# Scilab Textbook Companion for Material Science by V. Rajendran[1]

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# Book Description

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

**Exa** Example (Solved example)

**Eqn** Equation (Particular equation of the above book)

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

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

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# List of Scilab Codes

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# Chapter 1

# Materials Properties and Requirements

**Scilab code Exa 1.1** Resistance of the wire

```
// Example 1.1, page no-8
clear
clc

r=0.45*10^-3 //m
L=0.3 //m
rho=17*10^-9 //ohm-m
//Calculations
R=rho*(L/(%pi*r^2))
printf("The Resistance of the wire is %.3f ohm",R)
```

**Scilab code Exa 1.2** Extension of a wire

```
// Example 1.2, page no-8
clear
clc
```

```
r=1.25*10^-3 //m
L=3 //m
F=4900 //Newton
e=2.05*10^11 //Pa
s=F/(%pi*r^2*e)
printf("strain = %.3f\nTherefore, extension = %.3f",
    s,s*3)
```

# Chapter 2

# Crystal Structure

**Scilab code Exa 2.2** Lattice spacing from Miller indices

```
// Example 2.2, page no-29
clear
clc
// Intercepts are in the ratio 3a:4b along X,Y and parallel to Z axis
//x intercept 3,y intercept 4 and z intercept infinity
a=2*10^-10// 2 Angstrom
h=4
k=3
l=0
d=a/sqrt(h^2+k^2+l^2)
printf("The lattice spacing for the plane 430 is %.1f*10^-10 m",d*10^10)
```

---

**Scilab code Exa 2.3** Lattice constant of Sodium

```
// Example 2.3, page no-31
```

```
clear
clc

d=9.6*10^2//kg/m^3
awt=23
n=2
avg=6.023*10^26
m=n*awt/avg
a=(m/d)^(1/3)
printf("The lattice constant od sodium is %.1f  A ",
    a*10^10)
```

**Scilab code Exa 2.4** Avogadro Constant

```
// Example 2.4, page no-31
clear
clc

d=4*10^3//kg/m^3
awtcs=132.9
awtcl=35.5
a=4.12*10^-10
m=d*a^3
N=(awtcs+awtcl)/m
printf("The value of Avogadro Constant %.4f *10^26
    per kg mole",N*10^-26)
```

**Scilab code Exa 2.5** Lattice spacing from Miller indices

```
// Example 2.5, page no-31
clear
clc
lam=1.5418*10^-10//m
```

```
theta=30//in degrees
h=1
k=1
l=1
a=lam*sqrt(h^2+k^2+l^2)/(2*sin(theta*%pi/180))
printf("The lattice constant is %.4f *10^-10 m",a
   *10^10)
```

**Scilab code Exa 2.6** Lattice spacing from Miller indices

```
// Example 2.6, page no-33
clear
clc
h=1
k=0
l=0
a=2.814*10^-10
d=a/sqrt(h^2+k^2+l^2)
printf("The lattice spacing for the plane(100) is %
   .3f*10^-10 m",d*10^10)
```

**Scilab code Exa 2.7** Lattice spacing from Miller indices

```
// Example 2.7, page no-33
clear
clc
h=3
k=2
l=1
a=4.12*10^-10
d=a/sqrt(h^2+k^2+l^2)
printf("The lattice spacing for the plane(321) is %
   .4f*10^-10 m",d*10^10)
```

**Scilab code Exa 2.8** Lattice spacing from Miller indices

```
// Example 2.8, page no-34
clear
clc
///(i)
h=1
k=0
l=1
a=4.2*10^-10
d=a/sqrt(h^2+k^2+l^2)
printf("\nThe lattice spacing for the plane(101) is
    %.3f*10^-10 m",d*10^10)
///(ii)
h=2
k=2
l=1
a=4.12*10^-10
d=a/sqrt(h^2+k^2+l^2)
printf("\nThe lattice spacing for the plane(220) is
    %.1f*10^-10 m",d*10^10)
```

**Scilab code Exa 2.13** Lattice spacing from Miller indices

```
// Example 2.13, page no-37
clear
clc
//(i)
h=1
k=1
l=1
```

```
a=4.12*10^-10
d=a/sqrt(h^2+k^2+l^2)
printf("\nFor (111) plane\nThe lattice spacing is %
   .3f*10^-10 m",d*10^10)
//(ii)

h=1
k=1
l=2
a=4.12*10^-10
d=a/sqrt(h^2+k^2+l^2)
printf("\n\nFor (112) plane\nThe lattice spacing is
   %.3f*10^-10 m",d*10^10)
//(iii)

h=1
k=2
l=3
a=4.12*10^-10
d=a/sqrt(h^2+k^2+l^2)
printf("\n\nFor (123) plane\nThe lattice spacing is
   %.3f*10^-10 m",d*10^10)
```

**Scilab code Exa 2.15** Lattice spacing from Miller indices

```
// Example 2.15, page no-38
clear
clc
h=2
k=2
l=0
a=4.938*10^-10
d=a/sqrt(h^2+k^2+l^2)
printf("\nThe lattice spacing for (220) plane is %.3
   f*10^-10 m",d*10^10)
```

**Scilab code Exa 2.16** Number of atoms in Al foil

```
// Example 2.16, page no-39
clear
clc
a=0.405*10^-10//m
t=0.005//m
A=25*10^-2//m
n=t*A/a^3
printf("The number of atoms in the Al foil is %.2f *
    10^28",n*10^-28)
```

**Scilab code Exa 2.17** no of unit cells in 1 kg metal

```
// Example 2.17, page no-39
clear
clc
a=2.88*10^-10//
d=7200//k/m^3
n=1/(d*a^3)
printf("The number of unit cell present in 1 kg
   metal is %.4f *10^24",n*10^-24)
```

