

Scilab Textbook Companion for
Engineering Physics
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Book Description

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

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

```

```

5 Io=10^-12//threshold intensity of sound in Wm^-2
6
7 //CALCULATION
8 IL=(10*log10(I/Io))//The intensity level in dB
9
10 //OUTPUT
11 printf('The intensity level is %i dB',IL)

```

Scilab code Exa 1.5 Intensity level in dB

```

1 clc
2 clear
3 //INPUT DATA
4 Q=3.56//rate of energy radiates in W
5 r=15//distance of intensity level in m
6 Io=100//reference intensity in Wm^-2
7
8 //CALCULATION
9 A=4*3.14*r*r//Area in m^2
10 I=(Q/A)//sound intensity in Wm^-2
11 IL=(10*log10(I/Io))//The intensity level in dB
12
13 //OUTPUT
14 printf('The intensity level is %3.3f dB',IL)

```

Scilab code Exa 1.6 Resultant sound level

```

1 clc
2 clear
3 //INPUT DATA
4 I11=70//sound in dB
5 I12=80//sound in dB
6

```

```

7 //CALCULATION
8 I1=10^(I11/10)//ratio of intensity
9 I2=10^(I12/10)//ratio of intensity
10 I=I1+I2//intensity of sound in dB
11 I1=10*log10(I)//resultant intensity in dB
12
13 //OUTPUT
14 printf('The resultant sound level is %3.2f dB',I1)

```

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
    %3.3 f*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 //CALCULATION
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 %3.2 f
    sec',T)

```

Scilab code Exa 1.10 Average absorption coefficient and reverberation time

```

1  clc
2  clear
3  //INPUT DATA
4  V=1500//volume of room in m3
5  a1=0.03//average sound coefficient for wall in
    sabine
6  a2=0.06//average sound coefficient for the ceiling
    in sabine
7  a3=0.8//average sound coefficient for the floor in
    sabine
8  S1=260//The wall area of the room in m2
9  S2=140//The floor area of the room in m2
10 S3=140//The ceiling area of the room in m2
11
12 //CALCULATION
13 a=((a1*S1)+(a2*S2)+(a3*S3))/(S1+S2+S3)//The average
    absorbtion coefficient in O.W.U
14 TS=S1+S2+S3//total area of the room in m2
15 x=(a*TS)//Total sound absorbtion of the room in O.W.
    U-m2
16 T=((0.167*V)/x)//The reverberation time in sec
17
18 //OUTPUT
19 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

```

1  clc
2  clear
3  //INPUT DATA
4  V=12000//volume of auditorium in m3
5  T=1.5//The reverberation time of the auditorium in
    sec

```



```

6 a=0.4//average absorption coefficient in sabine
7
8 //CALCULATION
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

```

```

6 a2S2=200//The number of cushioned chairs are
   additionally placed in the hall in sabine-m^2
7
8 //CALCULATION
9 Ta1S1=(0.167*V)/T1//The reverberation time before
   placed cushioned chairs in sabine -m^2
10 T2=(0.167*V)/(Ta1S1+a2S2)//The new reverberation
   time after placing the cushioned chairs in sec
11
12 //OUTPUT
13 printf('The new reverberation time after placing the
   cushioned chairs is %3.4f sec',T2)

```

Scilab code Exa 1.14 Reverberation time in sec

```

1 clc
2 clear
3 //INPUT DATA
4 V=475//volume of hall in m^3
5 a1=0.025//absorbtion coefficient for wall in O.W.U
6 a2=0.02//absorbtion coefficient for the ceiling in O
   .W.U
7 a3=0.55//absorbtion coefficient for the floor in O.W
   .U
8 S1=200//The wall area of the room in m^2
9 S2=100//The floor area of the room in m^2
10 S3=100//The ceiling area of the room in m^2
11
12 //CALCULATION
13 TaS=((a1*S1)+(a2*S2)+(a3*S3))//The average
   absorbtion coefficient in O.W.U-m^2
14 T=((0.167*V)/TaS)//The reverberation time in sec
15
16 //OUTPUT
17 printf('The reverberation time for the hall is %3.4f

```

sec',T)

Scilab code Exa 1.15 Effect of reverberation time

```
1  clc
2  clear
3  //INPUT DATA
4  V=2265//volume of hall in m^3
5  Ta1S1=94.85//The total absorbtion coefficient in m^2
6
7  //CALCULATION
8  T1=((0.167*V)/Ta1S1)//The reverberation time in the
   hall without audience in sec
9  Ta2S2=2*Ta1S1//The new absorbtion coefficient in m^2
10 T2=((0.167*V)/Ta2S2)//The reverberation time in the
   hall with audience in sec
11
12 //OUTPUT
13 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

```
1  clc
2  clear
3  //INPUT DATA
4  V=120000//Volume of the hall in m^3
5  T=1.55//The reverberation time in sec
6  S=26500//The total absorbing surface in m^2
7
```

```
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

```
1  clc
2  clear
3  //INPUT DATA
4  v=5.5*10^3//Velocity of longitudinal waves in Quartz
    Crystal in m/s
5  t=0.05//Thickness of Quartz Crystal in m
6
7  //CALCULATION
8  w=2*t//wavelength in m
9  v1=(v/w)/10^4//Frequency in the first mode of
    vibration in Hz *10^4
10 v2=(2*v1)/(10^-4*10^3)//Frequency in the second mode
    of vibration in Hz *10^3
11
12 //OUTPUT
13 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

```
1  clc
2  clear
3  //INPUT DATA
4  f=0.09*10^6//Frequency of Ultrasonic source in Hz
5  t=0.55//time in sec
6  v=1800//velocity of sound in water in m/s
7
8  //CALCULATION
9  D=(v*t)/2//Depth of sea in m
10 W=(v/f)//Wavelength of ultrasonic pulse in m
11
12 //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(h2+k2+l2)))/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

