Scilab Textbook Companion for Engineering Physics by G. Vijayakumari[1]

Created by
Potnuru Sattibabu
B.Tech
Mechanical Engineering
SASTRA UNIVERSITY
College Teacher
Prof. Chintam Suresh Kumar
Cross-Checked by
Lavitha Pereira

December 3, 2013

[1]Funded by a grant from the National Mission on Education through ICT, http://spoken-tutorial.org/NMEICT-Intro. This Textbook Companion and Scilab codes written in it can be downloaded from the "Textbook Companion Project" section at the website http://scilab.in

Book Description

Title: Engineering Physics

Author: G. Vijayakumari

Publisher: Vikas Publishing, Noida

Edition: 2

Year: 2007

ISBN: 9788125924098

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

Contents

List of Scilab Codes

Chapter 1

Acoustics

Scilab code Exa 1.1 sound intensity level

```
1 clc
2 clear
3 //INPUT DATA
4 i=20//the intensity of a source is increased 20
     times
5
6 //CALCULATION
7 I=(10*(log10(i)))//intensity of sound in dB
8
9 //OUTPUT
10 printf('The sound intensity level is imcreased by %i
     dB when the intensity is doubled',I)
```

Scilab code Exa 1.2 Intensity level

```
1 clc
2 clear
3 //INPUT DATA
```

```
4 i=4//the intensity of a source is increased 4 times
5
6 //CALCULATION
7 I=(10*(log10(i)))//intensity of sound in dB
8
9 //OUTPUT
10 printf('The sound intensity level is increased by %i
    dB',I)
```

Scilab code Exa 1.3 Intensity level of plane

```
1 clc
2 clear
3 //INPUT DATA
4 I=1000//sound intensity of plane leaving the runway
    in Wmˆ-2
5 Io=10^-12//threshold intensity of sound in Wmˆ-2
6
7 //CALCULATION
8 IL=(10*log10(I/Io))//The intensity level of a plane
    just leaving the runway in dB
9
10 //OUTPUT
11 printf('The intensity level of a plane just leaving
    the runway is %i dB',IL)
```

Scilab code Exa 1.4 Intensity of sound in dB

```
1 clc
2 clear
3 //INPUT DATA
4 I=10^-6//intensity of sound during heavy traffic in
    Wmˆ-2
```

```
Io=10^-12//threshold intensity of sound in Wm^-2

//CALCULATION
IL=(10*log10(I/Io))//The intensity level in dB

//OUTPUT
printf('The intensity level is %i dB',IL)
```

Scilab code Exa 1.5 Intensity level in dB

```
clc
clear
//INPUT DATA
Q=3.56//rate of energy radiates in W
r=15//distance of intensity level in m
Io=100//reference intensity in Wm^-2

//CALCULATION
A=4*3.14*r*r//Area in m^2
I=(Q/A)//sound intensity in Wm^-2
IL=(10*log10(I/Io))//The intensity level in dB

//OUTPUT
printf('The intensity level is %3.3f dB',IL)
```

Scilab code Exa 1.6 Resultant sound level

```
clc
clear
//INPUT DATA
Il1=70//sound in dB
Il2=80//sound in dB

```

```
7 //CALCULATION
8 I1=10^(Il1/10)//ratio of intensity
9 I2=10^(Il2/10)//ratio of intensity
10 I=I1+I2//intensity of sound in dB
11 Il=10*log10(I)//resultant intensity in dB
12
13 //OUTPUT
14 printf('The resultant sound level is %3.2f dB',Il)
```

Scilab code Exa 1.7 Noise level

```
1 clc
2 clear
3 //INPUT DATA
4 i=4//the intensity of a source when 4 such drills
    are working at the same distance away
5 I1=95//The noise level of sound from a drill in dB
6
7 //CALCULATION
8 I2=(10*(log10(i)))//intensity of source in dB
9 IL=I1+I2//The noise level at this point when 4 such
    drills are working at the same distance away in
    dB
10
11 //OUTPUT
12 printf('The noise level at this point when 4 such
    drills are working at the same distance away is
    %3.2f dB',IL)
```

Scilab code Exa 1.8 Flow of energy

```
1 clc
2 clear
```

```
3 //INPUT DATA
4 f=426//frequency of sound in Hz
5 a=0.65*10^-2//amplitude of sound wave in m
6 A=1//area in m^2
7 v=340//velocity of sound in air in ms^-1
8 d=1.29//density of air in Kg m^-3
9
10 //CALCULATION
11 I=(2*3.14*3.14*f^2*a^2*d*v)/10^4//The flow of energy
       across 1m^2 per second in Wm^-2*10^4
12
13 //OUTPUT
14 printf('The flow of energy across 1m^2 per second is
       %3.3f*10^4 Wm^-2',I)
```

Scilab code Exa 1.9 Reverberation time

```
1 clc
2 clear
3 //INPUT DATA
4 V=1000//volume of hall in m^3
5 S=400//sound absorbing surface of area in m^2
6 a=0.2//average absorption coefficient in sabine
7
8 //CALCULTION
9 T=(0.167*V)/(a*S)//The reverberation time of the
      hall in sec
10
11 //OUTPUT
12 printf('The reverberation time of the hall is %3.2f
      sec',T)
```

Scilab code Exa 1.10 Average absorption coefficient and reverberation time

```
clc
clear
//INPUT DATA
V=1500//volume of room in m^3
a1=0.03//average sound coefficient for wall in
   sabine
a2=0.06//average sound coefficient for the ceiling
   in sabine
a3=0.8//average sound coefficient for the floor in
   sabine
S1=260//The wall area of the room in m^2
S2=140//The floor area of the room in m^2
S3=140//The ceiling area of the room in m^2

//CALCULATION
a=((a1*S1)+(a2*S2)+(a3*S3))/(S1+S2+S3)//The average
   absorbtion coefficient in O.W.U
TS=S1+S2+S3//total area of the room in m^2
x=(a*TS)//Total sound absorbtion of the room in O.W.
   U-m^2
T=((0.167*V)/x)//The reverberation time in sec

//OUTPUT
printf('The average absorbtion coefficient is %3.4f
   O.W.U \n The reverberation time is %3.4f sec',a,T
   )
```

Scilab code Exa 1.11 Area of interior surfaces

```
clc
clear
//INPUT DATA
V=12000//volume of auditorium in m^3
T=1.5//The reverberation time of the auditorium in
   sec
```

```
6 a=0.4//average absorption coefficient in sabine
7
8 //CALCULTION
9 S=(0.167*V)/(a*T)//area of interior surfaces in m^2
10
11 //OUTPUT
12 printf('The area of interior surfaces is %i m^2',S)
```

Scilab code Exa 1.12 Total absorption

```
1 clc
2 clear
3 //INPUT DATA
4 V=7500//volume of cinema hall in m^3
5 T=1.5//The reverberation time of the cinema hall in
    sec
6
7 //CALCULATION
8 TaS=(0.167*V)/(T)//The total absorbtion in the hall
    in sabine m^2
9
10 //OUTPUT
11 printf('The total absorbtion in the hall is %i
    sabine m^2',TaS)
```

Scilab code Exa 1.13 New reverberation time

```
1 clc
2 clear
3 //INPUT DATA
4 V=12500//volume of hall in m^3
5 T1=1.5//The reverberation time of the hall in sec
```

```
a2S2=200//The number of cushioned chairs are
   additionally placed in the hall in sabine-m^2

//CALCULATION
Ta1S1=(0.167*V)/T1//The reverberation time before
   placed cushioned chairs in sabine -m^2
T2=(0.167*V)/(Ta1S1+a2S2)//The new reverberation
   time after placing the cushioned chairs in sec

//OUTPUT
printf('The new reverberation time after placing the
    cushioned chairs is %3.4f sec',T2)
```

Scilab code Exa 1.14 Reverberation time in sec

```
clc
clear
//INPUT DATA
V=475//volume of hall in m^3
a1=0.025//absorbtion coefficient for wall in O.W.U
a2=0.02//absorbtion coefficient for the ceiling in O
   .W.U
a3=0.55//absorbtion coefficient for the floor in O.W
   .U
S1=200//The wall area of the room in m^2
S2=100//The floor area of the room in m^2
S3=100//The ceiling area of the room in m^2

//CALCULATION
TaS=((a1*S1)+(a2*S2)+(a3*S3))//The average
   absorbtion coefficient in O.W.U-m^2
T=((0.167*V)/TaS)//The reverberation time in sec

//OUTPUT
printf('The reverberation time for the hall is %3.4f
```

```
sec',T)
```

Scilab code Exa 1.15 Effect of reverberation time

```
clc
clear
//INPUT DATA
V=2265//volume of hall in m^3
Ta1S1=94.85//The total absorbtion coefficient in m^2

//CALCULATION
T1=((0.167*V)/Ta1S1)//The reverberation time in the
   hall without audience in sec
Ta2S2=2*Ta1S1//The new absorbtion coefficient in m^2
T2=((0.167*V)/Ta2S2)//The reverberation time in the
   hall with audience in sec

//OUTPUT
printf('The reverberation time in the hall without
   audience is %3.3f sec \n The reverberation time
   in the hall with audience is %3.3f sec \n Thus,
   the reverberation reduces to half of its initial
   value when the audience fill the hall.',T1,T2)
```

Scilab code Exa 1.16 Average absorbing power of the surface

```
clc
clear
//INPUT DATA
V=120000//Volume of the hall in m^3
T=1.55//The reverberation time in sec
S=26500//The total absorbing surface in m^2

```

```
8  //CALCULATION
9  TaS=(0.167*V)/T//The average absorbtion coefficient
       in sabine-m^2
10 a=(TaS/S)//The average absorbing power of the
       surface in sabine
11
12 //OUTPUT
13 printf('The average absorbing power of the surface
       is %3.4f sabine',a)
```

Chapter 2

Ultrasonics

Scilab code Exa 2.1 Frequency of vibration

```
1  clc
2  clear
3  //INPUT DATA
4  E=80*10^9//Young's modulus of material of piezo
       electric crystal in Pa
5  d=2654 //Density of material of piezo electric
       crystal in Kg/m^3
6  t=0.1*10^-2//Thickness of  piezo electric crystal in
        m
7  p=1//for fundamental first overtone
8
9  //CALCULATION
10 f=((p/(2*t))*(sqrt(E/d)))/10^6//Frequency of
       vibration of first overtone in Hz *10^6
11
12 //OUTPUT
13 printf('The frequency of vibration is %3.4f *10^6.Hz
       ',f)
```

Scilab code Exa 2.2 Frequency of first and second node of vibration

```
clc
clear
//INPUT DATA
v=5.5*10^3//Velocity of longitudanal waves in Quartz
    Crystal in m/s
t=0.05//Thickness of Quartz Crystal in m

//CALCULATION
w=2*t//wavelength in m
v1=(v/w)/10^4//Frequency in the first mode of
   vibration in Hz *10^4
v2=(2*v1)/(10^-4*10^3)//Frequency in the second mode
    of vibration in Hz *10^3

//OUTPUT
printf('Frequency in the first mode of vibration is
   %3.1f *10^4.Hz \n Frequency in the second mode of
    vibration is %i *10^3.Hz',v1,v2)
```

Scilab code Exa 2.3 Depth and wavelength

```
clc
clear
//INPUT DATA
f=0.09*10^6//Frequency of Ultrasonic source in Hz
t=0.55//time in sec
v=1800//velocity of sound in water in m/s

//CALCULATION
D=(v*t)/2//Depth of sea in m
W=(v/f)//Wavelength of ultrasonic pulse in m

//OUTPUT
```

```
13 printf('The depth of sea is %im \n The wavelength of
       ultrasonic pulse is %3.2fm',D,W)
```

Chapter 3

Crystal physics

Scilab code Exa 3.1 Miller indices

```
1  clc
2  clear
3  //INPUT DATA
4  x1=%inf//intercept of x-axis from figure 3.15(a) on
       page no:57
5  y1=1/2//intercept of y-axis from figure 3.15(b) on
       page no:57
6  z1=%inf//intercept of z-axis from figure 3.15(c) on
       page no:57
7  x2=1//intercept of x-axis from figure 3.15(a) on
       page no:57
8  y2=1/2//intercept of y-axis from figure 3.15(b) on
       page no:57
9  z2=%inf//intercept of z-axis from figure 3.15(c) on
       page no:57
10 x3=1/2//intercept of x-axis from figure 3.15(a) on
       page no:57
11 y3=1/2//intercept of y-axis from figure 3.15(b) on
       page no:57
12 z3=%inf//intercept of z-axis from figure 3.15(c) on
       page no:57
```

```
13
14 //CALCULATION
15 p1=1/x1//The miller indices of x-axis
16 q1=1/y1//The miller indices of y-axis
17 r1=1/z1//The miller indices of z-axis
18 p2=1/x2//The miller indices of x-axis
19 q2=1/y2//The miller indices of y-axis
20 r2=1/z2//The miller indices of z-axis
21 p3=1/x3//The miller indices of x-axis
22 q3=1/y3//The miller indices of y-axis
23 r3=1/z3//The miller indices of z-axis
24
25 //OUTPUT
26 printf('The miller indices of plane shown in figure
   3.15(a) is (%i %i %i) \n The miller indices of
   plane shown in figure 3.15(b) is (%i %i %i) \n
   The miller indices of plane shown in figure 3.15(
   c) is (%i %i %i) ',p1,q1,r1,p2,q2,r2,p3,q3,r3)
```

Scilab code Exa 3.3 Interplanar distance

```
1 clc
2 clear
3 //INPUT DATA
4 h=3//miller indices with respect to x axis
5 k=1//miller indices with respect to y axis
6 l=1//miller indices with respect to z axis
7 a=2.109*10^-10//lattice constant of plane in a
   simple cubic lattice in m
8
9 //CALCULATION
10 d=(a/(sqrt(h^2+k^2+l^2)))/10^-11//The interplanar
   distance in m *10^-11
11
12 //OUTPUT
```

```
13 printf('The interplanar distance is %3.3f*10^-11 m',
     d)
```