**Scilab code Exa 2.18** percentage volume change during structural changes

```
// Example 2.18, page no-39
clear
clc
rbcc=0.1258*10^-9
```

```
rfcc=0.1292*10^-9
a=4*rbcc/sqrt(3)
vbcc=(a^3)/2
a1=4*rfcc/sqrt(2)
vfcc=(a1^3)/4
vp=(vbcc-vfcc)
vp=floor(vp*10^32)
vp=vp*10^-32/vbcc
printf("The volume change in %% duringg the
    structural change is %.4f",vp*100)
```

**Scilab code Exa 2.19** Copper Density

```
// Example 2.19, page no-40
clear
clc
awt=63.5*10^-3//g
avg=6.023*10^26
r=1.273*10^-10
n=4
a=4*r/sqrt(2)
d=n*awt/(avg*a^3)
printf("The density of copper is %.4f gm/m^3",d)
```

**Scilab code Exa 2.20** Atomic Radius

```
// Example 2.20, page no-41
clear
clc
d=7860
m=55.85
n=2
avg=6.023*10^26
```

```
a=(n*m*10^-3/(avg*d))^(1/3)
r=a*sqrt(3)/4
printf("\nThe lattice constant of alfa-iron is %.4f
   A ",a*10^10)
printf("\nThe atomic radius of alfa-iron is %.5f
   *10^-10 m",r*10^10)
```

**Scilab code Exa 20.21** Lattice constant

```
// Example 2.21, page no-42
clear
clc
d=8960
m=63.54
n=4
avg=6.023*10^26
a=(n*m*10^-3/(avg*d))^(1/3)
printf("\nThe lattice constant of copper is %.4f A
   ",a*10^10)
```

**Scilab code Exa 2.22** Glancing angle

```
// Example 2.22, page no-42
clear
clc
a=3.81*10^-10//m
h=1
k=3
l=2
lam=0.58*10^-10
n=2
d=a/sqrt(h^2+k^2+l^2)
theta=asin(n*lam/(2*d))
```

```
printf("The angle of glancing at which 2nd order
    diffraction pattern of NaCl occurs is %.2f ",
    theta*180/%pi)
```

**Scilab code Exa 2.23** Lattice constant

```
// Example 2.23, page no-43
clear
clc
h=3
k=0
l=2
theta=35//in degrees
lam=0.7*10^-10//m
n=1
d=n*lam/(2*sin(theta*%pi/180))
printf("\nThe interplanar distance for(302) plane is
     %.3f*10^-11 m",d*10^11)
a=d*sqrt(h^2+k^2+l^2)
printf("\nThe lattice constance is %.2f*10^-10 m",a
    *10^10)
```

**Scilab code Exa 2.24** Plane Drawing

```
// Example 2.24, page no-44
clear
clc
///for plane (0,0,1)
deff('z=f(x,y)','z=x^0-y^0')
x=0:0.2:3 ;y=x ;
//clf() ;
```

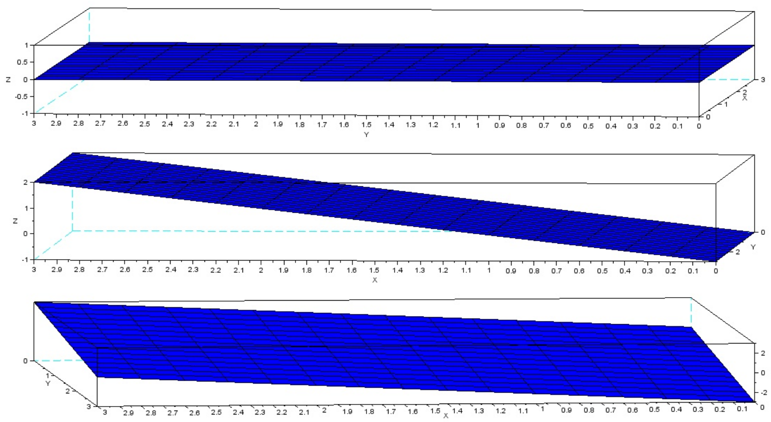

Figure 2.1: Plane Drawing

```
subplot(311)
fplot3d(x,y,f,alpha=5,theta=31)

///For plane(1,0,1)
deff('z=f(x,y)','z=x^1-y^0')
x=0:0.2:3 ;y=x ;
//clf() ;
subplot(312)
fplot3d(x,y,f,alpha=5,theta=31)

///For plane(1,1,1)
deff('z=f(x,y)','z=x^1-y^1')
x=0:0.2:3 ;y=x ;
//clf() ;
subplot(313)
fplot3d(x,y,f,alpha=5,theta=31)
```