```

```

5 y=35.45//atomic weight of chloide
6 AW=58.45//atomic weight of sodium chloride(NaCl)
7 n=4//no.of atoms in FCC structure
8 d=2.18*10^6//density of NaCl crystal of FCC
  structure in kg/m^3
9 N=6.023*10^23//Avogadro's Number per Kg mol
10
11 //CALCULATION
12 a=((n*AW)/(d*N))^(1/3)/10^-10//The lattice
  constant in m
13 r=(a/2)//The distance between two adjacent atoms in
  m *10^-10
14
15 //OUTPUT
16 printf('The distance between two adjacent atoms is
  %3.2f*10^-10 m',r)

```

Scilab code Exa 3.19 Atomic radius

```

1 clc
2 clear
3 //INPUT DATA
4 n=2//no.of atoms in BCC structure
5 d=7.86*10^6//density of iron of FCC structure in kg/
  m^3
6 AW=55.85//atomic weight of Fe
7 N=6.023*10^23//Avogadro's Number per Kg mol
8
9 //CALCULATION
10 a=((n*AW)/(d*N))^(1/3)/10^-10//The lattice
  constant in m
11 r=((a*sqrt(3))/4)//The atomic radius of Fe which has
  BCC structure in armstrong*10^-10
12
13 //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

```
1  clc
2  clear
3  //INPUT DATA
4  r1=0.1258*10^-9//atomic radii of the iron atom in
   BCC structure in m
5  r2=0.1292*10^-9//atomic radii of the iron atom in
   FCC structure in m
6  T=910//metallic iron changes from BCC to FCC in
   centigrade
7
8  //CALCULATION
9  a1=((4*r1)/sqrt(3))//lattice constant of BCC
   structure in m
10 v1=((a1*a1*a1)/2)//The volume occupied by one BCC
   atom in m^3
11 a2=((4*r2)/sqrt(2))//lattice constant of FCC
   structure in m
12 v2=((a2*a2*a2)/4)//The volume occupied by one FCC
   atom in m^3
13 V=((v1-v2)/v1)*100//The change in volume percentage
14
15 //OUTPUT
16 printf('The change in volume percentage is %3.5f',V)
```

Scilab code Exa 3.26 Number of unit cells

```
1  clc
2  clear
3  //INPUT DATA
4  a=0.405*10^-9//lattice constant of unit cell of
   aluminium which is face centered cubic in m
5  s=25*10^-2//Side of aluminium foil in m
6  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 lighth 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

```

1  clc
2  clear
3  //INPUT DATA
4  w=6000*10^-10//wavelength in m
5  Re=1.54//Refractive index of double refracting
    crystal for e ray
6  Ro=1.65//Refractive index of double refracting
    crystal for o ray
7
8  //CALCULATION
9  t=((w/(2*(Ro-Re))))/10^-6//thickness of a double
    refracting crystal required at w/2 in m *10^-6
10
11 //OUTPUT
12 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

```

1  clc
2  clear
3  //INPUT DATA
4  w=5*10^-7//wavelength in m
5  Re=1.5573//Refractive index for e ray when the
    emergent beam will be plane polarised
6  Ro=1.5442//Refractive index for o ray when the
    emergent beam will be plane polarised
7
8  //CALCULATION
9  t=((w/(4*(Re-Ro))))/10^-6//least thickness of a
    plate in m *10^-6
10
11 //OUTPUT
12 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

```
1  clc
2  clear
3  //INPUT DATA
4  w=5893*10-10//wavelength of sodium light in m
5  Ro=1.658//Refractive index of calcite for o ray
6  Re=1.486//Refractive index of calcite for e ray
7
8  //CALCULATION
9  t=((w/(2*(Ro-Re))))/10-7//thickness of the quarter
    wave plate for calcite in m *10-7
10
11 //OUTPUT
12 printf('The thickness of the quarter wave plate for
    calcite is %3.3f *10-7.m',t)
13 //Answer given in the book is wrong
```

Scilab code Exa 4.11 Wavelength of half wave plate

```
1  clc
2  clear
3  //INPUT DATA
4  t=30*10-6//thickness of wave plate in m
5  Ro=1.55//Refractive index of wave plate for o ray
6  Re=1.54//Refractive index of wave plate for e ray
7
8  //CALCULATION
9  w=(2*t*(Ro-Re))/10-9//wavelength for which it can
    act as a half wave plate in m *10-9
10
```

```
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

```
1  clc
2  clear
3  //INPUT DATA
4  t=300//temperature in k
5  w=698.3*10^-9//wavelength of photon in m
6  h=6.625*10^-34// Planck's constant in m^2 Kg/sec
7  c=3*10^8//velocity of light in m/s
8  Kb=1.38*10^-23//Boltzmann's constant in m^2 Kg.s^-2
   k^-1
9
10 //CALCULATION
11 Ratio=(exp((-h*c)/(w*Kb*t)))/10^-30//ratio of
   propulsion of the two states in a laser *10^-30
12
13 //OUTPUT
14 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

```

1  clc
2  clear
3  //INPUT DATA
4  w=1.55*10^-6//wavelength of light emission in m
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  e=1.6*10^-19//charge of electron in coulombs
8
9  //CALCULATION
10 Eg=(h*c)/(w*e)//band gap in eV
11
12 //OUTPUT
13 printf('The band gap for lnp laser diode is %3.4f eV
        ',Eg)

```

Scilab code Exa 5.3 wavelength limit

```

1  clc
2  clear
3  //INPUT DATA
4  E=0.02*1.6*10^-19//Ionisation energy in J
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
8  //CALCULATION
9  w=((h*c)/E)/10^-5// long wavelength limit of an
        extrinsic semiconductor in m *10^-5
10
11 //OUTPUT
12 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