Scilab code Exa 3.4 Lattice constant

```
1  clc
2  clear
3  //INPUT DATA
4  h=1//miller indices with respect to x axis
5  k=1//miller indices with respect to y axis
6  l=0//miller indices with respect to z axis
7  d=2.86*10^-10//the distance between miller indices
     in m
8
9  //CALCULATION
10 a=(d*(sqrt(h^2+k^2+l^2)))/10^-10//The lattice
     constant in m *10^-10
11
12 //OUTPUT
13 printf('The lattice constant is %3.3f*10^-10 m',a)
```

Scilab code Exa 3.6 Ratio of intercepts

```
1  clc
2  clear
3  //INPUT DATA
4  h=1//miller indices of x-axis
5  k=1//miller indices of y-axis
6  l=1//miller indices of z-axis
7
8  //CALCULATION
9  p=1/h//intercept on x-axis
10 q=1/k//intercept on y-axis
```

```
11 r=1/l//intercept on z-axis
12 //OUTPUT
13 printf('The ratio of intercepts on the three axis by
       (%i %i %i) plane is %i:%i:%i',h,k,l,p,q,r)
```

Scilab code Exa 3.7 Interplanar distance

```
1  clc
2  clear
3  //INPUT DATA
4  r=1.246*10^-10//atomic radius of Fcc crystal in m
5  h1=1//miller indices with respect to x axis in 1st
       plane
6  k1=1//miller indices with respect to y axis in 1st
       plane
7  l1=1//miller indices with respect to z axis in 1st
       plane
8  h2=2//miller indices with respect to x axis in 2nd
       plane
9  k2=0//miller indices with respect to y axis in 2nd
       plane
10 l2=0//miller indices with respect to z axis in 2nd
       plane
11 h3=2//miller indices with respect to x axis in 3rd
       plane
12 k3=2//miller indices with respect to y axis in 3rd
       plane
13 l3=0//miller indices with respect to z axis in 3rd
       plane
14
15 //CALCULATION
16 a=(4*r)/sqrt(2)//The lattice constant in a FCC
       crystal in m
17 d1=(a/(sqrt(h1^2+k1^2+l1^2)))/10^-10//inter planar
       spacing distance in 1st plane in m*10^-10
```

```
18 d2=(a/(sqrt(h2^2+k2^2+l2^2)))/10^-10//inter planar
   spacing distance in 2nd plane in m*10^-10
19 d3=(a/(sqrt(h3^2+k3^2+l3^2)))/10^-10//inter planar
   spacing distance in 3rd plane in m*10^-10
20
21 //OUTPUT
22 printf('The inter planar spacing distance in 1st
   plane is %3.3f*10^-10 m \n The inter planar
   spacing distance in 2nd plane is %3.4f*10^-10 m \
   nThe inter planar spacing distance in 3rd plane
   is %3.3f*10^-10 m',d1,d2,d3)
```

Scilab code Exa 3.8 Interplanar distance

```
1 clc
2 clear
3 //INPUT DATA
4 a=1//the lattice constant of a simple cubic system
   in m
5 h1=1//miller indices with respect to x axis in 1st
   plane
6 k1=0//miller indices with respect to y axis in 1st
   plane
7 l1=0//miller indices with respect to z axis in 1st
   plane
8 h2=1//miller indices with respect to x axis in 2nd
   plane
9 k2=1//miller indices with respect to y axis in 2nd
   plane
10 l2=0//miller indices with respect to z axis in 2nd
   plane
11 h3=1//miller indices with respect to x axis in 3rd
   plane
12 k3=1//miller indices with respect to y axis in 3rd
   plane
```

```
13 l3=1//miller indices with respect to z axis in 3rd
      plane
14
15 //CALCULATION
16 x1=(sqrt(h1^2+k1^2+l1^2))
17 d100=(a/x1)//inter planar spacing distance in 1st
      plane in m
18 x2=sqrt(h2^2+k2^2+l2^2)
19 d110=(a/(x2))//inter planar spacing distance in 2nd
      plane in m
20 x3=(sqrt(h3^2+k3^2+l3^2))
21 d111=(a/x3)//inter planar spacing distance in 3rd
      plane in m
22
23 //OUTPUT
24 printf('The inter planar spacing distance in 1st
      plane is %i m \n The inter planar spacing
      distance in 2nd plane is %3.4f m \nThe inter
      planar spacing distance in 3rd plane is %3.3fm \n
       Ratio of interplanar distance of three planes is
       d100:d110:d111=%i:%3.3f:%3.3f',(1/x1),(1/x2),(1/
      x3),d100,d110,d111)
```

Scilab code Exa 3.9 Miller indices of a plane

```
1 clc
2 clear
3 //INPUT DATA
4 p=1//x-intercept of the plane
5 q=1/2//y-intercept of the plane
6 r=3//z-intercept of the plane
7
8 //CALCULATION
9 h=(1/p)*3//miller indices with respect to x axis
10 k=(1/q)*3//miller indices with respect to y axis
```

```
11 l=(1/r)*3//miller indices with respect to z axis
12
13 //OUTPUT
14 printf('The miller indices of the plane is (h k l)=(
     %i %i %i)',h,k,l)
```

Scilab code Exa 3.10 Distance

```
1  clc
2  clear
3  //INPUT DATA
4  a=2.814//the lattice constant of a simple cubic
     system in armstrong
5  h1=1//miller indices with respect to x axis
6  k1=0//miller indices with respect to y axis
7  l1=0//miller indices with respect to z axis
8
9  //CALCULATION
10 d=(a/(sqrt(h1^2+k1^2+l1^2)))//inter planar d spacing
     distance in armstrong
11
12 //OUTPUT
13 printf('The inter planar d-spacing distance is %3.3f
     armstrong',d)
```

Scilab code Exa 3.11 Miller indices

```
1  clc
2  clear
3  //INPUT DATA
4  OA=0.025//The unit cell makes intercepts on a in nm
5  OB=0.02//The unit cell makes intercepts on b in nm
6  OC=0.01//The unit cell makes intercepts on c in nm
```

```
7 a=0.05//The unit cell edge of an orthorhombic
    crystal in nm
8 b=0.04//The unit cell edge of an orthorhombic
    crystal in nm
9 c=0.03//The unit cell edge of an orthorhombic
    crystal in nm
10
11 //CALCULATION
12 p=a/OA//miller indices with respect to x axis
13 q=b/OB//miller indices with respect to y axis
14 r=c/OC//miller indices with respect to z axis
15
16 //OUTPUT
17 printf('The miller indices of the set of parallel
    lines is (%i %i %i)',p,q,r)
```

Scilab code Exa 3.12 Miller indices

```
1 clc
2 clear
3
4 //INPUT
5 a=0.424;//value of one axial unit
6 b=1;//value of second axial unit
7 c=0.367;//value of third axial unit
8 i1=0.212;//value at x-intercept
9 j1=1;//value at y-intercept
10 k1=0.183;//value at z-intercept
11 i2=0.848;//value at x-intercept
12 j2=1;//value at y-intercept
13 k2=0.732;//value at z-intercept
14 i3=0.424;//value at x-intercept
15 j3=%inf;//value at y-intercept
16 k3=0.123;//value at z-intercept
17
```

```
18 //CALCULATIONS
19 p1=1/(i1/a);//miller indices at x-intercept
20 q1=1/(j1/b);//miller indices at y-intercept
21 r1=1/(k1/c);//miller indices at z-intercept
22 p2=1/(i2/a)*2;//miller indices at x-intercept
23 q2=1/(j2/b)*2;//miller indices at y-intercept
24 r2=1/(k2/c)*2;//miller indices at z-intercept
25 p3=1/(i3/a);//miller indices at x-intercept
26 q3=1/(j3/b);//miller indices at y-intercept
27 r3=1/(k3/c);//miller indices at z-intercept
28
29 //OUTPUT
30 mprintf('The miller indices are (%i %i %i) \n The
     miller indices are (%i %i %i) \n The miller
     indices are (%i %i%3.0f)',p1,q1,r1,p2,q2,r2,p3,q3
     ,r3)
```

Scilab code Exa 3.13 Miller indices

```
1 clc
2 clear
3 //INPUT DATA
4 OB=2//The intercept made by the parrell line ,OB=2b
5 OC=7//The intercept made by the parrell line ,OC=2c
6 OA=%inf//The intercept made by the parrell line ,OB
     =2b
7
8 //CALCULATION
9 A=1/OA//miller indice along x-axis
10 B=1/OB//miller indice along y-axis
11 C=1/OC//miller indice along z-axis
12 X=(B*(OC*OB))//taking L.C.M
13 Y=(C*(OC*OB))//taking L.C.M
14
15
```

```
16 //Output
17 printf('Miller indices are (1/%f 1/%i 1/%i)=(%i %i
     %i)',OA,OB,OC,A,X,Y)
```

Scilab code Exa 3.14 Atomic radius

```
1 clc
2 clear
3 //INPUT DATA
4 a=3.6//lattice parameter of copper in armstrong
5
6 //CALCULATION
7 r=(a*sqrt(2))/4//The atomic radius of copper in
     armstrong
8
9 //OUTPUT
10 printf('The atomic radius of copper is %3.3f
     armstrong',r)
```

Scilab code Exa 3.15 Interplanar distance

```
1 clc
2 clear
3 //INPUT DATA
4 a=4.12//the lattice constant of a simple cubic
     system in armstrong
5 h1=3//miller indices with respect to x axis
6 k1=2//miller indices with respect to y axis
7 l1=1//miller indices with respect to z axis
8
9 //CALCULATION
10 d=(a/(sqrt(h1^2+k1^2+l1^2)))//inter planar d spacing
     distance in armstrong
```

```
11
12 //OUTPUT
13 printf('The inter planar d-spacing distance is %3.4f
       armstrong',d)
```

Scilab code Exa 3.16 Density

```
1  clc
2  clear
3  //INPUT DATA
4  n=4//no.of atoms in FCC structure
5  A=63.54//Atomic weight of copper
6  r=1.278*10^-10//atomic radius in m
7  N=6.023*10^26//Avogadro's Number per Kg mol
8
9  //CALCULATION
10 a=((4*r)/sqrt(2))//The lattice constant in m
11 d=((A*n)/(N*a*a*a))//The density of copper in Kg/m^3
12
13 //OUTPUT
14 printf('The density of copper is %i Kg/m^3',d)
```

Scilab code Exa 3.17 Distance

```
1  clc
2  clear
3  //INPUT DATA
4  h1=1//miller indices with respect to x axis in 1st
       plane
5  k1=0//miller indices with respect to y axis in 1st
       plane
6  l1=0//miller indices with respect to z axis in 1st
       plane
```

```
7 h2=1//miller indices with respect to x axis in 2nd
    plane
8 k2=1//miller indices with respect to y axis in 2nd
    plane
9 l2=0//miller indices with respect to z axis in 2nd
    plane
10 h3=1//miller indices with respect to x axis in 3rd
    plane
11 k3=1//miller indices with respect to y axis in 3rd
    plane
12 l3=1//miller indices with respect to z axis in 3rd
    plane
13 a=1//The lattice constant in a in a simple cubic
    lattice in m
14
15 //CALCULATION
16 d100=(a/(sqrt(h1^2+k1^2+l1^2)))//inter planar
    spacing distance in 1st plane in m
17 d110=(a/(sqrt(h2^2+k2^2+l2^2)))//inter planar
    spacing distance in 2nd plane in m
18 d111=(a/(sqrt(h3^2+k3^2+l3^2)))//inter planar
    spacing distance in 3rd plane in m
19
20 //OUTPUT
21 printf('The ratio of interplanar distance between
    successive lattice planes in a simple cubic
    lattice is d100:d110:d111=%i:%3.3f:%3.3f',d100,
    d110,d111)
```

Scilab code Exa 3.18 Distance

```
1 clc
2 clear
3 //INPUT DATA
4 x=23//atomic weight of sodium
```

```
y=35.45//atomic weight of chloide
AW=58.45//atomic weight of sodium chloride(NaCl)
n=4//no.of atoms in FCC structure
d=2.18*10^6//density of NaCl crystal of FCC
    structure in kg/m^3
N=6.023*10^23//Avogadro's Number per Kg mol

//CALCULATION
a=(((n*AW)/(d*N))^(1/3))/10^-10//The lattice
    constant in m
r=(a/2)//The distance between two adjacent atoms in
    m *10^-10

//OUTPUT
printf('The distance between two adjacent atoms is
    %3.2f*10^-10 m',r)
```

Scilab code Exa 3.19 Atomic radius

```
clc
clear
//INPUT DATA
n=2//no.of atoms in BCC structure
d=7.86*10^6//density of iron of FCC structure in kg/
    m^3
AW=55.85//atomic weight of Fe
N=6.023*10^23//Avogadro's Number per Kg mol

//CALCULATION
a=(((n*AW)/(d*N))^(1/3))/10^-10//The lattice
    constant in m
r=((a*sqrt(3))/4)//The atomic radius of Fe which has
    BCC structure in armstrong*10^-10

//OUTPUT
```

```
14 printf('The atomic radius of Fe which has BCC
      structure is %3.3f armstrong',r)
```

Scilab code Exa 3.20 Lattice constant

```
1  clc
2  clear
3  //INPUT DATA
4  n=4//no.of atoms in FCC structure
5  d=2.7*10^3//density of potassium bromide in Kg/m^3
6  AW=119//molecular weight of KBr
7  N=6.023*10^26//Avagadro's number per Kg mol
8
9  //CALCULATION
10 a=(((n*AW)/(d*N))^(1/3))/10^-10//The lattice
      constant in armstrong *10^-10
11
12 //OUTPUT
13 printf('The lattice constant is %3.1f Armstrong',a)
```