**Scilab code Exa 2.25** Interplanar spacing

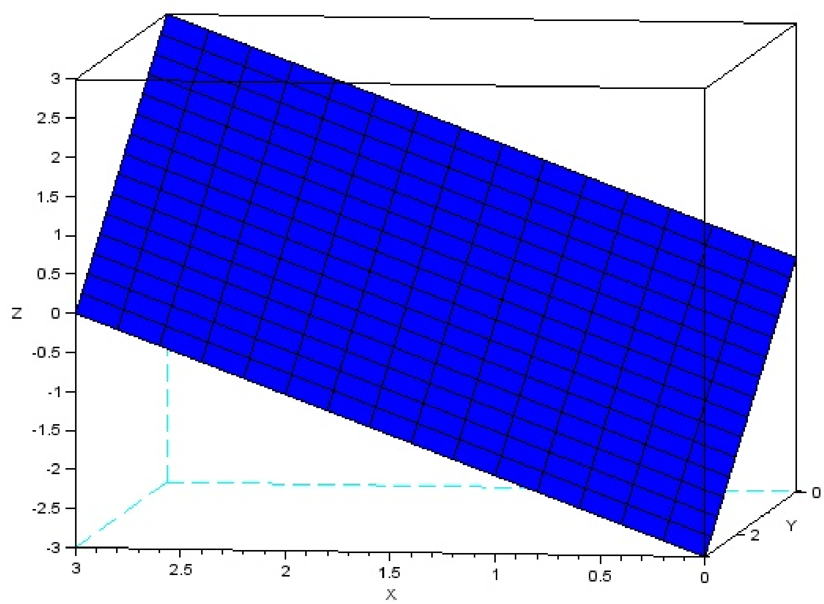


Figure 2.2: Plane Drawing

```
// Example 2.25, page no-45
clear
clc
theta=12//in degrees
lam=2.82*10^-10//m
n=1
d=n*lam/(2*sin(theta*%pi/180))
printf("The interplanar spacing is %.3f *10^-10 m",d
    *10^10)
```

**Scilab code Exa 2.26** Lattice spacing and deBroglie wavelength

```
// Example 2.26, page no-46
clear
clc
theta=27.5/2//in degrees
a=0.563*10^-9
n=1
h=1
k=1
l=1
d=a/sqrt(h^2+k^2+l^2)
printf("\nThe lattice spacing for the plane (111) is
     %.2f * 10^-10 m",d*10^10)
lam=2*d*sin(theta*%pi/180)/n
printf("\nThe deBroglie wavelength of the neutrons
    is %.3f *10^-10 m",lam*10^10)
```

**Scilab code Exa 2.27** Lattice constant and atomic radius

```
// Example 2.27, page no-46
clear
clc
```

```
h=1
k=1
l=0
d=2*10^-10//m
a=d*sqrt(h^2+k^2+l^2)
R=a/(2*sqrt(2))
printf("The lattice constant is %.3f*10^-10 m\nThe
    atomic radius of the crystal is %.1f *10^-10 m",a
    *10^10,R*10^10)
```

**Scilab code Exa 2.28** energy of the neutron

```
// Example 2.28, page no-47
clear
clc
theta=22//in degrees
d=1.8*10^-10//m
n=1
h=6.626*10^-34
m=9.1*10^-31//kg
e=1.6*10^-19//C
lam=2*d*sin(theta*%pi/180)/n
E=(1/(2*m))*(h/lam)^(2)
printf("\nThe deBroglie wavelength of the neutron is
    %.3f *10^-10\nthe energy of the neutron is %.2f
    eV",lam*10^10,E/e)
```

**Scilab code Exa 2.29** InterPlanar Spacing

```
// Example 2.29, page no-48
clear
clc

```

```
h=1
k=1
l=1
a=3*10^-10
d=a/sqrt(h^2+k^2+l^2)
printf("\nThe interplanar spacing for the plane(101) is %.3f*10^-10 m",d*10^10)
```

**Scilab code Exa 2.30** Lattice spacing from Miller indices

```
// Example 2.30, page no-48
clear
clc
h=3
k=2
l=1
rfcc=0.1278*10^-9//m
a=4*rfcc/sqrt(2)
d=a/sqrt(h^2+k^2+l^2)
printf("\nThe lattice constant = %.3f *106-10\nThe interplanar spacing for the plane(321) is %.3f *10^-11 m",a*10^10,d*10^11)
```

**Scilab code Exa 2.31** Number of atoms in Al foil

```
// Example 2.31, page no-49
clear
clc
a=0.4049*10^-10//m
t=0.005//m
A=25*10^-2//m
n=t*A/a^3
```

```
printf("The number of atoms in the Al foil is %.2f *
    10^28",n*10^-28)
```

**Scilab code Exa 2.32** energy of the neutron

```
// Example 2.32, page no-49
clear
clc
theta=20//in degrees
d=2*10^-10//m
n=1
h=6.626*10^-34
m=1.67*10^-27//kg
e=1.6*10^-19//C
lam=2*d*sin(theta*%pi/180)/n
E=(1/(2*m))*(h/lam)^(2)
printf("\nThe deBroglie wavelength of the neutron is
    %.3f *10^-10\nthe energy of the neutron is %.4f
   eV",lam*10^10,E/e)
```

**Scilab code Exa 2.35** deBroglie wavelength of electrons

```
// Example 2.35, page no-51
clear
clc
e=1.6*10^-19//C

h=6.626*10^-34
m=9.1*10^-31//kg
ek=235.2*e
n=1
theta=9.21
lam=h/sqrt(2*m*ek)
```

```
d=n*lam/(2*sin(theta*%pi/180))
printf("\nThe deBroglie wavelength of electron is %
   .3f *10^-11 m\nThe interplanar spacing is %.3f
   *10^-10 m",lam*10^11,d*10^10)
```

**Scilab code Exa 2.36** Lattice spacing from Miller indices

```
// Example 2.36, page no-52
clear
clc
// Intercepts are in the ratio 3a:4b along X,Y and
   parallel to Z axis
//x intercept 3,y intercept 4 and z intercept
   infinity
a=2*10^-10// 2 Angstrom
h=4
k=3
l=0
d=a/sqrt(h^2+k^2+l^2)
printf("The lattice spacing for the plane 430 is %.1
   f*10^-10 m",d*10^10)
```

**Scilab code Exa 2.38** Plane Drawing

```
// Example 2.38, page no-53
clear
clc
printf("Same as example 2.24 of the same chapter")
```

# Chapter 3

# Characterisation of material

**Scilab code Exa 3.1** wavelength and frequency of Xrays

```
// Example 3.1, page no-89
clear
clc
h=6.626*10^-34//Js
e=1.6*10^-19//C
c=3*10^8//m/s
v=10000//V
lam_min=(h*c)/(e*v)
V=c/lam_min
printf("\n(i)\nThe wavelength of X-rays emitted
   Lamda_min = %.2f A \n(ii)\nThe frequency of X-
   ray beam emitted is %.1f*10^18 Hz",lam_min*10^10,
   V*10^-18)
```

