 Vrms=Vs*sqrt(2);//V
14 Vm=Vrms/2;//V(Across half secondary winding)
15 Idc=2*Vm/%pi/(RL*1000);//A
```

```
16  Vdc=Idc*RL*1000;//V
17  disp(Vdc,"dc output Voltage(V) : ");
18  //Answer in the textbook is not accurate.
```

Scilab code Exa 6.20 Calculate input voltage

```
1  //Example 6_20
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  Vdc=30;//V
8  RL=1;//kohm
9  Gamma=0.015;//Ripple factor
10 Idc=Vdc/RL;//mA
11 C=2900/Gamma/(RL*1000);//micro F
12 disp(C,"Filter capacitor(micro F) : ");
13 format('v',6);
14 Vm=Vdc+5000*Idc/1000/C;///V
15 V2=2*Vm/sqrt(2);//V
16 disp(V2,"Required intput Voltage(V) : ");
17 //Answer in the textbook is not accurate.
```

Scilab code Exa 6.21 Inductance and output voltage

```
1  //Example 6_21
2  clc;
3  clear;
4  close;
5  format('v',5);
6  //given data :
7  IL=0.1;//A
```

```
 8  C=40; ///micro F
 9  R=40; //ohm
10  Vrms=40; //V
11  Gamma=0.0001; //Ripple factor
12  n=2; //For 2 stage filter
13  L=1.76/C*(0.472/Gamma)^(1/n); //H
14  disp(L,"(a) Value of inductance(H) : ");
15  Vdc=2*sqrt(2)*Vrms/%pi-IL*R; //V
16  disp(Vdc,"(b) Output Voltage(V) : " );
```

Scilab code Exa 6.22 dc output voltage and ripple voltage

```
 1  //Example 6_22
 2  clc;
 3  clear;
 4  close;
 5  format('v',7);
 6  //given data :
 7  IL=50; //micro A
 8  C=4; ///micro F
 9  C1=4; ///micro F
10  L=20; ///H(Choke Inductance)
11  R=200; //ohm(Choke Resistance)
12  V=300; //V
13  Idc=IL/1000; //mA
14  Vdc=V*sqrt(2)-4170*Idc/C-Idc*R; //V
15  disp(Vdc,"Output Voltage(V) : " );
16  r=3300*Idc/C/C1/L/R; //Ripple factor
17  Vrms=r*Vdc; //V
18  disp(Vrms,"Ripple Voltage(V) : ");
19  //Answer in the textbook is wrong. calculation &
        value putting mistake.
```

Chapter 7

BJT Fundamentals

Scilab code Exa 7.1 Base and collector current

```
1  //Ex_7_1
2  clc ;
3  clear ;
4  close ;
5  //given data :
6  format ('v',6) ;
7  alfa =0.90; //current gain
8  ICO =15; //micro A( reverse saturation currenrt )
9  IE =4; //mA( Emitter currenrt )
10 IC = ICO *10^ -3+ alfa * IE ; //mA
11 IB = IE - IC ; //mA
12 IB = IB *1000; //micro A
13 disp (IC ,"Collector Current (mA)") ;
14 disp (IB ,"Base Current ( micro A)") ;
```

Scilab code Exa 7.2 Value f alfa

```
1  //Ex_7_2
```

```
 2  clc ;
 3  clear ;
 4  close ;
 5  //given data :
 6  format ('v',6);
 7  Beta =90; //unitless
 8  IC =4; //mA( Collector  Current )
 9  alfa=Beta /(1+Beta); //current  gain
10  IB=IC/Beta; //mA( Base  Current )
11  IE=IC+IB; //mA( Emitter  currenrt )
12  disp(alfa ,"Value  of  alfa");
13  disp(IB*1000 ,"Base  Current ( micro  A)");
14  disp(IE ,"Emmiter  Current (mA)");
```

Scilab code Exa 7.3 `Calculate the collector current`

```
 1  //Ex_7_3
 2  clc ;
 3  clear ;
 4  close ;
 5  format ('v',6);
 6  //given  data :
 7  alfa =0.90; //current  gain
 8  ICO =15; //micro  A( reverse  saturation  currenrt )
 9  IB =0.5; ///mA( Base  Current )
10  Beta=alfa /(1-alfa); //unitless
11  IC=Beta*IB +(1+Beta)*ICO /1000; //mA( Collector  Current )
12  disp(IC ,"Collector  Current (mA)");
```

Scilab code Exa 7.4 `Value of Beta`