```
1 clc
2 clear
3 //INPUT DATA
4 E=3.5*10-3*60//power output in J/min
5 w=0.621*10-6//wavelength of light in m
6 h=6.625*10-34// Planck's constant in m2 Kg/sec
7 c=3*108//velocity of light in m/s
8
9 //CALCULATION
10 e=(h*c)/w//energy emitted by one photon in J
11 n=(E/e)/1017//The number of photons emitted per
   minute in photons /minute *1017
12
13 //OUTPUT
14 printf('The number of photons emitted per minute is
   %3.3f *1017 photons /minute',n)
```

Chapter 6

Fiber optics

Scilab code Exa 6.1 Critical and acceptance angle and numerical aperture

```
1  clc
2  clear
3  //INPUT DATA
4  n1=1.545//refractive index of optical fibre core
5  n2=1.495//refractive index of cladding
6
7  //CALCULATION
8  CA=asind(n2/n1)//critical angle in degree
9  AA=asind(sqrt((n1)^2-(n2)^2))//acceptance angle in
   degree
10 NA=sind(AA)//numerical aperture
11
12 //OUTPUT
13 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

```

1  clc
2  clear
3  //INPUT DATA
4  n1=1.54//refractive index of optical fibre core
5  n2=1.5//refractive index of cladding
6
7  //CALCULATION
8  NA=sqrt((n1)^2-(n2)^2)//numerical aperture
9
10 //OUTPUT
11 printf('The numerical aperture is %3.4f',NA)

```

Scilab code Exa 6.3 Critical and acceptance and numerical aperture

```

1  clc
2  clear
3  //INPUT DATA
4  n1=1.55//refractive index of optical fibre core
5  n2=1.47//refractive index of cladding
6
7  //CALCULATION
8  CA=asind(n2/n1)//critical angle in degree
9  NA=(sqrt((n1)^2-(n2)^2))//acceptance angle in degree
10 AA=asind(NA)//numerical aperture
11
12
13 //OUTPUT
14 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

```

1  clc
2  clear
3  //INPUT DATA
4  n2=1.55//refractive index of cladding
5  no=1.33//refractive index of water
6  NA=0.20//numerical aperture of optical fibre
7
8  //CALCULATION
9  n1=sqrt((n2)^2+(NA)^2)//refractive index of optical
    fibre
10 NAW=(sqrt((n1)^2-(n2)^2)/no)//numerical aperture
    when fibre is in water
11 AA=asind(NAW)//Acceptance angle for the fibre in
    water in degrees
12
13 //OUTPUT
14 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

```

1  clc
2  clear
3  //INPUT DATA
4  NA=0.22//numerical aperture of optical fibre
5  no=0.012//refractive index difference
6
7  //CALCULATION
8  n1=(NA/(sqrt(2*no)))//The refractive index of the
    core of a fibre
9  n2=n1*(1-no)//The refractive index of the cladding
10
11 //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 carriers is %3.3f
      *10^-3 m^2 V^-1 s^-1',J,z)
```

Scilab code Exa 7.2 Drift velocity of the free electrons

```
1 clc
2 clear
3 //INPUT DATA
4 n=8.5*10^28 //density of free electrons in copper in
   m^-3
5 A=1.05*10^-6 //sectional area of copper in m^2
6 e=1.6*10^-19 //charge of electron in coulombs
7 I=1 //copper wire carries a current in A
8
9 //CALCULATION
10 V=(1/(A*n*e))/10^-5 //drift velocity of free
   electrons in copper wire in ms^-1 *10^-5
11
12 //OUTPUT
13 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

```
1 clc
2 clear
3 //INPUT DATA
4 X=3.5*10^-3 // mobility of free electrons in copper
   in m^2 V^-1 s^-1
5 E=0.5 //elactric field strength of copper in V m^-1
6
7 //CALCULATION
8 V=X*E/10^-3 //drift velocity of free electrons in
   copper in m s^-1 *10^-3
9
```

```
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
```

```

9 k=1.38*10^-23//boltzmann constant in m^2 Kg s^-2 k
  ^-1
10
11 //CALCULATION
12 t=(m/(r*n*(e^2)))//relaxation time in s
13 v=sqrt((3*k*T)/m) //thermal velocity in ms^-1
14 L=t*v/10^-9//mean free path between collision of
  free electrons in copper in m*10^-9
15
16 //OUTPUT
17 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

```

1 clc
2 clear
3 //INPUT DATA
4 t=1*10^-3//thickness of metal in m
5 V=1//potential difference applied in volts in V
6 T=300//temperature in k
7 m=0.04//mobility in m^2 V^-1 s^-1
8 k=1.38*10^-23//boltzmann constant in m^2 Kg s^-2 k
  ^-1
9 m1=9.11*10^-31//mass of a electron in kg
10
11 //CALCULATION
12 v=(sqrt((3*k*T)/m1)/10^3) //thermal velocity in ms
  ^-1 *10^3
13 E=V/t//unit potenyal voltage gradient in V m^-1
14 vd=E*m//drift velocity of electrons in m s^-1
15
16 //OUTPUT
17 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

```
1  clc
2  clear
3  //INPUT DATA
4  AW=63.5//atomic weight of copper
5  D=8.93*10^3//density of copper in kg m^-3
6  t=2.48*10^-14//relaxation time of copper in s
7  AV=6.023*10^26//avagadro no in mole^-1
8  e=1.6*10^-19//charge of electron in coulombs
9  m=9.11*10^-31//mass of a electron in kg
10
11 //CALCULATION
12 n=(AV*D)/AW//density of electrons per unit volume in
    m^-3
13 EC=((n*e^2*t)/m)/10^7//electrical conductivity of
    copper in Sm^-1 *10^7
14
15 //OUTPUT
16 printf('The electrical conductivity of copper is %3
    .2f *10^7 in S m^-1',EC)
17 //mho=siemens
```

Scilab code Exa 7.8 Drift velocity of electrons in copper