Scilab code Exa 3.21 Number of atoms

```
1  clc
2  clear
3  //INPUT DATA
4  d=9.6*10^2//density of crystal in Kg/m^3
5  AW=23//molecular weight of the crystal
6  N=6.023*10^26//Avagadro's number per Kg mol
7  a=4.3*10^-10//lattice constant in m
8
9  //CALCULATION
10 n=((d*N*a*a*a)/AW)//Number of atoms per unit cell of
      a crystal
```

```
11
12 //OUTPUT
13 printf('Number of atoms per unit cell of a crystal
      is %3.2f \n If n=2,the crystal system is body
      centered cubic.',n)
```

Scilab code Exa 3.22 Volume of its unit cell

```
1 clc
2 clear
3 //INPUT DATA
4 r=1.2*10^-10//atomic radius of crystal of BCC
      structure in m
5
6 //CALCULATION
7 a=((4*r)/sqrt(3))//lattice constant of BCC structure
      in m
8 V=((a*a*a)/10^-29)//The volume of cell in m^3*10^-29
9
10 //OUTPUT
11 printf('The volume of cell is %3.3f*10^-29 m^3',V)
```

Scilab code Exa 3.23 Planar distance

```
1 clc
2 clear
3 //INPUT DATA
4 a=4*10^-7//lattice constant of the crystal in mm
5 h1=1//miller indices with respect to x axis in 1st
      plane
6 k1=0//miller indices with respect to y axis in 1st
      plane
```

```
7 l1=0//miller indices with respect to z axis in 1st
    plane
8
9 //CALCULATION
10 n=4*(1/4)//Number of atoms contained in a plane per
    unit cell
11 A=a*a//Area of the plane in mm^2
12 d=(n/A)/10^12//The planar atomic density in atoms/mm
    ^2
13
14 //OUTPUT
15 printf('The planar atomic density is %3.2f*10^12
    atoms/mm^2',d)
```

Scilab code Exa 3.24 Lattice constant

```
1 clc
2 clear
3 //INPUT DATA
4 n=4//no.of atoms in Face centered cubic lattice
5 d=6250//density of potassium bromide in Kg/m^3
6 AW=60.2//molecular weight of crysal with face
    centered cubic lattice
7 N=6.023*10^26//Avagadro's number per Kg mol
8
9 //CALCULATION
10 a=(((n*AW)/(d*N))^(1/3))/10^-10//The lattice
    constant in armstrong *10^-10
11
12 //OUTPUT
13 printf('The lattice constant is %3.3f*10^-10
    Armstrong',a)
```

Scilab code Exa 3.25 Volume change in percentage

```
clc
clear
//INPUT DATA
r1=0.1258*10^-9//atomic radii of the iron atom in
   BCC structure in m
r2=0.1292*10^-9//atomic radii of the iron atom in
   FCC structure in m
T=910//metallic iron changes from BCC to FCC in
   centigrade

//CALCULATION
a1=((4*r1)/sqrt(3))//lattice constant of BCC
   structure in m
v1=((a1*a1*a1)/2)//The volume occupied by one BCC
   atom in m^3
a2=((4*r2)/sqrt(2))//lattice constant of FCC
   structure in m
v2=((a2*a2*a2)/4)//The volume occupied by one FCC
   atom in m^3
V=((v1-v2)/v1)*100//The change in volume percentage

//OUTPUT
printf('The change in volume percentage is %3.5f',V)
```

Scilab code Exa 3.26 Number of unit cells

```
clc
clear
//INPUT DATA
a=0.405*10^-9//lattice constant of unit cell of
   aluminium which is face centered cubic in m
s=25*10^-2//Side of aluminium foil in m
t=0.005*10^-2//Thickness of aluminium foil in m
```

```
7
8 //CALCULATION
9 ar=(s*s)//area of aluminium foil in m^2
10 V=(ar*t)//volume of the aluminium foil in m^3
11 v=(a*a*a)//volume of the unit cell in m^3
12 n=(V/v)/10^22//Number of unit cells *10^22
13
14 //OUTPUT
15 printf('The Number of unit cells is %3.4f*10^22',n)
```

Scilab code Exa 3.27 Volume of the unit cell

```
1 clc
2 clear
3 //INPUT DATA
4 r=0.1605*10^-9//radius of magnesium atom which has
     HCP structure in m
5
6 //CALCULATION
7 a=2*r//lattice constant of magnesium which has HCP
     structure in m
8 c=(a*sqrt(8/3))//height of the HCP structure in m
9 V=((3*sqrt(3)*a*a*c)/3)/10^-28//Volume of the unit
     cell of Magnesium which has HCP structure in m
     ^3*10^-28
10
11 //OUTPUT
12 printf('The Volume of the unit cell of Magnesium
     which has HCP structure is %3.4f*10^-28 m^3',V)
```

Chapter 4

Wave optics

Scilab code Exa 4.1 wavelength of ligth used

```
1 clc
2 clear
3 //INPUT DATA
4 n=125//number of fingers cross the field of view
5 d=0.04*10^-3//distance of one of mirror moved in m
6
7 //CALCULATION
8 w=((2*d)/n)/10^-9//wavelength of light used in m
9
10 //OUTPUT
11 printf('The wavelength of light used is %i *10^-9.m'
   ,w)
```

Scilab code Exa 4.2 wavelength of light

```
1 clc
2 clear
3 //INPUT DATA
```

```
4 Ri=1.5//refractive index of thin film of glass
5 n=30//number of fringes of sodium light is observed
     across the field of view
6 t=0.018*10^-3//thickness of glass film in m
7
8 //CALCULATION
9 w=((2*(Ri-1)*t)/n)/10^-7//wavelength of the light
     used in m *10^-7
10
11 //OUTPUT
12 printf('The wavelength of light used is %i *10^-7.m'
     ,w)
```

Scilab code Exa 4.3 wavelength of monochromatic source

```
1 clc
2 clear
3 //INPUT DATA
4 n=200//number of fringes cross the field of view
5 d=0.0589*10^-3//distance of mirror displaced in m
6
7 //CALCULATION
8 w=((2*d)/n)/10^-7//wavelength of the monochromatic
     source used in m *10^-7
9
10 //OUTPUT
11 printf('The wavelength of the monochromatic source
     used is %3.2f *10^-7.in m',w)
```

Scilab code Exa 4.4 Thickness of the film

```
1 clc
2 clear
```

```
3 //INPUT DATA
4 x=1.55//refractive index of transparent film of
     glass
5 w=480*10^-9//wavelength of light in m
6 n=450//number of fringes to sweep across the field
7
8 //CALCULATION
9 t=((n*w)/(2*(x-1)))/10^-4//thickness of the film in
     m *10^-4
10
11 //OUTPUT
12 printf('The thickness of the film is %3.4f *10^-4.m'
     ,t)
```

Scilab code Exa 4.5 Refractive index of the material

```
1 clc
2 clear
3 //INPUT DATA
4 t=0.004*10^-2//thickness of transparent sheet in m
5 d=0.0027*10^-2//distance of mirror displaced in m
6
7 //CALCULATION
8 X=((d/t)+1)//refractive index of the material
9
10 //OUTPUT
11 printf('The refractive index of material is %3.3f',X
     )
```

Scilab code Exa 4.6 Number of fringes

```
1 clc
2 clear
```

```
3 //INPUT DATA
4 d=0.03205*10^-3//distance of movable mirror
     displaced in m
5 w=580.9*10^-9//wavelength of light in m
6
7 //CALCULATION
8 n=(2*d)/w//number of fringes shifted across the
     cross wire of eye piece of the telescope
9
10 //OUTPUT
11 printf('The number of fringes shifted across the
     cross wire of eye piece of the telescope is %i',n
     )
```

Scilab code Exa 4.7 Thickness of a quarter wave plate

```
1 clc
2 clear
3 //INPUT DATA
4 w=5893*10^-10//wavelength of sodium light in m
5 Re=1.5532//Refractive index of quartz for e ray
6 Ro=1.5332//Refractive index of quartz for o ray
7
8 //CALCULATION
9 t=((w/(4*(Re-Ro))))/10^-6//thickness of a quarter
     wave plate of quartz for sodium light in m *10^-6
10
11 //OUTPUT
12 printf('The thickness of a quarter wave plate of
     quartz for sodium light is %3.4f *10^-6.m',t)
```

Scilab code Exa 4.8 Thickness of a double refracting crystal

```
clc
clear
//INPUT DATA
w=6000*10^-10//wavelength in m
Re=1.54//Refractive index of double refracting
    crystal for e ray
Ro=1.65//Refractive index of double refracting
    crystal for o ray

//CALCULATION
t=((w/(2*(Ro-Re))))/10^-6//thickness of a double
    refracting crystal required  at w/2 in m *10^-6

//OUTPUT
printf('The thickness of a double refracting crystal
    required at w/2 is %3.3f *10^-6.m',t)
```

Scilab code Exa 4.9 Least thickness of a plate

```
clc
clear
//INPUT DATA
w=5*10^-7//wavelength in m
Re=1.5573//Refractive index for e ray when the
    emergent beam will be plane polarised
Ro=1.5442//Refractive index for o ray when the
    emergent beam will be plane polarised

//CALCULATION
t=((w/(4*(Re-Ro))))/10^-6//least thickness of a
    plate in m *10^-6

//OUTPUT
printf('The least thickness of a plate when the
    emergent beam will be plane polarised is %3.2f
```

```
*10^-6.m',t)
```

Scilab code Exa 4.10 Thickness of the Calcite plate

```
clc
clear
//INPUT DATA
w=5893*10^-10//wavelength of sodium light in m
Ro=1.658//Refractive index of calcite for o ray
Re=1.486//Refractive index of calcite for e ray

//CALCULATION
t=((w/(2*(Ro-Re))))/10^-7//thickness of the quarter
    wave plate for calcite in m *10^-7

//OUTPUT
printf('The thickness of the quarter wave plate for
    calcite is %3.3f *10^-7.m',t)
//Answer given in the book is wrong
```

Scilab code Exa 4.11 Wavelength of half wave plate

```
clc
clear
//INPUT DATA
t=30*10^-6//thickness of wave plate in m
Ro=1.55//Refractive index of wave plate for o ray
Re=1.54//Refractive index of wave plate for e ray

//CALCULATION
w=(2*t*(Ro-Re))/10^-9//wavelength for which it can
    act as a half wave plate in m *10^-9

```

```
11 //OUTPUT
12 printf('The wavelength for which it can act as a
      half wave plate is %i *10^-9.m',w)
```

Scilab code Exa 4.12 Thickness of a sheet

```
1 clc
2 clear
3 //INPUT DATA
4 w=546.1*10^-9//wavelength of light in m
5 Re=1.592//Refractive index of mica for e ray
6 Ro=1.586//Refractive index of mica for o ray
7
8 //CALCULATION
9 t=((w/(2*(Re-Ro))))/10^-5//thickness of a mica sheet
      in m *10^-5
10
11 //OUTPUT
12 printf('The thickness of a mica sheet required for
      making a half wave plate for a light of
      wavelength w is %3.4f *10^-5.m',t)
```

Chapter 5

Laser

Scilab code Exa 5.1 Ratio of population

```
clc
clear
//INPUT DATA
t=300//temperature in k
w=698.3*10^-9//wavelength of photon in m
h=6.625*10^-34// Planck's constant in m^2 Kg/sec
c=3*10^8//velocity of light in m/s
Kb=1.38*10^-23//Boltzmann's constant in m^2 Kg.s^-2
   k^-1

//CALCULATION
Ratio=(exp((-h*c)/(w*Kb*t)))/10^-30//ratio of
   propulsion of the two states in a laser *10^-30

//OUTPUT
printf('The ratio of propulsion of the two states in
    a laser is %3.4f *10^-30',Ratio)
```

Scilab code Exa 5.2 Band gap

```
clc
clear
//INPUT DATA
w=1.55*10^-6//wavelength of light emission in m
h=6.625*10^-34// Planck's constant in m^2 Kg/sec
c=3*10^8//velocity of light in m/s
e=1.6*10^-19//charge of electron in coulombs

//CALCULATION
Eg=(h*c)/(w*e)//band gap in eV

//OUTPUT
printf('The band gap for lnp laser diode is %3.4f eV
   ',Eg)
```

Scilab code Exa 5.3 wavelength limit

```
clc
clear
//INPUT DATA
E=0.02*1.6*10^-19//Ionisation energy in J
h=6.625*10^-34// Planck's constant in m^2 Kg/sec
c=3*10^8//velocity of light in m/s

//CALCULATION
w=((h*c)/E)/10^-5// long wavelength limit of an
   extrinsic semiconductor in m *10^-5

//OUTPUT
printf('The long wavelength limit of an extrinsic
   semiconductor is %3.4f *10^-5.m',w)
```

Scilab code Exa 5.4 Number of photons emitted

```
clc
clear
//INPUT DATA
E=3.5*10^-3*60//power output in J/min
w=0.621*10^-6//wavelength of light in m
h=6.625*10^-34// Planck's constant in m^2 Kg/sec
c=3*10^8//velocity of light in m/s

//CALCULATION
e=(h*c)/w//energy emitted by one photon in J
n=(E/e)/10^17//The number of photons emitted per
   minute in photons /minute *10^17

//OUTPUT
printf('The number of photons emitted per minute is
   %3.3f *10^17 photons /minute',n)
```