```
 1  //Ex_7_4
 2  clc ;
```

```
 3  clear;
 4  close;
 5  format('v',6);
 6  //given data :
 7  IB=20;///micro A(Base Current)
 8  IC=5;//mA(Collector Current)
 9  Beta=IC*1000/IB;//unitless
10  disp(Beta,"Beta=");
```

Scilab code Exa 7.5 Value of IE

```
 1  //Ex_7_5
 2  clc;
 3  clear;
 4  close;
 5  format('v',6);
 6  //given data :
 7  IB=50;///micro A(Base Current)
 8  IC=5;//mA(Collector Current)
 9  IE=IC+IB/1000;//mA
10  Beta=IC*1000/IB;//unitless
11  alfa=IC/IE;//current gain
12  disp(IE,"Emitter Current(mA)");
13  disp(Beta,"Beta=");
14  disp(alfa,"alfa=");
15  disp("Verify that alfa=Beta/(Beta+1)");
16  disp(string(alfa==Beta/(Beta+1)));
17  disp("Verify that Beta=alfa/(1-alfa)");
18  disp(string(Beta==round(alfa/(1-alfa))));
```

Scilab code Exa 7.6 Value of alfa and beta

```
 1  //Ex_7_6
```

```
2  clc ;
3  clear ;
4  close ;
5  format ( 'v ' ,6) ;
6  // given data :
7  IE =10; // mA
8  IB =5; ///mA( Base Current )
9  IC = IE - IB ; // mA( Collector Current )
10 BetaR = IC / IB ; // unitless
11 alfaR = IC / IE ; // current gain
12 disp ( BetaR ," BetaR =") ;
13 disp ( alfaR ," alfaR =") ;
14 // Answer is wrong in the book .
```

Scilab code Exa 7.7 Find current and voltage

```
1  // Ex_7_7
2  clc ;
3  clear ;
4  close ;
5  format ( 'v ' ,6) ;
6  // given data :
7  Beta =100; // unitless
8  VBE =0.7; // V
9  VCC =10; // V
10 // ( a ) VE= −0.7; // V
11 disp (" For the circuit in fig ( a )") ;
12 VE = -0.7; // V( Constant voltage )
13 R1 =10; // kohm
14 R2 =10; // kohm
15 IE =( VCC + VE ) / R2 ; // mA
16 IB = IE /( Beta +1) ; // mA
17 VC = VCC - R1 *1000*( IE - IB ) /1000; // V
18 disp ( VE ," Constant voltage fo the given transistor ,
       VE (V )") ;
```

```
19  disp(IE,"Emitter current(mA)");
20  format('v',5);
21  IB=IB*1000; ///micro A
22  disp(IB,"Base current(micro A)");
23  format('v',6);
24  disp(VC,"VC(V)");
25
26  //(b) VE=-0.7;//V
27  R1=5; //kohm
28  R2=5; //kohm
29  VEE=-15; //V
30  disp("For the circuit in fig(b)");
31  VE=-0.7; //V(Constant voltage)
32  R1=5; //kohm
33  R2=5; //kohm
34  IE=(VCC+VE)/R2; //mA
35  IC=IE*Beta/(Beta+1); //mA
36  VC=VEE+R2*IC; //V
37  disp(VE,"Constant voltage fo the given transistor ,
        VE(V)");
38  disp(IE,"Emitter current(mA)");
39  disp(IC,"Base current(mA)");
40  format('v',5);
41  disp(VC,"VC(V)");
```

Scilab code Exa 7.8 Find the voltage

```
1  //Ex_7_8
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  Beta=%inf; //Current gain
8  VBE=0.7; ////V
```

```
9   VB =0; //V( For  large  Beta )
10  VE = VB - VBE ; ////V
11  disp (VE ,VB ," (a)  Value  of  VB(V) & VE(V)  are  :  " );
12  // Part  (b)
13  R1 =5; /// kohm
14  R2 =5; /// kohm
15  VCC =10; ///V
16  VEE = -15; ///V
17  VE = VBE ; ////V
18  VC = VEE + R1 / R2 *( VCC - VBE ); //V
19  disp (VC ,VE ," (b)  Value  of  VE(V) & VC(V)  are  :  " );
```

Scilab code Exa 7.9 Find VB IB IE IC

```
1   // Ex_7_9
2   clc ;
3   clear ;
4   close ;
5   format ( 'v' ,6 );
6   // given  data  :
7   VEE =5; ////V
8   VCC = -5; ////V
9   VE =1; ////V
10  RB =20; // kohm
11  RE =5; // kohm
12  RC =5; // kohm
13  VBE =0.7; ////V
14  VB = VE - VBE ; ///V
15  IB = VB / RB ; ///mA
16  IE =( VEE - VE )/ RE ; //mA
17  IC = IE - IB ; //mA
18  VC = VCC + IC * RC ; //V
19  Beta = IC / IB ; // Current  gain
20  Alfa = IC / IE ; // Current  gain
21  disp (VB ," VB(V)  :  " );
```