```
1  clc
2  clear
3  //INPUT DATA
4  I=10//current in A
5  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

```
1 clc
2 clear
3 //INPUT DATA
4 D=8.92*10^3//density of copper in Kg m^-3
5 AW=63.5//atomic weight of copper
6 r=1.73*10^-8//resistivity of copper in ohm metre
7 AV=6.023*10^26//avagadro no in mole^-1
8 e=1.6*10^-19//charge of electron in coulombs
9 m=9.11*10^-31//mass of a electron in kg
10
11 //CALCULATION
12 n=(AV*D)/AW//density of electrons per unit volume in
    m^-3
13 t=(m/(r*n*(e^2)))/10^-14//average time collision of
    electrons in copper in s *10^-14
14 mo=(1/(r*n*e))/10^-2//mobility of charge in m^2 V^-1
    s^-1 *10^-2
15
16 //OUTPUT
17 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

```
1 clc
2 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
9 i=15//aluminum wire carries a current in A

```

```

10 fe=3//number of free electrons
11 AV=6.023*10^26//avagadro no in mole^-1
12 e=1.6*10^-19//charge of electron in coulombs
13
14 //CALCULATION
15 n=(AV*d*fe)/AW//density of electrons per unit volume
    in electrons/m^-3
16 z=(1/(n*e*r))/10^-3//mobility of the charge in m^2V
    ^-1S^-1 * 10^-3
17 E=((i*R)/l)//free electron concentration in V/m
18 vd=(z*E)/(10^-4*10^3)//drift velocity in m s^-1 *
    10^-4
19
20 //OUTPUT
21 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

```

1 clc
2 clear
3 //INPUT DATA
4 l=1*10^-2//length of intrinsic Ge rod in m
5 b=1*10^-3//breadth of intrinsic Ge rod in m
6 t=1*10^-3//thickness of intrinsic Ge rod in m
7 temp=300//temperature in k
8 d=2.5*10^19//intrinsic carrier density in Kg /m^3
9 z=0.39//mobility of electron in m^2V^-1S^-1
10 zh=0.19//mobility of hole in m^2V^-1S^-1
11 e=1.6*10^-19//charge of electron in coulombs
12
13 //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*1)/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

```

1  clc
2  clear
3  //INPUT DATA
4  er=50*10^-8//electrical resistivity in ohm metre
5  t=300//temperature in k
6  r=13*10^-3//radius of brass in m
7  th=35*10^-3//thickness of brass in m
8  L=2.44*10^-8//Lorentz number in W ohm K^-2
9
10 //CALCULATION
11 K=(L*t)/er//thermal conductivity of brass in W m^-1
    K^-1
12 A=3.14*r*r //area of brass disk in m^2
13 Rt=th/(K*A)//thermal resistance of brass in K W^-1
14
15 //OUTPUT
16 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

```

1  clc
2  clear
3  //INPUT DATA
4  x=5.87*10^7//electrical conductivity in ohm^-1 m^-1
5  k=380//thermal conductivity of copper in W m^-1 K^-1
6  t=293//temperature of copper in k
7
8  //CALCULATION
9  L=(k/(x*t))/10^-8//Lorentz number in W ohm K^-2
    *10^-8
10
11 //OUTPUT
12 printf('Lorentz number is %3.4f *10^-8 W.ohm.K^-2',L

```

)

Scilab code Exa 7.17 Thermal conductivity of copper

```
1 clc
2 clear
3 //INPUT DATA
4 x=6.40*107//electrical conductivity in mho m-1
5 t=300//temperature of copper in k
6 L=2.44*10-8//Lorentz number in W ohm K-2
7
8 //CALCULATION
9 K=x*t*L//thermal conductivity of copper in W m-1 K
   ^-1
10
11 //OUTPUT
12 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

```
1  clc
2  clear
3  //INPUT DATA
4  W=0.1*10^-9//wavelength of photon in m
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  e=1.6*10^-19//charge of electron in coulombs
8
9  //CALCULATION
10 E=((h*c)/(W*e))//energy of photon in eV
11 P=(h/W)/10^-24//momentum of the photon in Kgms^-1
12
13 //OUTPUT
14 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

```

1  clc
2  clear
3  //INPUT DATA
4  w=5893*10^-10//wavelength of emitted light in m
5  e=100//total energy emitted per sec
6  h=6.625*10^-34// Planck's constant in m^2 Kg /sec
7  c=3*10^8//velocity of light m/s
8
9  //CALCULATION
10 E=((h*c)/w)//energy of one photon in J
11 N=(e/E)/10^20//The total numberof photons emitted in
    sec
12
13 //OUTPUT
14 printf('The total number of photons emitted per
    second is %3.3f *10^20 per sec',N)

```

Scilab code Exa 8.3 Energy density

```

1  clc
2  clear
3  //INPUT DATA
4  w=4000*10^-10//wavelength in black body in m
5  t=1500//temperature of black body in k
6  h=6.625*10^-34// Planck's constant m^2 Kg /sec
7  c=3*10^8//velocity of light in m/s
8  Kb=1.38*10^-23//Boltzmann's constant in m^2 Kg s^-2
    k^-1
9
10 //CALCULATION
11 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
12
13 //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  
electron in 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
        %3.4 f 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 %3.2 f
        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

```



```

2  clear
3  //INPUT DATA
4  a=0.1*10^-9//width of high potential box in m
5  h=6.625*10^-34//Planck's constant in m^2 Kg /sec
6  m=9.11*10^-31//mass of electron in Kg
7  e=1.6*10^-19//charge of electron in coulombs
8  n=1//take n equal to one
9
10 //CALCULATION
11 E=((n^2*h^2)/(8*m*a^2*e))//The least energy of the
    particle can be obtained in eV
12
13 //OUTPUT
14 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