Chapter 6

Fiber optics

Scilab code Exa 6.1 Critical and acceptance angle and numerical aperture

```
clc
clear
//INPUT DATA
n1=1.545//refractive index of optical fibre core
n2=1.495//refractive index of cladding

//CALCULATION
CA=asind(n2/n1)//critical angle in degree
AA=asind(sqrt((n1)^2-(n2)^2))//acceptance angle in
   degree
NA=sind(AA)//numerical aperture

//OUTPUT
printf('The critical angle is %3.2f degrees \n The
   acceptance angle is %3.2f degrees \n The
   numerical aperture is %3.4f',CA,AA,NA)
```

Scilab code Exa 6.2 Numerical aperture

```
clc
clear
//INPUT DATA
n1=1.54//refractive index of optical fibre core
n2=1.5//refractive index of cladding

//CALCULATION
NA=sqrt((n1)^2-(n2)^2)//numerical aperture

//OUTPUT
printf('The numerical aperture is %3.4f',NA)
```

Scilab code Exa 6.3 Critical and acceptance and numerical aperture

```
clc
clear
//INPUT DATA
n1=1.55//refractive index of optical fibre core
n2=1.47//refractive index of cladding

//CALCULATION
CA=asind(n2/n1)//critical angle in degree
NA=(sqrt((n1)^2-(n2)^2))//acceptance angle in degree
AA=asind(NA)//numerical aperture


//OUTPUT
printf('The critical angle is %3.2f degrees \n The
   numerical aperture is %3.4f \n The acceptance
   angle is %3.2f degrees',CA,NA,AA)
```

Scilab code Exa 6.4 Acceptance angle

```
clc
clear
//INPUT DATA
n2=1.55//refractive index of cladding
no=1.33//refractive index of water
NA=0.20//numerical aperture of optical fibre

//CALCULATION
n1=sqrt((n2)^2+(NA)^2)//refractive index of optical
   fibre
NAW=(sqrt((n1)^2-(n2)^2)/no)//numerical aperture
   when fibre is in water
AA=asind(NAW)//Acceptance angle for the fibre in
   water in degrees

//OUTPUT
printf('The refractive index of optical fibre is %3
   .4f\n The numerical aperture when fibre is in
   water is %3.4f\n The Acceptance angle for the
   fibre in water is %3.2f degrees',n1,NAW,AA)
```

Scilab code Exa 6.5 Refractive index

```
clc
clear
//INPUT DATA
NA=0.22//numerical aperture of optical fibre
no=0.012//refractive index difference

//CALCULATION
n1=(NA/(sqrt(2*no)))//The refractive index of the
   core of a fibre
n2=n1*(1-no)//The refractive index of the cladding

//OUTPUT
```

```
12 printf('The refractive index of the core of a fibre
     is %3.3f \n The refractive index of the cladding
     is %3.3f',n1,n2)
```

Chapter 7

Conducting materials

Scilab code Exa 7.1 Mobility of the charge carriers

```
1 clc
2 clear
3 //INPUT DATA
4 n=5.9*10^28 //electron concentration of conductor in
    m^-3
5 v=0.625//drift velocity of a conductor in ms^-1
6 x=6.22*10^7// electrical conductivity in ohm^-1 m^-1
7 e=1.6*10^-19//charge of electron in coulombs
8
9 //calculation
10 J=n*e*v/10^9//current density in the conductor
    corresponds to drift velocity in Am^-1 * 10^9
11 z=(x/(n*e))/10^-3//mobility of the charge in m^2V^-1
    s^-1 * 10^-3
12
13 //OUTPUT
14 printf('The current density in the conductor
    corresponds to a drift velocity is %3.1f * 10^9 A
    m^-1 \n Mobility of the charge carrires is %3.3f
    *10^-3 m^2 V^-1 s^-1',J,z)
```

Scilab code Exa 7.2 Drift velocity of the free electrons

```
clc
clear
//INPUT DATA
n=8.5*10^28 //density of free electrons in copper in
    m^-3
A=1.05*10^-6 //sectional area of copper in m^2
e=1.6*10^-19//charge of electron in coloumbs
I=1 //copper wire carries a current in A

//CALCULATION
V=(1/(A*n*e))/10^-5//drift velocity of free
   electrons in copper wire in ms^-1 *10^-5

//OUTPUT
printf('The drift velocity of free electron in a
   copper wire is %3.3f *10^-5 in ms^-1',V)
```

Scilab code Exa 7.3 Drift velocity of the free electrons

```
clc
clear
//INPUT DATA
X=3.5*10^-3 // mobility of free electrons in copper
   in m^2 V^-1 s^-1
E=0.5 //elactric field strength of copper in V m^-1

//CALCULATION
V=X*E/10^-3//drift velocity of free electrons in
   copper in m s^-1 *10^-3

```

```
10 //OUTPUT
11 printf('The drift velocity of free electrons in
      copper is %3.2f*10^-3 in ms^-1',V)
```

Scilab code Exa 7.4 Relaxation time

```
1 clc
2 clear
3 //INPUT DATA
4 n=6.5*10^28 //conduction electron in m^-3
5 r=1.435*10^-8 //metal resistivity in ohm-metre
6 e=1.6*10^-19//charge of electron in coulombs
7 m=9.11*10^-31//mass of a electron in kg
8
9 //CALCULATION
10 T=(m/(r*n*e^2))/10^-14//relaxation time of
      conduction electrons in s*10^-14
11
12 //OUTPUT
13 printf('The relaxation time of conduction electrons
      is %3.3f*10^-14 s',T)
```

Scilab code Exa 7.5 Mean free path between collisions of the free electrons

```
1 clc
2 clear
3 //INPUT DATA
4 r=1.72*10^-8//resistivity of copper  in ohm metre
5 T=293//temperature of copper in k
6 n=8.48*10^28 //density of free electron in m^-3
7 e=1.6*10^-19//charge of electron in coulombs
8 m=9.11*10^-31//mass of a electron in kg
```

```
k=1.38*10^-23//boltzmann constant in m^2 Kg s^-2 k
   ^-1

//CALCULATION
t=(m/(r*n*(e^2)))//relaxation time in s
v=sqrt((3*k*T)/m) //thermal velocity in ms^-1
L=t*v/10^-9//mean free path between collision of
   free electrons in copper in m*10^-9

//OUTPUT
printf('The mean free path between collision of free
    electrons in copper is %3.4f *10^-9 m',L)
```

Scilab code Exa 7.6 Drift velocity of electrons

```
clc
clear
//INPUT DATA
t=1*10^-3//thickness of metal in m
V=1//potential difference applied in volts in V
T=300//temperature in k
m=0.04//mobility in m^2 V^-1 s^-1
k=1.38*10^-23//boltzmann constant in m^2 Kg s^-2 k
   ^-1
m1=9.11*10^-31//mass of a electron in kg

//CALCULATION
v=(sqrt((3*k*T)/m1)/10^3) //thermal velocity in ms
   ^-1 *10^3
E=V/t//unit potenyial voltage gradient in V m^-1
vd=E*m//drift velocity of electrons in m s^-1

//OUTPUT
printf('The thermal velocity is %3.2f *10^3 m s^-1 \
   n Drift velocity of electrons is %i m s^-1 \n
```

```
Thus the terminal velocity is high compared to
the drift velocity',v,vd)
```

Scilab code Exa 7.7 Electrical conductivity of copper

```
clc
clear
//INPUT DATA
AW=63.5//atomic weight of copper
D=8.93*10^3//density of copper in kg m^-3
t=2.48*10^-14//relaxation time of copper in s
AV=6.023*10^26//avagadro no in mole^-1
e=1.6*10^-19//charge of electron in coulombs
m=9.11*10^-31//mass of a electron in kg

//CALCULATION
n=(AV*D)/AW//density of electrons per unit volume in
    m^-3
EC=((n*e^2*t)/m)/10^7//electrical conductivity of
   copper in Sm^-1 *10^7

//OUTPUT
printf('The electrical conductivity of copper is %3
   .2f *10^7 in S m^-1',EC)
//mho=siemens
```

Scilab code Exa 7.8 Drift velocity of electrons in copper

```
clc
clear
//INPUT DATA
I=10//current in A
r=0.8*10^-2//radius of wire in m
```

```
6 n=8.48*10^28 //density of free electron in m^-3
7 e=1.6*10^-19//charge of electron in coulombs
8
9 //CALCULATION
10 J=(I/(3.14*r^2))/10^4 //current density of copper in
    Am^-2 *10^4
11 v=(J/(n*e))/(10^-6*10^-4)//drift velocity of copper
   in ms^-1 *10^-6
12
13 //OUTPUT
14 printf('The drift velocity in copper is %3.4f *10^-6
    in ms^-1 \n The current density in copper is %3
   .4f *10^4 in Am^-2',v,J)
```

Scilab code Exa 7.9 Drift velocity and mobility

```
1 clc
2 clear
3 //INPUT DATA
4 r=1.54*10^-8//resistivity of silver wire at room
   temperature in ohm metre
5 E=100//Electric field along the wire in V/m
6 n=5.8*10^28//nis assuming of conduction electrons in
    m^-3
7 e=1.6*10^-19//charge of electron in coulombs
8
9 //CALCULATION
10 m=(1/(r*n*e))/10^-3//mobility of charge in m^2 V^-1
   s^-1 *10^-3
11 v=m*E/1000//drift velocity of electrons in m s^-1
12
13 //OUTPUT
14 printf('The mobility of charge is %3.2f * 10^-3 in m
   ^2 V^-1 s^-1 \n The drift velocity of electrons
   is %3.4f in m.s^-1',m,v)
```

Scilab code Exa 7.10 Mobility and average time collision

```
clc
clear
//INPUT DATA
D=8.92*10^3//density of copper in Kg m^-3
AW=63.5//atomic weight of copper
r=1.73*10^-8//resistivity of copper  in ohm metre
AV=6.023*10^26//avagadro no in mole^-1
e=1.6*10^-19//charge of electron in coulombs
m=9.11*10^-31//mass of a electron in kg

//CALCULATION
n=(AV*D)/AW//density of electrons per unit volume in
    m^-3
t=(m/(r*n*(e^2)))/10^-14//average time collision of
   electrons in copper in s *10^-14
mo=(1/(r*n*e))/10^-2//mobility of charge in m^2 V^-1
    s^-1 *10^-2

//OUTPUT
printf('The relaxation time collision of electrons
   in copper obeying classical laws is %3.2f *10^-14
    in s \n The mobility charge of copper obeying
   classical laws is %3.3f *10^-2 in m^2 V^-1 s^-1',
   t,mo)
```

Scilab code Exa 7.11 Electrical resistivity

```
clc
clear
```

```
3 //INPUT DATA
4 r=1.85*10^-10//the radius of sodium atom in m
5 t=3*10^-14//the classic value of mean free time in
    sec
6 temp=0//temperature in centigrade
7 na=2//number of atoms in a unit cell
8 ne=1//number of electrons per unit cell
9 e=1.6*10^-19//charge of electron in coulombs
10 m=9.11*10^-31//mass of a electron in kg
11
12 //CALCULATION
13 a=(4*r)/sqrt(3)//a is one side in bcc structure unit
     cell in m
14 v=a*a*a//volume of bcc structure unit cell in m^3
15 n=(na*ne)/v//density of electrons per unit volume in
     m^-3
16 r=(m/(n*e^2*t))/10^-8//The electrical resistivity in
     ohm metre *10^-8
17
18 //OUTPUT
19 printf('The electrical resistivity is %3.2f *10^-8
    in ohm metre',r)
```

Scilab code Exa 7.12 Free electron concentration and mobility and drift velocity

```
1 clc
2 clear
3 //INPUT DATA
4 r=2.7*10^-8//electrical resistivity of aluminium in
    ohm metre
5 AW=26.98//atomic weight of aluminium
6 d=2.7*10^3//density of volume in Kg/m^3
7 R=60*10^-3//resistance in W
8 l=5//length of aluminium wire in m
```

```
i=15//aluminuim wire carries a current in A
fe=3//number of free electrons
AV=6.023*10^26//avagadro no in mole^-1
e=1.6*10^-19//charge of electron in coulombs

//CALCULATION
n=(AV*d*fe)/AW//density of electrons per unit volume
    in electrons/m^-3
z=(1/(n*e*r))/10^-3//mobility of the charge in m^2V
   ^-1S^-1 * 10^-3
E=((i*R)/l)//free electron concentration in V/m
vd=(z*E)/(10^-4*10^3)//drift velocity in m s^-1 *
   10^-4

//OUTPUT
printf('Free electron concentration in aluminium is
   %3.2f in V/m \n Mobility of the charge is %3.3f
   *10^-3 in m^2 V^-1 S^-1 \n The drift velocity of
   electrons is %3.3f*10^-4 in m s^-1',E,z,vd)
```

Scilab code Exa 7.13 Resistance

```
clc
clear
//INPUT DATA
l=1*10^-2//length of intrinsic Ge rod in m
b=1*10^-3//breadth of intrinsic Ge rod in m
t=1*10^-3//thickness of intrinsic Ge rod in m
temp=300//temperature in k
d=2.5*10^19//intrinsic carrier density in Kg /m^3
z=0.39//mobility of electron in m^2V^-1S^-1
zh=0.19//mobility of hole in m^2V^-1S^-1
e=1.6*10^-19//charge of electron in coulombs

//CALCULATION
```

```
14 x=(d*e)*(z+zh)//electrical conductivity in ohm^-1 m
   ^-1
15 r=1/x//electrical resistivity in ohm metre
16 A=b*t//area in m^2
17 R=((r*l)/A)//resistance of an intrinsic Ge rod in
   ohm
18
19 //OUTPUT
20 printf('The resistance of an intrinsic Ge rod is %i
   ohm',R)
```