**Scilab code Exa 3.2** wavelength and velocity of electrons

```
// Example 3.2, page no-89
clear
```

```
clc
v=10000//V
i=2*10^-3 //A
e=1.6*10^-19//C
t=1
m=9.1*10^-31//kg
//(i)
n=i*t/e
printf("The no of electrons striking the target per second =%.2f *10^16",n*10^-16)
//(ii)
v1=sqrt(2*e*v/m)
//(iii)
lam=12400/v
printf("\n(ii)\nThe velocity of electron =%.2f*10^7 m/s\n(iii)\nWavelength of x-rays=%.2f A ",v1*10^-7,lam)
```

**Scilab code Exa 3.3** wavelength and angle for 2nd order bragg reflection

```
// Example 3.3, page no-90
clear
clc
d=5.6534*10^-10
theta=13.6666 //in degrees
n=1
//(i)
lam=2*d*sin(theta*%pi/180)/n
printf("\n(i)\nLambda =%.3f*10^-10 m",lam*10^10)
//(ii)
n=2
theta=asin(n*lam/(2*d))
theta=theta*180/%pi
printf("\n(ii)\n2nd order Bragg reflection at angle Theta2 = %f ",theta)
```

**Scilab code Exa 3.4** Grating spacing and glancing angle

```
// Example 3.4, page no-91
clear
clc
v=24800
n=1
lam=1.54*10^-10//m
ga=15.8 //degree
//(i)
d=n*lam/(2*sin(ga*%pi/180))
printf("\n(i)\ngrating spacinf for NaCl crystal =%f
    *10^-10 m",d*10^10)
//(ii)
lam_min=12400/v
lam_min=lam_min*10^-10
theta=asin(n*lam_min/(2*d))
theta=theta*180/%pi
printf("\n(ii)\nglancing angle for minimum
    wavelength = %f degrees",theta)
```

**Scilab code Exa 3.5** wavelength of radiation

```
// Example 3.5, page no-92
clear
clc
lam=0.7078 *10^-10
wt=42
wt1=48
lam1=(lam*(wt-1)^2)/(wt1-1)^2
printf("\nWavelength of cadmium radiation is %.4f
    A ",lam1*10^10)
```

**Scilab code Exa 3.6** Energy of thermal neutron

```
// Example 3.6, page no-92
clear
clc
lam=10^-10//m
h=6.626*10^-34
m=1.675*10^-27
e1=1.602*10^-19//ev
e=(h^2)/(2*m*lam^2)
e=e/e1
printf("\nThe energy of thermal neutron with
    wavelength 1 A  is %f eV",e)
```

**Scilab code Exa 3.8** temperature of thermal neutron

```
// Example 3.8, page no-94
clear
clc
lam=0.1//nm
T=(2.516^2)/(lam)^2
printf("temperature of thermal neutron corresponding
    to 1A is %.0f K",T)
```

# Chapter 4

# Cohesion between atoms

**Scilab code Exa 4.1** Coulomb interatomic energy

```
// Example 4.1, page no-92
clear
clc
R=2.81*10^-10 //m
e=1.6*10^-19
eps=8.854*10^-12
U=-(e^2)/(4*%pi*eps*R)
printf("The Coulomb interatomic energy is %.2f eV",U
   *10^19/1.6)
```

# Chapter 5

# Crystal Imperfections

**Scilab code Exa 5.1** Average distance between dislocations

```
// Example 5.1, page no-130
clear
clc

a=3.615*10^-10//m
t_ang=0.75 //in degree
h=1
k=1
l=0
d_110=a/sqrt(h^2+k^2+l^2)
D=d_110/tan(t_ang*%pi/(180*2))
printf("The average distance between the
    dislocations is %.3f A ",D*10^6)
```

---

**Scilab code Exa 5.2** Schottky defects per unit cell

```
// Example 5.2, page no-130
clear
```

```
clc
lp=4.0185*10^-10//m
dens=4285//kg/m^3
avg=6.022*10^26
wt_cs=132.9
wt_cl=35.5
N=(dens*avg*lp^3)/(wt_cs+wt_cl)
sd=(1-N)*100/1
printf("The number of Schottky defects per unit cell
    = %.3f%%",sd)
```

# Chapter 6

# Classification of solids

**Scilab code Exa 6.1** Wavelength of light emitted from LED

```
// Example 6.1, page no-143
clear
clc
e=1.609*10^-19//C
eg=1.8  //eV
h=6.626*10^-34
c=3*10^8//m/s
E=e*eg
lamda=h*c/E
printf("The wavelength of light emitted from given
   LED is %.3f  m",lamda*10^7)
```

---

**Scilab code Exa 6.2** Band gap of given GaAsP

```
// Example 6.2, page no-144
clear
clc
lam=6715*10^-10//m
```

```
h=6.626*10^-34
c=3*10^8//m/s
e=1.6*10^-19//C
Eg=h*c/lam
Eg=Eg/e
printf("The band gap of the given GaAsP is %.2f eV",
   Eg)
```

# Chapter 7

# Elecron theory of Solids

**Scilab code Exa 7.1** mobility of electrons in copper

```
// Example 7.1, page no-160
clear
clc
rho=1.73*10^-8 //Ohm-m
z=63.5
d=8.92*10^3 //kg/m^3
avg=6.023*10^26
e=1.6*10^-19//C
m=9.11*10^-31//Kg

n=avg*d/z
sig=1/rho
tau=sig*m/(n*e^2)
mu=sig/(n*e)

printf("Mobility of electrons in copper is %.2f
    *10^-3 m^2/V-s",mu*10^3)
```