```

1  clc
2  clear
3  //INPUT DATA
4  a=10^-14//length of impenetrable box in m
5  m=1.67*10^-27//mass of neutron in Kg
6  n=1//for lowest energy
7  h=6.625*10^-34//Planck's constant in m^2 Kg /sec
8
9  //CALCULATION
10 E=((n^2*h^2)/(8*m*a^2))/10^-13//The least energy of
    the neutron can be obtained in eV*10^-13
11
12 //OUTPUT
13 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

```
1  clc
2  clear
3  //INPUT DATA
4  a=4*10^-10//width of electron box in m
5  h=6.625*10^-34//Planck's constant in m^2 Kg /sec
6  m=9.11*10^-31//mass of electron in Kg
7  e=1.6*10^-19//charge of electron in coulombs
8  n=1//first permitted level
9
10 //CALCULATION
11 E1=((n^2*h^2)/(8*m*a^2*e))//The first permitted
    energy level by taking n=1 in eV
12 E2=4*E1//The second permitted energy level by taking
    n=2 in eV
13 E3=9*E1//The third permitted energy level by taking
    n=3 in eV
14
15 //OUTPUT
16 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

```
1  clc
2  clear
3  //INPUT DATA
4  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

```
1  clc
2  clear
3  //INPUT DATA
4  a=0.1*10^-9//length of one dimensional box in m
5  n=1//first permitted level
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 E1=((n^2*h^2)/(8*m*a^2*e))//The ground state of
    electron in an one dimensional box in eV
12 E6=36*E1//The fifth exited state of electron in eV
13 E=E6-E1//The energy required the electron from its
    ground state to the fifth exited state in eV
14
15 //OUTPUT
16 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

```
1  clc
2  clear
3  //INPUT DATA
4  a=0.1*10^-9//length of one dimensional box in m
5  n=1//first permitted level
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 ne=3//the number of electrons
10
11 //CALCULATION
12 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
13
14 //OUTPUT
15 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

```
1  clc
2  clear
3  //INPUT DATA
4  //E-EF=KT
5  //K=KB is the boltzmann constant in m^2 Kg s^-2 k^-1
6
7  //CALCULATION
8  f=1/(1+exp(1))//The fermi function for an energy kt
   above fermi energy
9
10 //OUPUT
11 printf('The fermi function for an energy kt above
   fermi energy is %3.3f',f)
```

Scilab code Exa 9.2 Fermi function

```
1  clc
2  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 electron 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

```
1 clc
2 clear
3 //INPUT DATA
4 Vf=0.86*10^6//The femi energy of electons in the
   metal in m/sec
5 m=9.11*10^-31//mass of electon in Kg
6 KB=1.38*10^-23//Boltzmann's Constant in m^2 Kg s^-2
   k^-1
7
8 //CALCULATION
9 Ef=((1/2)*m*Vf^2)/10^-19//The fermi energy in a
   metal in J*10^-19
10 Tf=(Ef*10^-19/KB)/10^3//The fermi temperature in a
   metal in K*10^3
11
12 //OUTPUT
13 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

```
1 clc
2 clear
3 //INPUT DATA
4 Ef=3.2*1.6*10^-19//The fermi energy in a metal in J
5 m=9.11*10^-31//mass of electon in Kg
6 KB=1.38*10^-23//Boltzmann's Constant in m^2 Kg s^-2
   k^-1
7
```



```

8 //CALCULATION
9 Tf=(Ef/KB)/10^3//The fermi temperature 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 temperature 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

```
1  clc
2  clear
3  //INPUT DATA
4  Ef=2.1*1.6*10^-19//fermi energy level in potassium
   in J
5  f1=0.99//fermi factor for 1st
6  f2=0.01//fermi factor for 2nd
7  f3=0.5//fermi factor for 3rd
8  T=300//temperature in K
9  e=1.6*10^-19//charge of electro in C
10 KB=1.38*10^-23//Boltzmann's Constant in m^2 Kg s^-2
    k^-1
11
12 //CALCULATION
13 E1=(Ef+((KB*T)*(log(1-f1)-log(f1))))/e//The energy
    for probability of occupancy at 1st at which the
    300k in eV
14 E2=(Ef+((KB*T)*(log(1-f2)-log(f2))))/e//The energy
    for 1st at which the probability of occupancy at
    300k in eV
15 E3=(Ef+((KB*T)*(log(1-f3)-log(f3))))/e//The energy
    for 1st at which the probability of occupancy at
    300k in eV
16
17 //OUTPUT
18 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

```
1  clc
2  clear
3  //INPUT DATA
4  X=0.1*1.6*10^-19//difference between energy and
   fermi energy in J
5  T=300//temperature in k
6  KB=1.38*10^-23//Boltzmann's Constant in m^2 Kg s^-2
   k^-1
7
8  //CALCULATION
9  f=1-1/(1+exp(X/(KB*T)))//The probability of
   unoccupancy by an electron at room temperature
10
11 //OUTPUT
12 printf('The probability of unoccupancy by an
   electron at room temperature is %3.5f',f)
```

Scilab code Exa 9.9 Fermi factor

```
1  clc
2  clear
3  //INPUT DATA
4  n=4//number of atoms/unit cell in Aliminium
5  a=4.05*10^-10//lattice constant of Aluminium which
   is FCC crystal in m
6  nf=3//number of free electrons per atom in Aluminium
7  T=300//ambient temperature in K
8  x=0.1*1.6*10^-19//The same difference energy and
   fermi energy but in J
9  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 electron 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 electron 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//TheE
    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

```

```

6 m=9.11*10^-31//mass of electron in Kg
7 h=6.625*10^-34//plank's constant in m^2 Kg/sec
8 AV=6.02*10^23//Avagadro number in mole^-1
9 e=1.6*10^-19//charge of electro in C
10
11 //CALCULATION
12 nc=(AV*d)/AW//number of electrons per unit volume
13 Ef=(((h*h)/(8*m))*((3*nc)/3.14)^(2/3))/e)//The fermi
    energy for the sodium in eV
14
15 //OUTPUT
16 printf('The fermi energy for the sodium is %3.3f eV'
    ,Ef)