Scilab code Exa 7.14 Thermal conductivity of copper

```
1 clc
2 clear
3 //INPUT DATA
4 d=8.48*10^28//free electron density of copper in m
   ^-3
5 y=2.8138*10^-9//mean free path in m
6 v=1.1536*10^5//velocity of copper in m s^-1
7 t=20 //temperature of copper in c
8 Kb=1.38*10^-23//Boltzmann's constant in m^2 Kg s^-2
   k^-1
9
10 //CALCULATION
11 K=1/2*(d*v*y*Kb)//thermal conductivity of copper in
   W m^-1 K^-1
12
13 //OUTPUT
14 printf('The thermal conductivity of copper is %3.2f
   W m^-1 K^-1',K)
```

Scilab code Exa 7.15 Thermal conductivity and thermal resistance

```
clc
clear
//INPUT DATA
er=50*10^-8//electrical resistivity in ohm metre
t=300//temperature in k
r=13*10^-3//radius of brass in m
th=35*10^-3//thickness of brass in m
L=2.44*10^-8//Lorentz number in W ohm K^-2

//CALCULATION
K=(L*t)/er//thermal conductivity of brass in W m^-1
   K^-1
A=3.14*r*r //area of brass disk in m^2
Rt=th/(K*A)//thermal resistance of brass in K W^-1

//OUTPUT
printf('The thermal conductivity of brass is %3.2f W
    m^-1 K^-1 \n The thermal resistance of brass is
   %3.3f K W^-1',K,Rt)
```

Scilab code Exa 7.16 Lorentz number

```
clc
clear
//INPUT DATA
x=5.87*10^7//electrical conductivity in ohm^-1 m^-1
k=380//thermal conductivity of copper in W m-1 K^-1
t=293//temperature of copper in k

//CALCULATION
L=(k/(x*t))/10^-8//Lorentz number in W ohm K^-2
   *10^-8

//OUTPUT
printf('Lorentz number is %3.4f *10^-8 W.ohm.K^-2',L
```

)

Scilab code Exa 7.17 Thermal conductivity of copper

```
clc
clear
//INPUT DATA
x=6.40*10^7//electrical conductivity in mho m^-1
t=300//temperature of copper in k
L=2.44*10^-8//Lorentz number in W ohm K^-2

//CALCULATION
K=x*t*L//thermal conductivity of copper in W m^-1 K^-1

//OUTPUT
printf('The thermal conductivity of copper is %3.2f W.m^-1.K^-1',K)
```

Chapter 8

Quantum Physics

Scilab code Exa 8.1 Momentum

```
clc
clear
//INPUT DATA
W=0.1*10^-9//wavelength of photon in m
h=6.625*10^-34// Planck's constant in m^2 Kg /sec
c=3*10^8//velocity of light in m/s
e=1.6*10^-19//charge of electron in coulombs

//CALCULATION
E=((h*c)/(W*e))//energy of photon in eV
P=(h/W)/10^-24//momentum of the photon in Kgms^-1

//OUTPUT
printf('The energy of photon is %3.1f eV \n The
   momentum of the photon is %3.2f *10^-24.Kgms^-1',
   E,P)
```

Scilab code Exa 8.2 Number of photons

```
clc
clear
//INPUT DATA
w=5893*10^-10//wavelength of emitted light in m
e=100//total energy emitted per sec
h=6.625*10^-34// Planck's constant in m^2 Kg /sec
c=3*10^8//velocity of light m/s

//CALCULATION
E=((h*c)/w)//energy of one photon in J
N=(e/E)/10^20//The total numberof photons emitted in
    sec

//OUTPUT
printf('The total number of photons emitted per
   second is %3.3f *10^20 per sec',N)
```

Scilab code Exa 8.3 Energy density

```
clc
clear
//INPUT DATA
w=4000*10^-10//wavelength in black body in m
t=1500//temperature of black body in k
h=6.625*10^-34// Planck's constant m^2 Kg /sec
c=3*10^8//velocity of light in m/s
Kb=1.38*10^-23//Boltzmann's constant in m^2 Kg s^-2
   k^-1

//CALCULATION
Edw=((8*3.14*h*c)/w^5)*(1/(exp((h*c)/(w*Kb*t))-1))//
   The energy density per unit wavelength in a black
    body cavity in J/m^4

//OUTPUT
```

```
14 printf('The energy density per unit wavelength in a
      black body cavity is %3.5f J/m^4',Edw)
```

Scilab code Exa 8.4 Compton wavelength

```
1  clc
2  clear
3  //INPUT DATA
4  h=6.625*10^-34//Planck's constant in m^2 Kg /sec
5  c=3*10^8//velocity of light in m/s
6  m=9.11*10^-31//mass of electron in Kg
7
8  //CALCULATION
9  w=(h/(c*m))/10^-10//The compton wavelength for an
      electronin Armstrong
10
11 //OUTPUT
12 printf('The compton wavelength for an electron is %3
      .4f Armstrong',w)
```

Scilab code Exa 8.5 change in wavelength

```
1  clc
2  clear
3  //INPUT DATA
4  x=90//x ray photon scattered at a angle in degrees
5  h=6.625*10^-34//Planck's constant in J-sec
6  c=3*10^8//velocity of light m/s
7  m=9.11*10^-31//mass of electron in Kg
8
9  //CALCULATION
10 w=((h/(c*m))*(1-cosd(x)))/10^-10//The change in
      wavelength for Xray photon in A*10^-10
```

```
11
12 //OUTPUT
13 printf('The change in wavelength for X ray photon is
       %3.4f A',w)
```

Scilab code Exa 8.6 Wavelength of x rays

```
1  clc
2  clear
3  //INPUT DATA
4  angle=180//x ray carbon scattered at a angle in
       degrees
5  h=6.625*10^-34//Planck's constant in m^2 Kg /sec
6  c=3*10^8//velocity of light in m/s
7  m=9.11*10^-31//mass of electron in Kg
8  v=1.8*10^18//frequency of incident rays in s^-1
9
10 //CALCULATION
11 w=(c/v)//wavelength in m
12 tw=(h/(c*m))*(1-cosd(angle))//The change wavelength
       for Xray carbon in m
13 NW=(w+tw)/10^-10//The wavelength of X-rays carbon in
       Armstrong
14
15 //OUTPUT
16 printf('The wavelength of X-rays carbon is %3.2f
       Armstrong',NW)
```

Scilab code Exa 8.7 Wavelength of scattered photons

```
1  clc
2  clear
3  //INPUT DATA
```

```
4 w=3*10^-10//wavelength of incident photons in m
5 angle=60//angle of view in degrees
6 h=6.625*10^-34//Planck's constant in m^2 Kg /sec
7 c=3*10^8//velocity of light in m/sec
8 m=9.11*10^-31//mass of electron in Kg
9
10 //CALCULATION
11 tw=(w+((h/(c*m))*(1-cosd(angle))))/10^-10//The
      wavelength of scattered photons in Armstrong
12
13 //OUTPUT
14 printf('The wavelength of scattered photons is %3.3f
      Armstrong',tw)
```

Scilab code Exa 8.8 velocity of a moving electron

```
1 clc
2 clear
3 //INPUT DATA
4 x=4//Total energy increase to 4 times of its initial
      rest energy
5 c=3*10^8//velocity of light in m/sec
6 //CALCULATION
7 v=sqrt(c^2*(1-(1/x^2)))/10^8//The Velocity of moving
      electron in m/sec*10^8
8
9 //OUTPUT
10 printf('The Velocity of moving electron is %3.4f
     *10^8 m/sec',v)
```

Scilab code Exa 8.9 Energy of an electron

```
1 clc
```

```
clear
//INPUT DATA
a=0.1*10^-9//width of high potential box in m
h=6.625*10^-34//Planck's constant in m^2 Kg /sec
m=9.11*10^-31//mass of electron in Kg
e=1.6*10^-19//charge of electron in coulombs
n=1//take n equal to one

//CALCULATION
E=((n^2*h^2)/(8*m*a^2*e))//The least energy of the
    particle can be obtained in eV

//OUTPUT
printf('The least energy of the particle can be
    obtained is %3.2f eV',E)
```

Scilab code Exa 8.10 Lowest energy of a neutron

```
clc
clear
//INPUT DATA
a=10^-14//length of impenerable box in m
m=1.67*10^-27//mass of neutron in Kg
n=1//for lowest energy
h=6.625*10^-34//Planck's constant in m^2 Kg /sec

//CALCULATION
E=((n^2*h^2)/(8*m*a^2))/10^-13//The least energy of
    the neutron can be obtained in eV*10^-13

//OUTPUT
printf('The least energy of the neutron can be
    obtained is %3.3f*10^-13 eV',E)
```

Scilab code Exa 8.11 Three permitted energy levels

```
clc
clear
//INPUT DATA
a=4*10^-10//width of electron box in m
h=6.625*10^-34//Planck's constant in m^2 Kg /sec
m=9.11*10^-31//mass of electron in Kg
e=1.6*10^-19//charge of electron in coulombs
n=1//first permitted level

//CALCULATION
E1=((n^2*h^2)/(8*m*a^2*e))//The first permitted
   energy level by taking n=1 in eV
E2=4*E1//The second permitted energy level by taking
    n=2 in eV
E3=9*E1//The third permitted energy level by taking
   n=3 in eV

//OUTPUT
printf('The first permitted energy level by taking n
   =1 is %3.3f eV \n The second permitted energy
   level by taking n=2 is %3.3f eV \n The third
   permitted energy level by taking n=3 is %3.3f eV'
   ,E1,E2,E3)
```

Scilab code Exa 8.12 Lowest energy

```
clc
clear
//INPUT DATA
a=1.5*10^-10//each side of cubicalbox in m
```

```
5  n1=1//for lowest energy
6  n2=1//for lowest energy
7  n3=1//for lowest energy
8  h=6.625*10^-34//Planck's constant in m^2 Kg /sec
9  m=9.11*10^-31//mass of electron in Kg
10 e=1.6*10^-19//charge of electron in coulombs
11
12 //CALCULATION
13 n=(n1^2+n2^2+n3^2)//total value of n
14 E=((n*h^2)/(8*m*a^2*e))//The lowest energy of
       electron ina cubical box in eV
15
16 //OUTPUT
17 printf('The lowest energy of electron ina cubical
       box is %3.2f in eV',E)
```

Scilab code Exa 8.13 Minimum energy of an electron

```
1  clc
2  clear
3  //INPUT DATA
4  a=4*10^-9//width of potential well in m
5  n=1//For minimum energy n value
6  h=6.625*10^-34//Planck's constant in m^2 Kg /sec
7  m=9.11*10^-31//mass of electron in Kg
8  e=1.6*10^-19//charge of electron in coulombs
9
10 //CALCULATION
11 E=((n^2*h^2)/(8*m*a^2*e))//The lowest energy of
       electron in deep potential well in eV
12
13 //OUTPUT
14 printf('The lowest energy of electron in deep
       potential well is %3.5f eV',E)
```

Scilab code Exa 8.14 Energy required

```
clc
clear
//INPUT DATA
a=0.1*10^-9//length of one dimensional box in m
n=1//first permitted level
h=6.625*10^-34//Planck's constant in m^2 Kg /sec
m=9.11*10^-31//mass of electron in Kg
e=1.6*10^-19//charge of electron in coulombs

//CALCULATION
E1=((n^2*h^2)/(8*m*a^2*e))//The ground state of
   electron in an one dimensional box in eV
E6=36*E1//The fifth exited state of electron in eV
E=E6-E1//The energy required the electron from its
   ground state to the fifth exited state in eV

//OUTPUT
printf('The energy required the electron from its
   ground state to the fifth exited state is %i eV',
   E)
```

Scilab code Exa 8.15 Lowest energy

```
clc
clear
//INPUT DATA
a=0.1*10^-9//length of one dimensional box in m
n=1//first permitted level
h=6.625*10^-34//Planck's constant in m^2 Kg /sec
m=9.11*10^-31//mass of electron in Kg
```

```
e=1.6*10^-19//charge of electron in coulombs
ne=3//the number of electrons

//CALCULATION
E=((n^2*h^2)/(8*m*a^2*e))*ne//The lowest energy of the system consisting of three electron ia a one dimensional box in eV

//OUTPUT
printf('The lowest energy of the system consisting of three electron ia a one dimensional box is %3.4f eV',E)
```

Chapter 9

Energy Bands in Solids

Scilab code Exa 9.1 Fermi function

```
clc
clear
//INPUT DATA
//E-EF=KT
//K=KB is the boltzmann constant in m^2 Kg s^-2 k^-1

//CALCULATION
f=1/(1+exp(1))//The fermi function for an energy kt
   above fermi energy

//OUPUT
printf('The fermi function for an energy kt above
   fermi energy is %3.3f',f)
```

Scilab code Exa 9.2 Fermi function

```
clc
clear
```

```
3 //INPUT DATA
4 X=0.01*1.6*10^-19//difference between energy and
     fermi energy in J
5 T=200//temperature in k
6 KB=1.38*10^-23//Boltzmann's Constant in J/K
7
8 //CALCULATION
9 f=1/(1+exp(X/(KB*T)))//The fermi function
10
11 //OUTPUT
12 printf('The fermi function is %3.5f',f)
```

Scilab code Exa 9.3 Fermi velocity

```
1 clc
2 clear
3 //INPUT DATA
4 EF=11.63*1.6*10^-19//fermi energy of conducting
     electron in aluminium in J
5 t=7.3*10^-15//relaxation time for electron in sec
6 m=9.11*10^-31//mass of electon in Kg
7
8 //CALCULATION
9 Vf=(sqrt((2*EF)/m))/10^6//The fermi velocity fo
     conducting electron in aluminium in ms^-1*10^6
10 x=(t*Vf*10^6)/10^-9//mean free path for conducting
     electron of aluminium in nm
11
12 //OUTPUT
13 printf('The fermi velocity fo conducting electron in
      aluminium is %3.4f*10^6 ms^-1 \n The mean free
     path for conducting electron of aluminium is %3.4
     f nm',Vf,x)
```