**Scilab code Exa 7.2** resistivity of copper

```
// Example 7.2, page no-161
clear
clc
r=1.85*10^-10//m
t=3*10^-14//s
m=9.11*10^-31//Kg
e=1.6*10^-19//C
a=r*(4/sqrt(3))
ne=2/a^3
rho=m/(ne*t*e^2)
printf("Resistivity of copper is %.3f*10^-8 Ohm-m",
   rho*10^8)
```

**Scilab code Exa 7.3** resistivity of sodium

```
// Example 7.3, page no-161
clear
clc

r=1.85*10^-10//m
t=3.1*10^14//s
m=9.11*10^-31//Kg
e=1.6*10^-19//C
n=25.33*10^27
rho=m/(n*t*e^2)
printf("The electric Resistivity of sodium at 0 C
   is %.3f*10^-36 Ohm-m",rho*10^36)
```

**Scilab code Exa 7.4** mobility of electrons in meatls

```
// Example 7.4, page no-162
clear
clc
```

```

r=1.85*10^-10//m
t=3.4*10^-14//s
m=9.11*10^-31//Kg
e=1.6*10^-19//C
n=5.8*10^28//per m^3
rho=m/(n*t*e^2)
printf("\nThe electric resistivity of material is %.3f*10^-8 Ohm-m",rho*10^8)
mu=e*t/m
printf("\nThe mobility of the electron in a metal is %.2f*10^-3 m^2/v-s",mu*10^3)
```

**Scilab code Exa 7.5** drift velocity of electrons

```
// Example 7.5, page no-163
clear
clc

rho=1.54*10^-8//ohm-m
E=100//V/m
n=5.8*10^28//m^-3
e=1.6*10^-19//C
mu=1/(rho*n*e)
vd=mu*E
printf("\nMobility of electron in silvetr is %.4f*10^-3 m^2/v-s\n\nThe drift velocity of the electron in silver is %.5f m/s ",mu*10^3,vd)
```

**Scilab code Exa 7.6** mobility of electrons

```
// Example 7.6, page no-163
clear
```

```
clc

d=10.5*10^3 //kg/m^3
sig=6.8*10^7//per Ohm-m
wt=107.9//kg/m^3
e=1.6*10^-19//C
avg=6.023*10^26//atoms/m^3

n=avg*d/wt
mu=sig/(n*e)
printf("The mobility of electron is %.3f *10^-2 m^2.
    V/s",mu*10^2)
```

**Scilab code Exa 7.7** Lorentz Number

```
// Example 7.7, page no-164
clear
clc
sig=5.87*10^7
k=390//W/m-k
T=293
L=k/(sig*T)
printf("The Lorentz number is %.3f *10^-8 W.Ohm/K^2"
    ,L*10^8)
```

**Scilab code Exa 7.8** Lorentz Number

```
// Example 7.8, page no-164
clear
clc

t=1*10^-14//s
T=300//K
```

```
m=9.11*10^-31//Kg
e=1.6*10^-19//C
n=6*10^28//per m^3
sig=(n*t*e^2)/m
printf("\nthe electrical conductivity is %.4f *
    10^7/ohm-m",sig*10^-7)
k=1.38*10^-23
k1=n*%pi^2*k^2*T*t/(3*m)
printf("\n\nThermal conductivity is %.2f W/m-k",k1)
L=k1/(sig*T)
printf("\n\nthe Lorentz number is %.4f *10^-8 W.Ohm/
    k^2",L*10^8)
```

**Scilab code Exa 7.9** conductivity of copper

```
// Example 7.9, page no-165
clear
clc

d=8900 //kg/m^3
cu=63.5
t=10^-14 //s
avg=6.023*10^23
n=avg*d*1000/cu
m=9.1*10^-31//kg
e=1.6*10^-19

sig=(n*t*e^2)/m
printf("The electrical conductivity is %.3f *10^7 /
    Ohm-m",sig*10^-7)
```

**Scilab code Exa 7.10** drift velocity of electrons in silver piece

```
// Example 7.10, page no-166
clear
clc
rho=1.6*10^-8 //Ohm-m
e=1.6*10^-19//C
fe=5.5*e//J
avg=6.023*10^23
d=1.05*10^4//density
wt=107.9*10^-3//atomic weight
m=9.1*10^-31//kg
c=3*10^8//m/s
sig=1/rho
n=avg*d/wt
t=sig*m/(n*e^2)
printf("\nThe conductivity of silver piece is %.2f
    *10^7 per Ohm-m\n\nThe relaxation time is %.2f
    *10^-14 s",sig*10^-7,t*10^14)
lam=c*t
vd=sig*100/(n*e)
printf("\n\nThe driftt velocityy of electrons in the
     silver piece is %.2f m/s",vd)
```

**Scilab code Exa 7.11** resistivity of copper

```
// Example 7.11, page no-167
clear
clc
r1=1.7*10^-8
t2=300
t1=700+273
r2=r1*sqrt((t1/t2))
printf("The resistivityy of the copper wire is %.4f
    *10^-8 Ohm-m",r2*10^8)
```

**Scilab code Exa 7.12** mobility and drift velocity of electrons

```
// Example 7.12, page no-168
clear
clc

rho=1.54*10^-8
e=1.6*10^-19 //C
ef=5.5*e//J
n=5.8*10^28///per cubic meter
m=9.1*10^-31//kg

//(i)
t=m/(rho*n*e^2)
mu=e*t/m
printf("\n(i)\nThe relaxation time is %.2f*10^-14 s\nThe mobility of the electrons is %.4f *10^-3 m^2/V-s",t*10^14,mu*10^3)

//(ii)
vd=e*t*100/m
printf("\n\n(ii)\nthe drift velocity of elctron is %.5f m/s",vd)

//(iii)
vf=sqrt(2*ef/m)
printf("\n\n(iii)\nFermi velocity is %.2f*10^6 m/s",vf*10^-6)

//(iv)
lam=vf*t
printf("\n\n(iv)\nThe mean free path is %.3f*10^-8 m",lam*10^8)
```