```

Scilab code Exa 9.13 Fermi energy in copper

```

1 clc
2 clear
3 //INPUT DATA
4 AW=63.5//atomic weight of copper in u
5 M=63.5*1.66*10^-27//mass of one copper atom in Kg
6 d=8.94*10^3//density of sodium in Kg/m^3
7 m=9.11*10^-31//mass of electron in Kg
8 h=6.625*10^-34//plank's constant in m^2 Kg/sec
9 e=1.6*10^-19//charge of electro in C
10
11 //CALCULATION
12 nc=(d)/M//number of electrons per unit volume in
    electrons/m^3
13 Ef=(((h*h)/(8*m))*((3*nc)/3.14)^(2/3))/e)//The fermi
    energy for the sodium in eV
14
15 //OUTPUT
16 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

```
1  clc
2  clear
3  //INPUT DATA
4  d=2.37*1019//The intrinsic carrier density at room
    temperature in m-3
5  me=0.38//The electron mobility in m2 V-1 s-1
6  mh=0.18//The hole mobility in m2 V-1 s-1
7  e=1.6*10-19//charge of electron in coulombs
8
9  //CALCULATION
10 r=(1/(d*e*(me+mh)))//The resistivity of intrinsic
    carrier in ohm m
11
12 //OUTPUT
13 printf('The resistivity of intrinsic carrier is %3.4
    f ohm m',r)
```

Scilab code Exa 10.3 Intrinsic carrier density

```
1  clc
2  clear
3  //INPUT DATA
4  r=2*10-4//the resistivity of In-Sb in ohm m
5  me=6//The electron mobility in m2 V-1 s-1
6  mh=0.2//The hole mobility in m2 V-1 s-1
7  e=1.6*10-19//charge of electron in coulombs
8
9  //CALCULATION
10 d=(1/(r*e*(me+mh)))/1021//The intrinsic carrier
    density at room tepmerature in m-3 *1021
11
12 //OUTPUT
13 printf('The intrinsic carrier density at room
```

temperature is %3.3f *10²¹ m⁻³,d)

Scilab code Exa 10.4 Conductivity

```
1  clc
2  clear
3  //INPUT DATA
4  Eg=1.1*1.6*10-19//The energy gap of silicon in J
5  me=0.48//The electron mobility in m2 V-1 s-1
6  mh=0.13//The hole mobility in m2 V-1 s-1
7  h=6.625*10-34//Planck's constant in m2 Kg /sec
8  e=1.6*10-19//charge of electron in coulombs
9  m=9.11*10-31//mass of an electron
10 kb=1.38*10-23//Boltzmann's constant m2 Kg s-2 k
    ^-1
11 t=300//temperature in k
12
13 //CALCULATION
14 ni=2*((2*3.14*m*kb*t)/h2)(3/2)*exp(-Eg/(2*kb*t))//
    intrinsic carrier concentration in m-3
15 ec=(ni*e*(me+mh))/10-3//The electrical conductivity
    at room temperature in ohm-1 m-1 *10-3
16
17 //OUTPUT
18 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

```
1  clc
2  clear
3  //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=(1/(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

```
1  clc
2  clear
3  //INPUT DATA
4  Eg=1.2*1.6*10^-19//The energy gap of intrinsic
    semiconductor in J
5  T1=600//Temperature in K
6  T2=300//Temperature in K
7  e=1.6*10^-19//charge of electron in coulombs
8  kb=1.38*10^-23//Boltzmann's constant m^2 Kg s^-2 k
    ^-1
9
10 //CALCULATION
11 x=exp((-Eg/(2*kb))*((1/T1)-(1/T2)))/10^5//The ratio
    of conductiveness*10^5
12
13 //OUTPUT
14 printf('The ratio of conductiveness is %3.2f*10^5',x
    )
```

Scilab code Exa 10.10 Conductivity of Ge

```
1  clc
2  clear
3  //INPUT DATA
4  Eg=0.72*1.6*10^-19//The band gap of Ge in J
5  T1=293//Temperature in K
6  T2=313//Temperature in K
7  x1=2//The conductivity of Ge at T1 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 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 carrier 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 m2 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 m2 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 m2 V-1 s-1
10
11 //OUTPUT
12 printf('mobility of pure semi conductor is %3.6f m2

```


$V^{-1} s^{-1}, m)$

Scilab code Exa 10.14 Band gap energy of the semiconductor

```
1  clc
2  clear
3  //INPUT DATA
4  ec1=19.96//The electrical conductivity of an
      intrinsic semi conductor in ohm-1 m-1
5  ec2=79.44//The increasing electrical conductivity of
      an intrinsic semi conductor in ohm-1 m-1
6  t1=333//temperature of an intrinsic semi conductor
      in k
7  t2=373//increasing temperature of an intrinsic semi
      conductor in k
8  kb=1.38*10-23//Boltzmann's constant in m2 Kg s-2
      k-1
9
10 //CALCULATION
11 Eg=(2*kb*(log(ec2/ec1))*((t1*t2)/(t2-t1)))/10-19//
      The band gap of an intrinsic semi conductor in J
      *10-19
12
13 //OUTPUT
14 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

```
1  clc
2  clear
3  //INPUT DATA
4  ni=2.1*10^19//intrinsic charge carriers in m^-3
5  me=0.4//electron mobility in m^2 V^-1 s^-1
6  mh=0.2//hole mobility in m^2 V^-1 s^-1
7  d=4.5*10^23//density of boron in m^-3
8  e=1.6*10^-19//charge of electron in coulombs
9
10 //CALCULATION
11 C=(ni*e)*(me+mh)//conductivity before adding boron
    atoms in ohm^-1 m^-1
12 c=(d*e*mh)/10^4//conductivity after adding boron
    atoms in ohm^-1 m^-1 *10^4
13
14 //OUTPUT
15 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 $3.2 \times 10^4 \text{ ohm}^{-1} \text{ m}^{-1}$, C, c)

Scilab code Exa 11.2 Concentration of holes and electrons