Scilab code Exa 9.4 Fermi energy and temperature

```
clc
clear
//INPUT DATA
Vf=0.86*10^6//The femi energy of electons in the
    metal in m/sec
m=9.11*10^-31//mass of electon in Kg
KB=1.38*10^-23//Boltzmann's Constant in m^2 Kg s^-2
    k^-1

//CALCULATION
Ef=((1/2)*m*Vf^2)/10^-19//The fermi energy in a
    metal in J*10^-19
Tf=(Ef*10^-19/KB)/10^3//The fermi temperature in a
    metal in K*10^3

//OUTPUT
printf('The fermi energy in a metal is %3.4f*10^-19
    J \n The fermi temperature in a metal is %3.2f
    *10^3 K',Ef,Tf)
```

Scilab code Exa 9.5 Fermi temperature and velocity

```
clc
clear
//INPUT DATA
Ef=3.2*1.6*10^-19//The fermi energy in a metal in J
m=9.11*10^-31//mass of electon in Kg
KB=1.38*10^-23//Boltzmann's Constant in m^2 Kg s^-2
    k^-1

```

```
8 //CALCULATION
9 Tf=(Ef/KB)/10^3//The fermi temparature for sodium in
      K*10^6
10 Vf=(sqrt((2*Ef)/m))/10^6//The fermi velocity fo
     conducting electron in aluminium in ms^-1*10^6
11
12 //OUTPUT
13 printf('The fermi temparature for sodium is %3.2f
     *10^3 K \n The fermi velocity fo conducting
     electron in aluminium is %3.4f*10^6 ms^-1',Tf,Vf)
```

Scilab code Exa 9.6 Temperature

```
1 clc
2 clear
3 //INPUT DATA
4 E=5.5*1.6*10^-19//energy level in J
5 Ef=5*1.6*10^-19//fermi energy level in J
6 x=0.5*1.6*10^-19//Difference between energy and
     fermi energy in J
7 f=0.01//fermi function at which there is 1%
     probability that an electron in a solid
8 KB=1.38*10^-23//Boltzmann's Constant in m^2 Kg s^-2
     k^-1
9
10 //CALCULATION
11 T=(x/(KB*(log(1-f)-log(f))))/10^3//The temperature
     at which there is 1% probability that an electron
      in a solid in K*10^3
12
13 //output
14 printf('The temperature at which there is one
     percentage  probability that an electron in a
     solid is %3.4f*10^3 K',T)
```

Scilab code Exa 9.7 Energies

```
clc
clear
//INPUT DATA
Ef=2.1*1.6*10^-19//fermi energy level in potassium
   in J
f1=0.99//fermi factor for 1st
f2=0.01//fermi factor for 2nd
f3=0.5//fermi factor for 3rd
T=300//temperature in K
e=1.6*10^-19//charge of electro in C
KB=1.38*10^-23//Boltzmann's Constant in m^2 Kg s^-2
   k^-1

//CALCULATION
E1=(Ef+((KB*T)*(log(1-f1)-log(f1))))/e//The energy
   for probability of occupancy at 1st at which the
   300k in eV
E2=(Ef+((KB*T)*(log(1-f2)-log(f2))))/e//The energy
   for 1st at which the probability of occupancy at
   300k in eV
E3=(Ef+((KB*T)*(log(1-f3)-log(f3))))/e//The energy
   for 1st at which the probability of occupancy at
   300k in eV

//OUTPUT
printf('The energy for probability of occupancy at 1
   st at which the T is %3.2f eV\n The energy for
   probability of occupancy at 2nd at which the T is
    %3.2f eV\n The energy for probability of
   occupancy at 1st at which the T is %3.1f eV',E1,
   E2,E3)
```

Scilab code Exa 9.8 Probability of the level

```
clc
clear
//INPUT DATA
X=0.1*1.6*10^-19//difference between energy and
   fermi energy in J
T=300//temperature in k
KB=1.38*10^-23//Boltzmann's Constant in m^2 Kg s^-2
   k^-1

//CALCULATION
f=1-1/(1+exp(X/(KB*T)))//The probability of
   unoccupancy by an electron at room temperature

//OUTPUT
printf('The probability of unoccupancy by an
   electron at room temperature is %3.5f',f)
```

Scilab code Exa 9.9 Fermi factor

```
clc
clear
//INPUT DATA
n=4//number of atoms/unit cell in Aliminium
a=4.05*10^-10//lattice constant of Aluminium which
   is FCC crystal in m
nf=3//number of free electrons per atom in Aluminium
T=300//ambient temperature in K
x=0.1*1.6*10^-19//The same difference energy and
   fermi energy but in J
m=9.11*10^-31//mass of electon in Kg
```

```
10 h=6.625*10^-34//plank's constant in m^2 Kg/sec
11 KB=1.38*10^-23//Boltzmann's Constant in m^2 Kg s^-2
      k^-1
12
13 //CALCULATION
14 nc=(n*nf)/(a*a*a)//number of electrons per unit
      volume
15 Ef=((h*h)/(8*m)*((3*nc)/3.14)^(2/3))/10^-18//The
      fermi energy for the metal in eV*10^-18
16 f=1/(1+exp(x/(KB*T)))//The fermi factor
17
18 //OUTPUT
19 printf('The fermi energy for the metal is %3.2f
      *10^-18 eV \n The fermi factor is %3.4f',Ef,f)
```

Scilab code Exa 9.10 Fermi energy

```
1 clc
2 clear
3 //INPUT DATA
4 n=2//number of atoms/unit cell in cesium which is
      Bcc
5 a=6.14*10^-10//lattice constant of cesium which is
      BCC crystal in m
6 nf=1//number of free electrons per atom in cesium
7 m=9.11*10^-31//mass of electon in Kg
8 h=6.625*10^-34//plank's constant in m^2 Kg/sec
9 KB=1.38*10^-23//Boltzmann's Constant in m^2 Kg s^-2
      k^-1
10 e=1.6*10^-19//charge of electro in C
11
12 //CALCULATION
13 nc=(n*nf)/(a*a*a)//number of electrons per unit
      volume
14 Ef=(((h*h)/(8*m)*((3*nc)/3.14)^(2/3))/e)//The fermi
```

```
    energy for the metal in eV
15
16 //OUTPUT
17 printf('The fermi energy for cesium is %3.3f eV',Ef)
```

Scilab code Exa 9.11 Number of free electrons

```
1 clc
2 clear
3 //INPUT DATA
4 Ef=2.1*1.6*10^-19//The fermi energy level in
    potassium at a particular temperature in J
5 m=9.11*10^-31//mass of electon in Kg
6 h=6.625*10^-34//plank's constant in m^2 Kg/sec
7
8 //CALCULATION
9 nc=(((8*m)/(h*h)*Ef)^(3/2)*(3.14/3))/10^28//ThE
    Number of free electrons per unit volume in
    potassium at the same temperature in electrons/m
    ^3*10^28
10
11 //OUTPUT
12 printf('ThE Number of free electrons per unit volume
     in potassium at the same temperature is %3.3f
    *10^28 electrons/m^3',nc)
```

Scilab code Exa 9.12 Fermi energy

```
1 clc
2 clear
3 //INPUT DATA
4 AW=23//atomic weight of sodium in gm/mole
5 d=0.971*10^6//density of sodium in gm/m^3
```

```
m=9.11*10^-31//mass of electon in Kg
h=6.625*10^-34//plank's constant in m^2 Kg/sec
AV=6.02*10^23//Avagadro number in mole^-1
e=1.6*10^-19//charge of electro in C

//CALCULATION
nc=(AV*d)/AW//number of electrons per unit volume
Ef=(((h*h)/(8*m)*((3*nc)/3.14)^(2/3))/e)//The fermi
    energy for the sodium in eV

//OUTPUT
printf('The fermi energy for the sodium is %3.3f eV'
    ,Ef)
```

Scilab code Exa 9.13 Fermi energy in copper

```
clc
clear
//INPUT DATA
AW=63.5//atomic weight of copper in u
M=63.5*1.66*10^-27//mass of one copper atom in Kg
d=8.94*10^3//density of sodium in Kg/m^3
m=9.11*10^-31//mass of electon in Kg
h=6.625*10^-34//plank's constant in m^2 Kg/sec
e=1.6*10^-19//charge of electro in C

//CALCULATION
nc=(d)/M//number of electrons per unit volume in
    electrons/m^3
Ef=(((h*h)/(8*m)*((3*nc)/3.14)^(2/3))/e)//The fermi
    energy for the sodium in eV

//OUTPUT
printf('The fermi energy for the sodium is %3.3f eV'
    ,Ef)
```

Chapter 10

Intrinsic Semiconductors

Scilab code Exa 10.1 Electron and hole concentrations

```
1 clc
2 clear
3 //INPUT DATA
4 ec=4*10^-4//electrical conductivity of intrinsic
    silicon at room temperature in ohm^-1 m^-1
5 me=0.14//The electron mobility in m^2 V^-1 s^-1
6 mh=0.04//The hole mobility in m^2 V^-1 s^-1
7 e=1.6*10^-19//charge of electron in coulombs
8
9 //CALCULATION
10 ni=(ec/(e*(me+mh)))/10^16//The intrinsic carrier
    concentration at room temperature in m^-3 *10^16
11
12 //OUTPUT
13 printf('The intrinsic carrier concentration at room
    temperature is %3.3f *10^16.m^-3 \n Since ne=nh=
    ni from law of mass action the electron and hole
    concentrations are 1.33*10^16.m^-3',ni)
```

Scilab code Exa 10.2 Resistivity

```
clc
clear
//INPUT DATA
d=2.37*10^19//The intrinsic carrier density at room
   temperature in m^-3
me=0.38//The electron mobility in m^2 V^-1 s^-1
mh=0.18//The hole mobility in m^2 V^-1 s^-1
e=1.6*10^-19//charge of electron in coulombs

//CALCULATION
r=(1/(d*e*(me+mh)))//The resistivity of intrinsic
   carrier in ohm m

//OUTPUT
printf('The resistivity of intrinsic carrier is %3.4
   f ohm m',r)
```

Scilab code Exa 10.3 Intrinsic carrier density

```
clc
clear
//INPUT DATA
r=2*10^-4//the resistivity of In-Sb in ohm m
me=6//The electron mobility in m^2 V^-1 s^-1
mh=0.2//The hole mobility in m^2 V^-1 s^-1
e=1.6*10^-19//charge of electron in coulombs

//CALCULATION
d=(1/(r*e*(me+mh)))/10^21//The intrinsic carrier
   density at room tepmerature in m^-3 *10^21

//OUTPUT
printf('The intrinsic carrier density at room
```

```
tepmerature is %3.3f *10^21 m^-3',d)
```

Scilab code Exa 10.4 Conductivity

```
clc
clear
//INPUT DATA
Eg=1.1*1.6*10^-19//The energy gap of silicon in J
me=0.48//The electron mobility in m^2 V^-1 s^-1
mh=0.13//The hole mobility in m^2 V^-1 s^-1
h=6.625*10^-34//Planck's constant in m^2 Kg /sec
e=1.6*10^-19//charge of electron in coulombs
m=9.11*10^-31//mass of an electron
kb=1.38*10^-23//Boltzmann's constant m^2 Kg s^-2 k
   ^-1
t=300//temperature in k

//CALCULATION
ni=2*((2*3.14*m*kb*t)/h^2)^(3/2)*exp(-Eg/(2*kb*t))//
   intrinsic carrier concentration in m^-3
ec=(ni*e*(me+mh))/10^-3//The electrical conductivity
    at room temperature in ohm^-1 m^-1 *10^-3

//OUTPUT
printf('The electrical conductivity at room
   temperature is %3.4f *10^-3 ohm^-1 m^-1',ec)
```

Scilab code Exa 10.5 Intrinsic carrier concentration and conductivity

```
clc
clear
//INPUT DATA
```

```
4 Eg=1.43*1.6*10^-19//The energy gap of intrinsic GaAs
    in J
5 xe=0.85//The electron mobility in m^2 V^-1 s^-1
6 xh=0.04//The hole mobility in m^2 V^-1 s^-1
7 me=0.068*9.11*10^-31//effective mass of electron in
   m
8 mh=0.5*9.11*10^-31//effective mass of hole in m
9 h=6.625*10^-34//Planck's constant in m^2 Kg /sec
10 e=1.6*10^-19//charge of electron in coulombs
11 m=9.11*10^-31//mass of an electron in Kg
12 kb=1.38*10^-23//Boltzmann's constant m^2 Kg s^-2 k
   ^-1
13 t=300//temperature in k
14
15 //CALCULATION
16 ni=(2*((2*3.14*kb*t)/h^2)^(3/2)*(me*mh)^(3/4)*exp(-
   Eg/(2*kb*t)))/10^12//intrinsic carrier
   concentration in m^-3*10^12
17 ec=(ni*10^12*e*(xe+xh))/10^-7//The electrical
   conductivity at room temperature in ohm^-1 m^-1
   *10^-7
18
19 //OUTPUT
20 printf('The intrinsic carrier concentration is %3.4f
   *10^12 m^-3 \n The electrical conductivity at
   room temperature is %3.4f *10^-7 ohm^-1 m^-1',ni,
   ec)
```

Scilab code Exa 10.6 Position of the fermi level

```
1 clc
2 clear
3 //INPUT DATA
4 Eg=1.12*1.6*10^-19//Energy gap of Si semi conductor
   in J
```

```
5 me=0.12*9.11*10^-31//The electron mobility in m^2 V
    ^-1 s^-1
6 mh=0.28*9.11*10^-31//The hole mobility in m^2 V^-1 s
    ^-1
7 t=300//temperature of fermi level in k
8 kb=1.38*10^-23//Boltzmann's constant m^2 Kg s^-2 k
    ^-1
9 m=9.11*10^-31//mass of an electron in Kg
10
11 //CALCULATION
12 Ef=((Eg/2)+(((3*kb*t)/4)*log(mh/me)))/10^-20//
    position of the fermi level in J *10^-20
13
14 //OUTPUT
15 printf('The position of the fermi level is %3.5f
    *10^-20 J',Ef)
```