# Chapter 8

# Statics and Band theory of Solids

**Scilab code Exa 8.1** Fermi energy

```
// Example 8.1, page no-208
clear
clc
d_cu=8.96*10^3//density of cu
a_cu=63.55//Atomic weight of cu
d_z=7100
a_z=65.38
d_al=2700
a_al=27
avg=6.023*10^26
h=6.626*10^-34
m=9.1*10^-31//kg
e=1.6*10^-19//C

//(i)
n_cu=d_cu*avg/a_cu
e_cu=(h^2/(8*m))*(3*n_cu/%pi)^(2/3)
e_cu=e_cu/e
printf("\n(i)For Cu\nThe electron concentration in
```

```
Cu is %.4f*10^28 per m^3\nFermi energy at 0 k =%.4f eV ",n_cu*10^-28,e_cu)

//(ii)
n_z=d_z*avg*2/a_z
e_z=(h^2/(8*m))*(3*n_z/%pi)^(2/3)
e_z=e_z/e
printf("\n(i)For Zn\nThe electron concentration in Zn is %.4f*10^28 per m^3\nFermi energy at 0 k =%.4f eV ",n_z*10^-28,e_z)

//(i)
n_al=d_al*avg*3/a_al
e_al=(h^2/(8*m))*(3*n_al/%pi)^(2/3)
e_al=e_al/e
printf("\n(i)For Al\nThe electron concentration in Al is %.4f*10^28 per m^3\nFermi energy at 0 k =%.4f eV ",n_al*10^-28,e_al)
```

**Scilab code Exa 8.2** Density of States

```
// Example 8.2, page no-210
clear
clc
avg=6.023*10^26
h=6.626*10^-34
m=9.1*10^-31//kg
e=1.6*10^-19//C
n=8.4905*10^28

ef=(h^2/(8*m))*(3*n/%pi)^(2/3)
ef=ef/e
gam=6.82*10^27
x=(gam*sqrt(ef))/2
printf("The density of states for Cu at the Fermi
```

```
    level for T = 0 K is %.0f*10^27 m^-3",x*10^-27)
```

**Scilab code Exa 8.3** Nordheims Coefficient

```
// Example 8.3, page no-210
clear
clc
rni=63//n Ohm.m
rcr=129
k=1120
c=(k*10^-9)/(0.8*(1-0.8))
printf("The Nordheims coeeficient is %.0f *10^-6 Ohm
   -m",c*10^6)
```

**Scilab code Exa 8.4** Conductivity of Al

```
// Example 8.4, page no-211
clear
clc
d=2700//kh/m^3
awt=27
t=10^-14//s
e=1.6*10^-19//C
m=9.1*10^-31//Kg
avg=6.023*10^26
n=avg*d*3/awt
sig=(n*t*e^2)/m
printf("The conductivity of Al is %.4f*10^7 ohm-m.",
   sig*10^-7)
```

**Scilab code Exa 8.5** Fermi distribution Function

```
// Example 8.5 , page no-211
clear
clc
e1=0.01//eV
e=1.6*10^-19//C
ed=e*e1
T=200//K
E=1/(1+%e^(ed/(T*1.38*10^-23)))
printf("The Fermy distribution function for energy E
    is %.4f",E)
```

---

**Scilab code Exa 8.6** Fermi temperature

```
// Example 8.6 , page no-212
clear
clc

v=0.86*10^6//m/s
m=9.1*10^-31//Kg
e=1.6*10^-19//C
k=1.38*10^-23 //J/K
E=(m*v^2)/2
T=E/k
printf("\nThe fermi energy is %.3f*10^-19 J\nThe
   Fermi Temperature Tf is %.2f*10^4 K",E*10^19,T
   *10^-4)
```

---

**Scilab code Exa 8.7** Density of States

```
// Example 8.7 , page no-212
clear
```

```
clc

m=9.1*10^-31//Kg
dE=0.01 //eV
h=6.63*10^-34///Js
eF=3//eV
e=1.6*10^-19//C
E1=eF*e
E2=E1+e*dE

n=(4*%pi*(2*m)^(1.5))/h^3
k=((2*0.3523/3)*((E2^(1.5)-(E1^(1.5)))))
n=n*k
printf("The number of states lying between the
    energy level is %.2f*10^25",n*10^-25)
```

**Scilab code Exa 8.8** Fermi Velocity

```
// Example 8.8, page no-214
clear
clc
Tf=24600//K
m=9.11*10^-31//Kg
k=1.38*10^-23
vf=sqrt(2*k*Tf/m)
printf("The Fermi Velocity is %.4f *10^6 m/s",vf
    *10^-6)
```

**Scilab code Exa 8.9** Fermi Energy

```
// Example 8.9, page no-214
clear
clc
```

```
n=18.1*10^28//per cubic m
h=6.62*10^-34//Js
m=9.1*10^-31//Kg
e=1.6*10^-19//C
ef=((3*n/(8*%pi))^(2/3))*((h^2)/(2*m))
ef=ef/e
printf("The Fermi energy at 0 K is %.2f eV ",ef)
```

**Scilab code Exa 8.10** Fermi Energy

```
// Example 8.10, page no-215
clear
clc
n=18.1*10^28//per cubic m
h=6.62*10^-34//Js
m=9.1*10^-31//Kg
e=1.6*10^-19//C
ef=((3*n/(8*%pi))^(2/3))*((h^2)/(2*m))
ef=ef/e
printf("The Fermi energy at 0 K is %.2f eV ",ef)
```