```
1 clc
2 clear
3 //INPUT DATA
4 ni=1.5*10^16//intrinsic charge carriers in m^-3
5 me=1300*10^-4//electron mobility in m^2 V^-1 s^-1
6 mh=500*10^-4//hole mobility in m^2 V^-1 s^-1
7 c=3*10^4//conductivity of n-type silicon in ohm^-1 m
  ^-1
8 e=1.6*10^-19//charge of electron in coulombs
9
10 //CALCULATION
11 ne=(c/(e*me))/10^24//DensITy of electrons in n-type
  silicon in electrons/m^3 *10^24
12 nh=(ni^2/(ne*10^24))/10^8//Density of holes in n-
  type silicon in holes/m^3 *10^8
13 Ne=(c/(e*mh))/10^24//Density of holes in p-type
  silicon in holes/m^3 *10^24
14 Nh=(ni^2/(Ne*10^24))/10^7//Density of electrons in p
  -type silicon in holes/m^3 *10^7
15
16 //OUTPUT
17 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

```
1 clc
2 clear
3 //INPUT DATA
4 ni=2*10^16//intrinsic charge carriers in m^-3
5 Na=5*10^23//density of acceptor concentration of
   silicon with arsenic in atoms
6 Nd=3*10^23//density of donor concentration of
   silicon with arsenic in atoms
7
8 //CALCULATION
9 nh=(Na-Nd)//density of hole in m^-3
10 ne=(ni^2/(nh))/10^9//The electron concentration that
   is density of electrons in electrons /m^3*10^9
11
12 //OUTPUT
13 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

```
1 clc
2 clear
3 //INPUT DATA
4 d=5*10^28//density of silicon atom in atoms/m^3
5 nd=2.5*10^7//donor concentration in 1 atom per si
   atom
6 T=300//Temperature in K
7 Eg=1.1*1.6*10^-19//Eg for silicon in eV
8 kb=1.38*10^-23//Boltzmann's Constant in m^2 Kg s^-2
   k^-1
9 m=9.11*10^-31//mass of electron in Kg
10 h=6.625*10^-34//plank's constant in m^2 Kg/sec
11
```

```

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 m3 C-1*10-4
13
14 //OUTPUT
15 printf('Hall coefficient of silicon plate is %3.2f
    *10-4 m3 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 m3 C-1
5 rh=-7.35*10-5//Hall coefficient of silicon specimen
    in m3 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))/1022//The density of the charge
    carrier in electrons/m3*1022
11 me=(c*RH)/10-3//The mobility of the charge carrier
    in m2 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*1022 electrons/m3 \n The mobility of the
    charge carrier is %3.1f*10-3 m2 V-1 s-1',ne,
    me)

```

Scilab code Exa 11.10 Charge carrier density and electron mobility


```

1  clc
2  clear
3  //INPUT DATA
4  RH=4.16*10-4//Hall coefficient of n-type
    semiconductor in m3 C-1
5  c=180//conductivity in ohm-1 m-1
6  e=1.6*10-19//charge of electron in coulombs
7  x=1.18//correction factor for RH
8
9  //CALCULATION
10 ne=(x/(RH*e))/1022//The density of the charge
    carrier in electrons/m3*1022
11 me=(c/(ne*1022*e))//The mobility of the charge
    carrier in m2 V-1 s-1
12
13 //OUTPUT
14 printf('The density of the charge carrier is %3.3f
    *1022 electrons/m3 \n The mobility of the
    charge carrier is %3.5f m2 V-1 s-1',ne,me)

```

Scilab code Exa 11.11 Hall coefficient

```

1  clc
2  clear
3  //INPUT DATA
4  l=1*10-3//length of rectangular plane sheet of
    doped silicon in m
5  b=1*10-3//breadth of semi rectangular plane sheet
    of doped silicon in m
6  t=0.5*10-3//thickness of rectangular plane sheet of
    doped silicon in m
7  RH=1.25*10-3//Hall coefficient of the material in m
    3 C-1
8  I=1*10-3//current in A
9  B=0.7//magnetic flux density in Wb/m2

```

```

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

```

```

2 clear
3 //INPUT DATA
4 RH=0.0125//Hall coefficient of a sample n-type
   semiconductor in m3 C-1
5 rh=-0.0125//Hall coefficient of a sample n-type
   semiconductor in m3 C-1
6 me=0.36//electron mobility in m2 V-1 s-1
7 EH=100//electric field in V/m
8 e=1.6*10-19//charge of electron in coulombs
9
10 //CALCULATION
11 n=(1/(RH*e))//The density of the charge carrier in m
   -3
12 c=(n*e*me)//conductivity of n-type semiconductor in
   ohm-1 m-1
13 J=(c*EH)//The current density in A/m2
14
15 //OUTPUT
16 printf('The current density is %i A/m2',J)

```

Chapter 12

Superconducting materials

Scilab code Exa 12.1 Transition temperature

```
1  clc
2  clear
3  //INPUT DATA
4  M1=202//mass number of mercury
5  a=0.50//coefficient of mass number
6  T1=4.2//temperature in k for mass number 200
7  M2=200//mass number of mercury
8
9  //CALCULATION
10 T2=((M1/M2)^a)*T1//The transition temperature for
    the isotope of mercury of mass number 200 in k
11
12 //OUTPUT
13 printf('The transition temperature for the isotope
    of mercury of mass number200 is %3.4f k',T2)
```

Scilab code Exa 12.2 Critical field

```

1  clc
2  clear
3  //INPUT DATA
4  Tc=9.15//critical temperature of Nb in K
5  t=6//temperature of critical field in K
6  Ho=0.196//The critical field AT 0K in T
7
8  //CALCULATION
9  Hc=(Ho*(1-(t/Tc)^2))//The critical field at 6K in T
10
11 //OUTPUT
12 printf('The critical field at %iK is %3.4f T',t,Hc)

```

Scilab code Exa 12.3 Isotopic mass