Scilab code Exa 10.7 Temperature

```
1 clc
2 clear
3 //INPUT DATA
4 Eg=1*1.6*10^-19//Energy gap in J
5 E=0.1*1.6*10^-19//Fermi level is shifted by 10% in J
6 me=1*9.11*10^-31//The electron mobility in m^2 V^-1
    s^-1
7 mh=4*9.11*10^-31//Effective mass of holes is 4 times
     that of electrons that is the hole mobility in m
    ^2 V^-1 s^-1
8 m=9.11*10^-31//mass of an electron in Kg
9 kb=1.38*10^-23//Boltzmann's constant m^2 Kg s^-2 k
    ^-1
10
11 //CALCULATION
12 T=(4*E)/(3*kb*log(4))//The Temperature of the fermi
```

```
    level shifted by 10% from the middle of the
    forbidden energy gap in K
13
14 //OUTPUT
15 printf('The Temperature of the fermi level shifted
    by 10percentage from the middle of the forbidden
    energy gap is %3.2f K',T)
```

Scilab code Exa 10.8 Resistance of an intrinsic Ge rod

```
1  clc
2  clear
3  //INPUT DATA
4  l=1*10^-2//length of the intrinsic Ge rod in m
5  b=1*10^-3//breadth of the intrinsic Ge rod in m
6  t=1*10^-3//thickness of the intrinsic Ge rod in m
7  T=300//temperature of the intrinsic Ge rod in K
8  me=0.39//The electron mobility in m^2 V^-1 s^-1
9  mh=0.19//The hole mobility in m^2 V^-1 s^-1
10 ni=2.5*10^19//intrinsic carrier conduction in m^3
11 e=1.6*10^-19//charge of electron in coulombs
12
13 //CALCULATION
14 ec=(ni*e*(me+mh))//The electrical conductivity at
    room temperature in ohm^-1 m^-1
15 A=(b*t)//area in m^2
16 R=(l/(ec*A))//The resistance of an intrinsic Ge rod
    in ohm
17
18 //OUTPUT
19 printf('The resistance of an intrinsic Ge rod is %i
    ohm',R)
```

Scilab code Exa 10.9 Ratio between its conductivity

```
clc
clear
//INPUT DATA
Eg=1.2*1.6*10^-19//The energy gap of intrinsic
   semiconductor in J
T1=600//Temperature in K
T2=300//Temperature in K
e=1.6*10^-19//charge of electron in coulombs
kb=1.38*10^-23//Boltzmann's constant m^2 Kg s^-2 k
   ^-1

//CALCULATION
x=exp((-Eg/(2*kb))*((1/T1)-(1/T2)))/10^5//The ratio
   of conductiveness*10^5

//OUTPUT
printf('The ratio of conductiveness is %3.2f*10^5',x
   )
```

Scilab code Exa 10.10 Conductivity of Ge

```
clc
clear
//INPUT DATA
Eg=0.72*1.6*10^-19//The band gap of Ge in J
T1=293//Temperature in K
T2=313//Temperature in K
x1=2//The conductivity of Ge at T1 in ohm^-1 m^-1
e=1.6*10^-19//charge of electron in coulombs
kb=1.38*10^-23//Boltzmann's constant m^2 Kg s^-2 k
   ^-1

//CALCULATION
```

```
12 x2=x1*(exp((Eg/(2*kb))*((1/T1)-(1/T2))))//The ratio
   of conductiveness
13
14 //OUTPUT
15 printf('The conductivity of Ge at T2 is %3.4f ohm^-1
    m^-1',x2)
```

Scilab code Exa 10.11 Intrinsic career density

```
1 clc
2 clear
3 //INPUT DATA
4 Eg1=0.36//The energy gap of intrinsic semiconductor
   A in eV
5 Eg2=0.72//The energy gap of intrinsic semiconductor
   B in eV
6 T1=300//Temperature of semiconductor A in K
7 T2=300//Temperature of semiconductor B in K
8 m=9.11*10^-31//mass of an electron in Kg
9 KT=0.026//kt in eV
10
11 //CALCULATION
12 x=(exp((Eg2-Eg1)/(2*KT)))//The intrinsic carrier
   density of A to B
13
14 //OUTPUT
15 printf('The intrinsic carrier density of A to B is
   %i',x)
```

Scilab code Exa 10.12 Band gap

```
1 clc
2 clear
```

```
3 //INPUT DATA
4 T1=293//Temperature in K
5 T2=373//Temperature in K
6 x1=250//The conductivity of semiconductor at T1 in
    ohm^-1 m^-1
7 x2=1100//The conductivity of semiconductor at T2 in
    ohm^-1 m^-1
8 e=1.6*10^-19//charge of electron in coulombs
9 kb=1.38*10^-23//Boltzmann's constant m^2 Kg s^-2 k
    ^-1
10
11 //CALCULATION
12 Eg=(2*kb*log(x2/x1)*((T1*T2)/(T2-T1)))/10^-20//The
    band gap of semiconductor in J*10^-20
13
14 //OUTPUT
15 printf('The band gap of semiconductor is %3.4f
    *10^-20 J',Eg)
```

Scilab code Exa 10.13 Mobility

```
1 clc
2 clear
3 //INPUT DATA
4 me=50//The electron mobility of pure semi conductor
    in m^2 V^-1 s^-1
5 t1=4.2//temp of pure semi conductor in k
6 t2=300//temp in k
7
8 //CALCULATION
9 m=me*((t2^(-3/2))/(t1^(-3/2)))//mobility of pure
    semi conductor in m^2 V^-1 s^-1
10
11 //OUTPUT
12 printf('mobility of pure semi conductor is %3.6f m^2
```

```
V^-1 s^-1',m)
```

Scilab code Exa 10.14 Band gap energy of the semiconductor

```
clc
clear
//INPUT DATA
ec1=19.96//The electrical conductivity of an
   intrinsic semi conductor in ohm^-1 m^-1
ec2=79.44//The increasing electrical conductivity of
    an intrinsic semi conductor in ohm^-1 m^-1
t1=333//temperature of an intrinsic semi conductor
   in k
t2=373//increasing temperature of an intrinsic semi
   conductor in k
kb=1.38*10^-23//Boltzmann's constant in m^2 Kg s^-2
   k^-1

//CALCULATION
Eg=(2*kb*(log(ec2/ec1))*((t1*t2)/(t2-t1)))/10^-19//
   The band gap of an intrinsic semi conductor in J
   *10^-19

//OUTPUT
printf('The band gap of an intrinsic semi conductor
   is %3.6f*10^-19 J',Eg)
```

Chapter 11

Extrinsic Semiconductors

Scilab code Exa 11.1 Conductivity

```
clc
clear
//INPUT DATA
ni=2.1*10^19//intrinsic charge carriers in m^-3
me=0.4//electron mobility in m^2 V^-1 s^-1
mh=0.2//hole mobility in m^2 V^-1 s^-1
d=4.5*10^23//density of boron in m^-3
e=1.6*10^-19//charge of electron in coulombs

//CALCULATION
C=(ni*e)*(me+mh)//conductivity before adding boron
   atoms in ohm^-1 m^-1
c=(d*e*mh)/10^4//conductivity after adding boron
   atoms in ohm^-1 m^-1 *10^4

//OUTPUT
printf('Before adding boron atoms,the semiconductor
   is an intrinsic semiconductor \n conductivity
   before adding boron atoms is %3.3f ohm^-1 m^-1 \n
    Aefore adding boron atoms,the semiconductor
   becomes a P-type semiconductor \n conductivity
```

```
    after adding boron atoms is %3.2f*10^4 ohm^-1 m
    ^-1',C,c)
```

Scilab code Exa 11.2 Concentration of holes and electrons

```
clc
clear
//INPUT DATA
ni=1.5*10^16//intrinsic charge carriers in m^-3
me=1300*10^-4//electron mobility in m^2 V^-1 s^-1
mh=500*10^-4//hole mobility in m^2 V^-1 s^-1
c=3*10^4//conductivity of n-tpye silicon in ohm^-1 m
    ^-1
e=1.6*10^-19//charge of electron in coulombs

//CALCULATION
ne=(c/(e*me))/10^24//DensiTy of electrons in n-type
    silicon in electrons/m^3 *10^24
nh=(ni^2/(ne*10^24))/10^8//Density of holes in n-
    type silicon in holes/m^3 *10^8
Ne=(c/(e*mh))/10^24//Density of holes in p-type
    silicon in holes/m^3 *10^24
Nh=(ni^2/(Ne*10^24))/10^7//Density of electrons in p
    -type silicon in holes/m^3 *10^7

//OUTPUT
printf('DensiTy of electrons in n-type silicon is %3
    .4f *10^24 electrons/m^3 \n DensiTy of holes in n
    -type silicon is %3.2f*10^8 holes/m^3 \n DensiTy
    of holes in p-type silicon is %3.2f*10^24 holes/m
    ^3 \n DensiTy of electrons in p-type silicon is
    %i*10^7 electrons/m^3',ne,nh,Ne,Nh)
```

Scilab code Exa 11.3 Electron concentration

```
clc
clear
//INPUT DATA
ni=2*10^16//intrinsic charge carriers in m^-3
Na=5*10^23//density of acceptor concentration of
   silicon with arsenic in atoms
Nd=3*10^23//density of donor concentration of
   silicon with arsenic in atoms

//CALCULATION
nh=(Na-Nd)//density of hole in m^-3
ne=(ni^2/(nh))/10^9//The electron concentration that
    is density of electrons in electrons /m^3*10^9

//OUTPUT
printf('The electron concentration that is density
   of electrons is %i*10^9 electrons /m^3',ne)
```

Scilab code Exa 11.4 Position of fermi level

```
clc
clear
//INPUT DATA
d=5*10^28//density of silicon atom in atoms/m^3
nd=2.5*10^7//donor concentration in 1 atom per si
   atom
T=300//Temperature in K
Eg=1.1*1.6*10^-19//Eg for silicon in eV
kb=1.38*10^-23//Boltzmann's Constant in m^2 Kg s^-2
   k^-1
m=9.11*10^-31//mass of electon in Kg
h=6.625*10^-34//plank's constant in m^2 Kg/sec

```

```
12 //CALCULATION
13 Nd=(d/nd)//The donor concentration in atoms/m^3
14 Ef=((Eg/2)+(kb*T*(log(Nd/(2*((2*3.14*m*kb*T)/h^2)
      ^(3/2))))))/10^-20//The position of fermi level
      at 300K in Joule*10^-20
15
16 //OUTPUT
17 printf('The position of fermi level is %3.4f*10^-20
      Joule',Ef)
```

Scilab code Exa 11.5 Density of impurity atoms

```
1  clc
2  clear
3  //INPUT DATA
4  ni=1.5*10^16//intrinsic charge carriers in m^-3
5  r1=10*10^-2//resistivity of p-type silicon in ohm m
6  r2=10*10^-2//resistivity of n-type silicon in ohm m
7  me=1350*10^-4//The mobility of the charge carrier in
       m^2 V^-1 s^-1
8  mh=480*10^-4//The hole charge carrier in m^2 V^-1 s
      ^-1
9  e=1.6*10^-19//charge of electron in coulombs
10
11 //CALCULATION
12 Na=(1/(r1*e*mh))/10^21//The density of the intrinsic
       crystal for p-type in m^-3*10^21
13 ne=((ni^2)/(Na*10^21))/10^11//The minor carrier
      concentration for p-type in electrons/m^3*10^11
14 Nd=(1/(r2*e*me))/10^20//The density of the intrinsic
       crystal for n-type in m^-3*10^20
15 nh=((ni^2)/(Nd*10^20))/10^11//The minor carrier
      concentration for n-type in electrons/m^3*10^11
16
17 //OUTPUT
```

```
18 printf('The density of the intrinsic crystal for p-
   type is %3.4f*10^21 m^-3 \n The minor carrier
   concentration for p-type is %3.3f*10^11 electrons
   /m^3 \n The density of the intrinsic crystal for
   n-type is %3.3f*10^20 m^-3 \n The minor carrier
   concentration for n-type is %3.4f*10^11 holes/m^3
   ',Na,ne,Nd,nh)
```

Scilab code Exa 11.6 Charge carrier density and electron mobility

```
1 clc
2 clear
3 //INPUT DATA
4 c=112//conductivity of a n-type silicon specimen in
   ohm^-1 m^-1
5 RH=1.25*10^-3//Hall coefficient of a n-type silicon
   specimen in m^3 C^-1
6 e=1.6*10^-19//charge of electron in coulombs
7
8 //CALCULATION
9 me=(c*RH)//electron mobility in m^2 V^-1 s^-1
10 ne=(c/(me*e))/10^21//The charge carrier density in
   electrons/m^3*10^21
11
12 //OUTPUT
13 printf('The electron mobility is %3.2f m^2 V^-1 s^-1
    \n The charge carrier density is%3.0f*10^21
   electrons/m^3',me,ne)
```