**Scilab code Exa 8.11** Fermi distribution Function

```
// Example 8.11, page no-215
clear
clc
e=1.6*10^-19//C
Ed=0.5*e
k=1.38*10^-23
x=0.01
T=Ed/(k*log((1/x)-1))

```

```
printf("Temperature at which there is 1%%
   probability that a state with 0.5 eV energy
   occupied above the Fermi energy level is %.1f K",
   T)
```

**Scilab code Exa 8.12** theorotical example

```
// Example 8.12, page no-216
clear
clc
printf("Theorotical Exam[ple")
```

**Scilab code Exa 8.13** theorotical example

```
// Example 8.1, page no-217
clear
clc
printf("Theorotical Exam[ple")
```

**Scilab code Exa 8.14** Energies for different probabilities

```
// Example 8.14, page no-218
clear
clc
ef=2.1
k=1.38*10^-23
T=300//K
e=1.6*10^-19//c
//(i)
p1=0.99
```

```
E1=ef+(k*T*log(-1+1/p1))/e

//(ii)
p2=0.01
E2=ef+(k*T*log(-1+1/p2))/e

//(iii)
p3=0.5
E3=ef+(k*T*log(-1+1/p3))/e

printf("\nThe energies for the occupying of
   delectrons at %d K for the probability of %.2f is
    %.2f",T,p1,E1)

printf("\nThe energies for the occupying of
   delectrons at %d K for the probability of %.2f is
    %.2f",T,p2,E2)

printf("\nThe energies for the occupying of
   delectrons at %d K for the probability of %.2f is
    %.2f",T,p3,E3)
```

**Scilab code Exa 8.15** Fermi distribution Function

```
// Example 8.15, page no-219
clear
clc
e=1.6*10^-19 //C
ed=0.02*e
T1=200
T2=400
k=1.38*10^-23
fe1=1/(1+%e^(ed/(k*T1)))
fe2=1/(1+%e^(ed/(k*T2)))
printf("\nThe Fermi distribution function for the
```

```
    given energy at %d K is %.4f",T1,fe1)
printf("\nThe Fermi distribution function for the
    given energy at %d K is %.4f",T2,fe2)
```

---

**Scilab code Exa 8.16** Fermi Energy

```
// Example 8.16, page no-220
clear
clc
d=10500//density
avg=6.022*10^26
awt=107.9
n=d*avg/awt//per cubic m
h=6.62*10^-34//Js
m=9.1*10^-31//Kg
e=1.6*10^-19//C
ef=((3*n/(8*%pi))^(2/3))*((h^2)/(2*m))
ef=ef/e
printf("The Fermi energy for given metal is %.2f eV
    ",ef)
```

---

**Scilab code Exa 8.17** Fermi distribution Function

```
// Example 8.17, page no-221
clear
clc
e=1.6*10^-19 //C
ed=0.2*e
T1=300
T2=1000
k=1.38*10^-23
fe1=1/(1+%e^(ed/(k*T1)))
fe2=1/(1+%e^(ed/(k*T2)))
```

```
printf("\nThe Fermi distribution function for the
    given energy at %d K is %.6f",T1,fe1)
printf("\nThe Fermi distribution function for the
    given energy at %d K is %.4f",T2,fe2)
```

**Scilab code Exa 8.18** Electron density

```
// Example 8.18, page no-221
clear
clc

h=6.62*10^-34//Js
m=9.1*10^-31//Kg
e=1.6*10^-19//C
ef=3*e
k=((3/(8*%pi))^(2/3))*((h^2)/(2*m))
k=ef/k
n=k^(1.5)
printf("The number of free electrons concentration
    in metal is %.2f *10^28 per cubic meter ",n
    *10^-28)
```

**Scilab code Exa 8.19** concentration of free electrons

```
// Example 8.18, page no-221
clear
clc

h=6.62*10^-34//Js
m=9.1*10^-31//Kg
e=1.6*10^-19//C
ef=5.5*e
k=((3/(8*%pi))^(2/3))*((h^2)/(2*m))
```

```
k=ef/k
n=k^(1.5)
printf("The number of free electrons concentration
   in metal is %.3f *10^28 per cubic meter ",n
   *10^-28)
```

**Scilab code Exa 8.20** carrier density and fermi velocity

```
// Example 8.18, page no-221
clear
clc

h=6.62*10^-34//Js
m=9.1*10^-31//Kg
e=1.6*10^-19//C
ef=7*e
k=((3/(8*%pi))^(2/3))*((h^2)/(2*m))
k=ef/k
n=k^(1.5)
printf("The number of free electrons concentration
   in metal is %.2f *10^28 per cubic meter ",n
   *10^-28)
vth=sqrt(2*ef/m)
printf("\nThe termal velocity of electrons in copper
    is %.3f *10^6 m/s",vth*10^-6)
```

# Chapter 10

# Transport Properties of Semiconductors

**Scilab code Exa 10.1** Intrinsic concentration conductivity and resistivity

```
// Example 10.1, page no-267
clear
clc
T=300//K
mue=0.4//m^2/V-s
muh=0.2
e=1.6*10^-19//C
eg=0.7*e//J
m=9.1*10^-31//kg
me=0.55
mh=0.37
h=6.626*10^-34
k=1.38*10^-23
ni=2*(2*%pi*k*T/(h^2))^(1.5)
ni=ni*(m^1.5)*(mh*me)^(3/4)
ni=ni*%e^(-eg/(k*T))
printf("\nThe intrinsic concentration ni=%.3f *10^13
    /m^3",ni*10^-13)