```

1  clc
2  clear
3  //INPUT DATA
4  M1=199.5//Isotopic mass of metal
5  T1=4.185//Critical temperature for a metal with
   isotopic mass in k
6  T2=4.133//fall of critical temperature for a metal
   with isotopic mass in k
7  a=0.50//coefficient of mass
8
9  //CALCULATION
10 M2=(((M1)^a)*(T1/T2))^2//The Isotopic mass if the
   critical temperature falls to 4.133
11
12 //OUTPUT
13 printf('The Isotopic mass if the critical
   temperature falls to %3.3fK is %3.2f',T2,M2)

```

Scilab code Exa 12.4 Critical current

```
1  clc
2  clear
3  //INPUT DATA
4  Hc=7.2*10^3//The critical magnetic field in A/m
5  r=0.5*10^-3//radius of long thin superconducting
   wire in m
6
7  //CALCULATION
8  Ic=(2*3.14*Hc*r)//The critical current through a
   long thin superconductor in A
9
10 //OUTPUT
11 printf('The critical current through a long thin
   superconductor is %3.3f A',Ic)
```

Scilab code Exa 12.5 Critical field

```
1  clc
2  clear
3  //INPUT DATA
4  Tc=3.7//critical temperature of superconducting Sn
   in K
5  t=2//temperature of critical field in K
6  Ho=0.0306//The critical field at 0K in T
7
8  //CALCULATION
9  Hc=(Ho*(1-(t/Tc)^2))//The critical field at 6K in T
10
11 //OUTPUT
12 printf('The critical field at %iK is %3.6f tesla ',t,
   Hc)
```

Scilab code Exa 12.6 Critical current

```
1  clc
2  clear
3  //INPUT DATA
4  Ho=6.5*10^4//The critical field at 0K in A/m
5  Tc=7.18//The temperature for lead in K
6  r=0.5*10^-3//radius of superconducting wire of lead
   in m
7  T=4.2//temperature of superconducting wire in K
8
9  //CALCULATION
10 Hc=(Ho*(1-(T/Tc)^2))//The critical field in KA/m
11 Ic=2*3.14*Hc*r//The critical density for a
   superconducting wire of lead is in A
12
13 //OUTPUT
14 printf('The critical density for a superconducting
   wire of lead is %3.2f in A',Ic)
```

Scilab code Exa 12.7 Critical temperature

```
1  clc
2  clear
3  //INPUT DATA
4  Hc=10^5//The critical field for vanadium at 8.58K in
   A/m
5  Ho=2*10^5//The critical field for vanadium at 0K in
   A/m
6  T=8.58//temperature for vanadium in K
7
8  //CALCULATION
```

```

9 Tc=(T/(sqrt(1-(Hc/Ho))))//The critical temperature
  in K
10
11 //OUTPUT
12 printf('The critical temperature is %3.3f K',Tc)

```

Scilab code Exa 12.8 Frequency of the radiation

```

1 clc
2 clear
3 //INPUT DATA
4 V=5.9*10^-6//voltage applied across a Josephson
  junction in V
5 e=1.6*10^-19//charge of electron in coulombs
6 h=6.62*10^-34//Planck's constant in J-sec
7
8 //CALCULATION
9 v=((2*e*V)/h)/10^9//The frequency of the radiation
  emitted by the junction in Hz
10
11 //OUTPUT
12 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

```
1  clc
2  clear
3  //INPUT DATA
4  rp=11.7//relative permittivity of silicon
5  N=4.82*10^28//number of atoms per unit volume in
      atoms/m^3
6  ro=8.85*10^-12//permittivity of free space
7  E=10^4//E in Vm^-1
8  e=1.6*10^-19//charge of electron in coulombs
9  Z=14//atomic number of silicon
10
11 //CALCULATION
12 z=((ro*(rp-1))/N)//electronic polarisability in Fm^2
13 y=(z*E)/10^-35//The dipole moment of each atom in a
      field of 10^4 Vm^-1 in Cm^-3 *10^-35
14 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
15
16 //OUTPUT
17 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

```
1  clc
```

```

2 clear
3 //INPUT DATA
4 d=9.8*10^26//density of hydrogen gas in atoms/m^3
5 r=0.50*10^-10//radius of the hydrogen atom in m
6 ro=8.85*10^-12//permittivity of free space
7
8 //CALCULATION
9 z=(4*3.14*ro*r*r*r)/10^-41//electronic
   polarisability in Fm^2
10 rp=((d*z*10^-41)/ro)+1//The relative permittivity
   in hydrogen gas
11
12 //OUTPUT
13 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

```

1 clc
2 clear
3 //INPUT DATA
4 z=1.75*10^-40//electronic polarisability in Fm^2
5 d=1.8*10^3//density of argon atom in Kg/m^3
6 Z=39.95//atomic weight of argon
7 NA=6.025*10^26//Avagadro number in mole^-1
8 ro=8.85*10^-12//permittivity of free space
9
10 //CALCULATION
11 N=((NA*d)/Z)//The number of atoms/unit volume in
   atoms/m^3
12 rp=((N*z)/ro)+1//The static dielectric constant of
   solid argon
13
14 //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 dielectric constant of a material
5 n=2.69//n is the index of refraction
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

```
1  clc
2  clear
3  //INPUT DATA
4  t=0.1*10^-2//thickness of piezo electric crystal in
   m
5  E=80*10^9//Young's modulus of crystal in pa
6  d=2654//density of material of crystal in Kgm^-3
7
8  //CALCULATION
9  f=(1/(2*t)*sqrt(E/d))/10^6//The frequency to which a
   piezo electric oscillator circuit should be
   turned in Hz
10
11 //OUTPUT
12 printf('The frequency to which a piezo electric
   oscillator circuit should be turned is %3.4f*10^6
   Hz',f)
```