```
22 disp(IB,"IB(mA)  :  ");
23 disp(IE,"IE(mA)  :  ");
24 disp(IC,"IC(mA)  :  ");
25 format('v',5);
26 disp(Beta,"Beta  :  ");
27 disp(Alfa,"Alfa  :  ");
```

Scilab code Exa 7.10 `Voltage changes`

```
1  //Ex_7_10
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  delVB=0.4;//V
8  delVC=0;//V//No change
9  delVE=delVB;//V//Same change
10 disp(delVC,delVE,"delVE(V) & delVC(V)  are  :  ");
```

Scilab code Exa 7.11 `Emitter Voltage`

```
1  //Ex_7_11
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  VBE=0.7;////V
8  Beta=100;///Current Gain
9  //Part (a)
10 VCC=6;////V
11 VEE=0;////V
```

```
12  VB=2;////V
13  RE=18;//kohm
14  RC=3;//kohm
15  VE=VB-VBE;//V
16  disp(VE,"(a) Emitter Voltage(V) : ");
17  IE=1;///mA
18  IC=IE*Beta/(1+Beta);///mA
19  VC=VCC-IC*RC;//V
20  if VC>VE then
21      disp("Circuit is in active mode.");
22  end;
23  //Part (b)
24  VEE=6;////V
25  VCC=0;////V
26  VB=1;////V
27  RE=10;//kohm
28  RC=10;//kohm
29  VE=VB+VBE;//V
30  disp(VE,"(b) Emitter Voltage(V) : ");
31  IE=(VEE-VE)/RE;///mA
32  IC=IE;///mA(Assumed nearly equal)
33  VC=VCC+IC*RC;//V
34  if VC>VB then
35      disp("Circuit is in saturation mode.");
36  end;
37  //Part (c)
38  VEE=9.5;////V
39  VCC=-50;////V
40  VB=-5;////V
41  RE=200;//kohm
42  RC=20;//kohm
43  VE=VB+VBE;//V
44  disp(VE,"(c) Emitter Voltage(V) : ");
45  IE=(VEE-VE)/RE;///mA;///mA
46  IC=IE*Beta/(1+Beta);///mA
47  VC=VCC-IC*RC;//V
48  if VC>VE then
49      disp("Circuit is in active mode.");
```

```
50  elseif VC<VE
51      disp(" Circuit is in reverse active mode.")
52  end;
53  //Part (d)
54  VEE=-30; ////V
55  VCC=-10; ////V
56  VB=-20; ////V
57  RE=6; //kohm
58  RC=2; //kohm
59  VE=VB-VBE; //V
60  disp(VE,"(d) Emitter Voltage(V) : ");
61  IE=(VEE-VE)/RE; ///mA; ///mA
62  IC=IE*Beta/(1+Beta); ///mA
63  VC=VCC-IC*RC; //V
64  if VC>VE then
65      disp(" Circuit is in active mode.");
66  end;
67  //Note : Printing error in part (a) in the textbook.
        Answer is also not accurate in the textbook for
      part(c)
```

Chapter 8

BJT Circuits

Scilab code Exa 8.1 Calculate IB IC VCE

```
1  // Ex_8_1
2  clc;
3  clear;
4  close;
5  format('v',6);
6  // given data :
7  Beta=100; // unitless
8  Rc=2; // kohm
9  Rb=100; // kohm
10 Vcc=10; //V
11 VBE=0.7; //V
12 // Part (a)
13 IB=(Vcc-VBE)/(Beta*Rc+Rc+Rb); //mA
14 disp(IB,"IB(mA)");
15 format('v',4);
16 IC=Beta*IB; //mA
17 disp(IC,"IC(mA)");
18 format('v',5);
19 VCE=Vcc-(IB+IC)*Rc; //V
20 disp(VCE,"VCE(V)");
21 // Part (b)
```

```
22  format('v',8);
23  VCE=7;//V
24  ICB=(Vcc-VCE)/Rc;//mA(ICB=IC+IB)
25  IB=ICB/(1+Beta);//mA
26  IC=ICB*Beta;//mA
27  Rb=(Vcc-VBE-Rc*ICB)/IB;//kohm
28  disp(Rb,"Value of Rb(kohm)");
```

Scilab code Exa 8.4 Find Re R1 and R2