Scilab code Exa 11.7 Hall coefficient of semiconductor

```
1 clc
2 clear
```

```
3 //INPUT DATA
4 l=12*10^-3//length of semi conductor crystal in m
5 b=1*10^-3//breadth of semi conductor crystal in m
6 t=1*10^-3//thickness of semi conductor crystal in m
7 I=20*10^-3//current in A
8 Vh=37*10^-6//voltage measured across the width in V
9 B=0.5//magnetic flux density in Wb/m^2
10 e=1.6*10^-19//charge of electron in coulombs
11
12 //CALCULATION
13 RH=((Vh*t)/(I*B))/10^-6//Hall coefficient of
     semiconductor in C^-1 m^3 *10^-6
14 ne=(1/(RH*10^-6*e))/10^23//The density of the charge
     carrier in electrons/m^3*10^23
15
16 //OUTPUT
17 printf('Hall coefficient of semiconductor is %3.1f
     *10^-6 C^-1 m^3\n The density of the charge
     carrier is %3.2f*10^23 electrons/m^3',RH,ne)
```

Scilab code Exa 11.8 Hall coefficient

```
1 clc
2 clear
3 //INPUT DATA
4 l=100*10^-3//length of silicon plate in m
5 b=10*10^-3//breadth of silicon plate in m
6 t=1*10^-3//thickness of silicon plate in m
7 I=10^-2//current in A
8 Vh=1.83*10^-3//voltage measured across the width in
     V
9 B=0.5//magnetic flux density in Wb/m^2
10
11 //CALCULATION
12 RH=((Vh*t)/(I*B))/10^-4//Hall coefficient of silicon
```

```
    plate in m^3 C^-1*10^-4
13
14 //OUTPUT
15 printf('Hall coefficient of silicon plate is %3.2f
   *10^-4 m^3 C^-1',RH)
```

Scilab code Exa 11.9 Density and mobility of the charge carrier

```
1  clc
2  clear
3  //INPUT DATA
4  RH=7.35*10^-5//Hall coefficient of silicon specimen
      in m^3 C^-1
5  rh=-7.35*10^-5//Hall coefficient of silicon specimen
      in m^3 C^-1
6  c=200//conductivity in ohm^-1 m^-1
7  e=1.6*10^-19//charge of electron in coulombs
8
9  //CALCULATION
10 ne=(1/(RH*e))/10^22//The density of the charge
      carrier in electrons/m^3*10^22
11 me=(c*RH)/10^-3//The mobility of the charge carrier
      in m^2 V^-1 s^-1*10^-3
12
13 //OUTPUT
14 printf('The negative sign of the Hall coefficient
      indicates that the nature of the semiconductor is
       n-type \n The density of the charge carrier is
      %3.3f*10^22 electrons/m^3 \n The mobility of the
      charge carrier is %3.1f*10^-3 m^2 V^-1 s^-1',ne,
      me)
```

Scilab code Exa 11.10 Charge carrier density and electron mobility

```
clc
clear
//INPUT DATA
RH=4.16*10^-4//Hall coefficient of n-type
   semiconductor in m^3 C^-1
c=180//conductivity in ohm^-1 m^-1
e=1.6*10^-19//charge of electron in coulombs
x=1.18//correction factor for RH

//CALCULATION
ne=(x/(RH*e))/10^22//The density of the charge
   carrier in electrons/m^3*10^22
me=(c/(ne*10^22*e))//The mobility of the charge
   carrier in m^2 V^-1 s^-1

//OUTPUT
printf('The density of the charge carrier is %3.3f
   *10^22 electrons/m^3 \n The mobility of the
   charge carrier is %3.5f m^2 V^-1 s^-1',ne,me)
```

Scilab code Exa 11.11 Hall coefficient

```
clc
clear
//INPUT DATA
l=1*10^-3//length of rectangular plane sheet of
   doped silicon in m
b=1*10^-3//breadth of semi rectangular plane sheet
   of doped silicon in m
t=0.5*10^-3//thickness of rectangular plane sheet of
    doped silicon in m
RH=1.25*10^-3//Hall coefficient of the materialin m
   ^3 C^-1
I=1*10^-3//current in A
B=0.7//magnetic flux density in Wb/m^2
```

```
10 e=1.6*10^-19//charge of electron in coulombs
11
12 //CALCULATION
13 Vh=((RH*I*B)/t)/10^-3//The hall coefficient measured
       by the probes in mV
14
15 //OUTPUT
16 printf('The hall coefficient measured by the probes
      is %3.2f mV',Vh)
```

Scilab code Exa 11.12 Mobility and density of the charge carrier

```
1 clc
2 clear
3 //INPUT DATA
4 RH=3.66*10^-4//Hall coefficient of a doped silicon
      in m^3 C^-1
5 r=8.93*10^-3//The resistivity in ohm m
6 e=1.6*10^-19//charge of electron in coulombs
7
8 //CALCULATION
9 n=(1/(RH*e))/10^22//The density of the charge
      carrier in m^-3 *10^22
10 me=(RH/r)//The mobility is %3.4f m^2 V^-1 s^-1
11
12 //OUTPUT
13 printf('The density of the charge carrier is %3.4f
      *10^22 m^-3 \n The mobility is %3.4f m^2 V^-1 s
      ^-1',n,me)
```

Scilab code Exa 11.13 Current density

```
1 clc
```

```
clear
//INPUT DATA
RH=0.0125//Hall coefficient of a sample n-type
   semiconductor in m^3 C^-1
rh=-0.0125//Hall coefficient of a sample n-type
   semiconductor in m^3 C^-1
me=0.36//electron mobility in m^2 V^-1 s^-1
EH=100//electric field in V/m
e=1.6*10^-19//charge of electron in coulombs

//CALCULATION
n=(1/(RH*e))//The density of the charge carrier in m
   ^-3
c=(n*e*me)//conductivity of n-type semiconductor in
   ohm^-1 m^-1
J=(c*EH)//The current density in A/m^2

//OUTPUT
printf('The current density is %i A/m^2',J)
```

Chapter 12

Superconducting materials

Scilab code Exa 12.1 Transition temperature

```
clc
clear
//INPUT DATA
M1=202//mass number of mercury
a=0.50//coefficient of mass number
T1=4.2//temperature in k for mass number 200
M2=200//mass number of mercury

//CALCULATION
T2=((M1/M2)^a)*T1//The transition temperature for
   the isotope of mercury of mass number 200 in k

//OUTPUT
printf('The transition temperature for the isotope
   of mercury of mass number200 is %3.4f k',T2)
```

Scilab code Exa 12.2 Critical field

```
clc
clear
//INPUT DATA
Tc=9.15//critical temperature of Nb in K
t=6//temperature of critical field in K
Ho=0.196//The critical field AT 0K in T

//CALCULATION
Hc=(Ho*(1-(t/Tc)^2))//The critical field at 6K in T

//OUTPUT
printf('The critical field at %iK is %3.4f T',t,Hc)
```

Scilab code Exa 12.3 Isotopic mass

```
clc
clear
//INPUT DATA
M1=199.5//Isotopic mass of metal
T1=4.185//Critical temperature for a metal with
   isotopic mass in k
T2=4.133//fall of critical temperature for a metal
   with isotopic mass in k
a=0.50//coefficient of mass

//CALCULATION
M2=(((M1)^a)*(T1/T2))^2//The Isotopic mass if the
   critical temperature falls to 4.133

//OUTPUT
printf('The Isotopic mass if the critical
   temperature falls to %3.3fK is %3.2f',T2,M2)
```

Scilab code Exa 12.4 Critical current

```
clc
clear
//INPUT DATA
Hc=7.2*10^3//The critical magnetic field in A/m
r=0.5*10^-3//radius of long thin superconducting
   wire in m

//CALCULATION
Ic=(2*3.14*Hc*r)//The critical current through a
   long thin superconductor in A

//OUTPUT
printf('The critical current through a long thin
   superconductor is %3.3f A',Ic)
```

Scilab code Exa 12.5 Critical field

```
clc
clear
//INPUT DATA
Tc=3.7//critical temperature of superconducting Sn
   in K
t=2//temperature of critical field in K
Ho=0.0306//The critical field at 0K in T

//CALCULATION
Hc=(Ho*(1-(t/Tc)^2))//The critical field at 6K in T

//OUTPUT
printf('The critical field at %iK is %3.6f tesla',t,
   Hc)
```

Scilab code Exa 12.6 Critical current

```
clc
clear
//INPUT DATA
Ho=6.5*10^4//The critical field at 0K in A/m
Tc=7.18//The temperature for lead in K
r=0.5*10^-3//radius of superconducting wire of lead
   in m
T=4.2//temperature of superconducting wire in K

//CALCULATION
Hc=(Ho*(1-(T/Tc)^2))//The critical field in KA/m
Ic=2*3.14*Hc*r//The critical density for a
   superconducting wire of lead is in A

//OUTPUT
printf('The critical density for a superconducting
   wire of lead is %3.2f in A',Ic)
```

Scilab code Exa 12.7 Critical temperature

```
clc
clear
//INPUT DATA
Hc=10^5//The critical field for vanadium at 8.58K in
    A/m
Ho=2*10^5//The critical field for vanadium at 0K in
   A/m
T=8.58//temperature for vanadium in K

//CALCULATION
```

```
Tc=(T/(sqrt(1-(Hc/Ho))))//The critical temperature
   in K

//OUTPUT
printf('The critical temperature is %3.3f K',Tc)
```

Scilab code Exa 12.8 Frequency of the radiation

```
clc
clear
//INPUT DATA
V=5.9*10^-6//voltage applied across a Josephson
   junction in V
e=1.6*10^-19//charge of electron in coulombs
h=6.62*10^-34//Planck's constant in J-sec

//CALCULATION
v=((2*e*V)/h)/10^9//The frequency of the radiation
   emitted by the junction in Hz

//OUTPUT
printf('The frequency of the radiation emitted by
   the junction is %3.3f*10^9 Hz',v)
```

Chapter 13

Dielectrics

Scilab code Exa 13.1 Electronic polarisation

```
1 clc
2 clear
3 //INPUT DATA
4 a=3.61*10^-10//lattice constant of copper which is
    Fcc crystal in m
5 x=1*10^-18//average displacement of the electrons
    relative to the nucleus in m
6 z=29//atomic number of copper
7 n=4//number of atoms per unit cell in FCC crystal
8 e=1.6*10^-19//charge of electron in coulombs
9
10 //CALCULATION
11 ne=((n*z)/(a*a*a))//number of electrons in electrons
    /m^3
12 P=(ne*e*x)/(10^-7)//The electron polarisation in C/m
    ^2 *10^-7
13
14 //OUTPUT
15 printf('The electron polarisation is %3.3f*10^-7 in
    C/m^2',P)
```

Scilab code Exa 13.2 Effective distance

```
clc
clear
//INPUT DATA
rp=11.7//relative permittivity of silicon
N=4.82*10^28//number of atoms per unit volume in
   atoms/m^3
ro=8.85*10^-12//permittivity of free space
E=10^4//E in Vm^-1
e=1.6*10^-19//charge of electron in coulombs
Z=14//atomic number of silicon

//CALCULATION
z=((ro*(rp-1))/N)//electronic polarisability in Fm^2
y=(z*E)/10^-35//The dipole moment of each atom in a
   field of 10^4 Vm^-1 in Cm^-3 *10^-35
x=((y*10^-35)/(Z*e))/10^-18//The effective distance
   at this field strength between the centre of the
   electron cloud in each atom and the nucleus in m
   *10^-18

//OUTPUT
printf('The dipole moment of each atom in a field is
    %3.4f*10^-35 Cm^-3 \n The effective distance at
   this field strength between the centre of the
   electron cloud in each atom and the nucleus is %3
   .2f*10^-18 m',y,x)
```

Scilab code Exa 13.3 Polarisability and relative permittivity

```
clc
```

```
clear
//INPUT DATA
d=9.8*10^26//density of hydrogen gas in atoms/m^3
r=0.50*10^-10//radius of the hydrogen atom in m
ro=8.85*10^-12//permittivity of free space

//CALCULATION
z=(4*3.14*ro*r*r*r)/10^-41//electronic
   polarisability in Fm^2
rp=(((d*z*10^-41)/ro)+1)//The relative permittivity
   in hydrogen gas

//OUTPUT
printf('The electronic polarisability is %3.3f
   *10^-41 Fm^2 \n The relative permittivity in
   hydrogen gas is %3.4f',z,rp)
```

Scilab code Exa 13.4 Static dielectric constant

```
clc
clear
//INPUT DATA
z=1.75*10^-40//electronic polarisability in Fm^2
d=1.8*10^3//density of argon atom in Kg/m^3
Z=39.95//atomic weight of argon
NA=6.025*10^26//Avagadro number in mole^-1
ro=8.85*10^-12//permittivity of free space

//CALCULATION
N=((NA*d)/Z)//The number of atoms/unit volume in
   atoms/m^3
rp=(((N*z)/ro)+1)//The static dielectric constant of
    solid argon

//OUTPUT
```

```
15 printf('The static dielectric constant of solid
      argon is %3.5f',rp)
```

Scilab code Exa 13.5 Ratio between electronic and ionic polarisability

```
1  clc
2  clear
3  //INPUT DATA
4  er=4.94//static dielecric constant of a material
5  n=2.69//n is the index of friction
6
7  //CALCULATION
8  x=((er-1)*(n+2))/((er+2)*(n-1))-1//Ratio between
      ionic and electronic polarisability of this
      material
9  y=1/x//Ratio between electronic and ionic
      polarisability of this material
10
11 //OUTPUT
12 printf('Ratio between electronic and ionic
      polarisability of this material is %3.4f ',y)
```

Chapter 15

Non Destructive Testing

Scilab code Exa 15.1 Frequency

```
clc
clear
//INPUT DATA
t=0.1*10^-2//thickness of piezo electric crystal in
   m
E=80*10^9//Young's modulus of crystal in pa
d=2654//density of material of crystal in Kgm^-3

//CALCULATION
f=(1/(2*t)*sqrt(E/d))/10^6//The frequency to which a
    piezo electric oscillator circuit should be
   turned in Hz

//OUTPUT
printf('The frequency to which a piezo electric
   oscillator circuit should be turned is %3.4f*10^6
    Hz',f)
```