```
 1  //Ex_8_4
 2  clc;
 3  clear;
 4  close;
 5  format('v',6);
 6  //given data :
 7  Beta=50;//unitless
 8  VBE=0.7;//V
 9  VCC=22.5;//V
10  Rc=5.6;//kohm
11  VCE=12;//V
12  IC=1.5;//mA
13  S=3;//Stability factor(S<=3)
14  Rec=(VCC-VCE)/IC;//kohm(Rec=Re+Rc)
15  Re=Rec-Rc;//kohm
16  RbBYRe=(S-1)/(1-S/(1+Beta))
17  Rb=RbBYRe*Re;//kohm
18  IB=IC/Beta;//mA
19  V=IB*Rb+VBE+(IB/1000+IC)*Re;//V
20  R1=Rb*VCC/V;//kohm
21  R2=R1*V/(VCC-V);//kohm
22  disp(Re,"Value of Re(kohm)");
23  disp(R1,"Value of R1(kohm)");
24  disp(R2,"Value of R2(kohm)");
25  //Answer in the book is wrong for R1.
```

Scilab code Exa 8.5 Find R1 R2 Re

```scilab
1  //Ex_8_5
2  clc;
3  clear;
4  close;
5  format('v',6);
6  //given data :
7  VCC=20;//V
8  Rc=1.5;//kohm
9  VCE=8;//V
10 IC=4;//mA
11 Beta=50;//unitless\
12 VBE=0.2;//V
13 disp("Part (a)");
14 S=12;//Stability factor
15 IB=IC/Beta;//mA
16 Re=(VCC-VCE-IC*Rc)/(IB+IC);//kohm
17 RbBYRe=(S-1)/(1-S/(1+Beta))
18 Rb=RbBYRe*Re;//kohm
19 IE=IB+IC;//mA
20 VBN=VBE+IE*Re;//V
21 V=VBN+IB*Rb;//V
22 R1=Rb*VCC/V;//kohm
23 IR1=(VCC-VBN)/R1;//mA
24 IR2=IR1-IB;//mA
25 R2=VBN/IR2;//kohm
26 disp(R1,"Value of R1(kohm)");
27 disp(R2,"Value of R2(kohm)");
28 disp(Re,"Value of Re(kohm)");
29 disp("Part (b)");
30 S=3;//Stability factor
31 IB=IC/Beta;//mA
32 Re=(VCC-VCE-IC*Rc)/(IB+IC);//kohm
```

```
33  RbBYRe =( S -1) /(1 - S /(1+ Beta ))
34  Rb = RbBYRe * Re ; // kohm
35  IE = IB + IC ; // mA
36  VBN = VBE + IE * Re ; // V
37  V = VBN + IB * Rb ; // V
38  R1 = Rb * VCC / V ; // kohm
39  IR1 =( VCC - VBN )/ R1 ; // mA
40  IR2 = IR1 - IB ; // mA
41  R2 = VBN / IR2 ; // kohm
42  disp ( R1 , " Value  of  R1 ( kohm )");
43  disp ( R2 , " Value  of  R2 ( kohm )");
44  format ( 'v ' ,5);
45  disp ( Re , " Value  of  Re ( kohm )");
46  disp ( Rb , " Value  of  Rb ( kohm )");
47  // Answer  in  the  book  is  wrong .
```

Scilab code Exa 8.6 Determine Re and stability factor

```
1  // Ex_8_6
2  clc ;
3  clear ;
4  close ;
5  format ( 'v ' ,6);
6  // given  data  :
7  VBE =0.7; // V
8  Beta =50; // unitless
9  VCE =4; // V
10  VCC =12; // V
11  Rc =4.3; // kohm
12  VEE = -6; // V
13  IC =1.5; // mA
14  S =3; // Stability  factor ( S <=3)
15  Rec =( VCC - VCE )/ IC ; // kohm ( Rec = Re + Rc )
16  Re = Rec - Rc ; // kohm
17  RbBYRe =( S -1) /(1 - S /(1+ Beta ))
```

```scilab
18  Rb=RbBYRe*Re; //kohm
19  IB=IC/Beta; //mA
20  V=IB*Rb+VBE+(IB/1000+IC)*Re; //V
21  R1=Rb*VCC/V; //kohm
22  R2=R1*V/(VCC-V); //kohm
23  disp(Re,"Value of Re(kohm)");
24  disp(R1,"Value of R1(kohm)");
25  disp(R2,"Value of R2(kohm)");
26  //Answer in the book is wrong for R1.
```