```

```
sig=ni*e*(mue+muh)
rho=1/sig
printf("\nIntrinsic Conductivity,Sigma =%.3f *10^-6
   per m^3\nIntrinsic Resistivity , rho = %.2f*10^6
   Ohm-m",sig*10^6,rho*10^-6)
```

**Scilab code Exa 10.2** Fermi Energy

```
// Example 10.2, page no-268
clear
clc
ni=1.45*10^10//cm^-3
nd=10^16//cm^-3
k=1.38*10^-23
T=300
e=1.6*10^-19//C
Ef=k*T*log(nd/ni)
Ef=Ef/e
printf("The Fermi energyy with respect to Ef in
   intrinsic Si = %.3f eV",Ef)
```

**Scilab code Exa 10.3** Resistance of Germanium

```
// Example 10.3, page no-269
clear
clc
ni=2.5*10^19//m^-3
mue=0.39//m^2/V-s
muh=0.19
l=10^-2//m
e=1.6*10^-19//C
sig=ni*e*(mue+muh)
R=l/(sig*10^-6)
```

```
printf("The conductivity of intrinsic Ge is %.2f /
    ohm-m\nThe Resistance is %.0f",sig,R)
```

**Scilab code Exa 10.4** conductivity of Intrinsic semiconductor

```
// Example 10.4, page no-269
clear
clc
ni=1.5*10^16//m^-3
mue=0.13//m^2/V-s
muh=0.05
e=1.6*10^-19//C
sig=ni*e*(mue+muh)
printf("The conductivity of intrinsic Ge is %.2f
    *10^-4 /ohm-m",sig*10^4)
```

**Scilab code Exa 10.5** Intrinsic Resistivity

```
// Example 10.5, page no-270
clear
clc
ni=2.15*10^13//cm^-3
mue=3900//cm^2/V-s
muh=1900
e=1.6*10^-19//C
sig=ni*e*(mue+muh)
r=1/sig

printf("The conductivity of intrinsic Ge is %.2f
    *10^-2 /ohm-cm\n The intrinsic resistivity is %.0
    f Ohm-cm",sig*10^2,r)//answers not matching with
    book's ans.
```

**Scilab code Exa 10.6** electrical conductivity of boron doped semiconductor

```
// Example 10.6, page no-270
clear
clc
ni=2.1*10^19//m^-3
mue=0.4//m^2/V-s
muh=0.2
e=1.6*10^-19//C
p=4.5*10^23//m^-3
sig=ni*e*(mue+muh)
r=p*e*muh

printf("The conductivity of intrinsic Ge is %.3f
    *10^-2 /ohm-cm\nThe intrinsic resistivity is %.2f
     *10^4",sig,r*10^-4)
```

---

**Scilab code Exa 10.7** Hole concentration conductivity and Resistance

```
// Example 10.7, page no-271
clear
clc
n=5*10^28//m^-3
ni=1.45*10^13//m^-3
mue=1.35//m^2/V-s
muh=0.45
e=1.6*10^-19//C
p=4.5*10^23//m^-3
sig=ni*e*(mue+muh)
rho=1/sig
//rho=rho*10^12
```

```
r=rho*10^12
nd=n/10^9
p=(ni^2)/nd
sig2=nd*e*mue

printf("\nThe intrinsic conductivity is %.2f *10^-6
   /ohm-cm\n\nThe intrinsic resistivity is %.2f
   *10^-5Ohm-m\n\nResistance = %.2f*10^7 Ohm\n\
   nDonar concentration is %.0f*10^19\n\
   nConcentration of hole is %.1f*10^6 m^-3\n\
   nConductivity = %.1f per ohm-m",sig*10^6,rho
   *10^-5,r*10^-17,nd*10^-19,p*10^-6,sig2)
```

**Scilab code Exa 10.8** Band Gap of Ge

```
// Example 10.8, page no-272
clear
clc

T=300//K
rho=2.12//ohm-m
mue=0.36//m^2/V-s
muh=0.17
e=1.6*10^-19//C
m=9.1*10^-31//kg
h=6.626*10^-34
sig=1/rho
ni=sig/(e*(muh+mue))
printf("\nConductivity = %.6f per Ohm-m\nIntrinsic
   carrier concentration , ni=%.5f*10^18",sig,ni
   *10^-18)

k=1.38*10^-23
Nc=2*(2*%pi*k*T/h^(2))^(1.5)
Nc=Nc*(0.5*m)^(1.5)
```

```
Nv=2*(2*%pi*k*T/h^(2))^(1.5)
Nv=Nv*(0.37*m)^(1.5)
printf("\nNc=%.3f*10^24\nNv=%.3f*10^24",Nc*10^-24,Nv*10^-24)
eg=2*k*T*log(sqrt(Nc*Nv)/ni)
eg=eg/e
printf("\nThe band gap of Ge is %.3f eV",eg)
```

**Scilab code Exa 10.9** carrier concentration of intrinsic semiconductor

```
// Example 10.9, page no-273
clear
clc
e=1.6*10^-19//C
m=9.1*10^-31//kg
h=6.626*10^-34
k=1.38*10^-23
eg=0.7*e
T=300//K
ni=2*(2*%pi*m*k*T/(h^(2)))^(1.5)
ni=ni*%e^(-eg/(2*k*T))
printf("The carrier concentration of an intrinsic semiconductor is = %.2f*10^18 per m^3",ni*10^-18)
```

**Scilab code Exa 10.10** Electrical conductivity of Si

```
// Example 10.9, page no-273
clear
clc
e=1.6*10^-19//C
m=9.1*10^-31//kg
h=6.626*10^-34
k=1.38*10^-23
```

```
eg=1.1*e
mue=0.48//m^2/V.s
muh=0.013//m^2/V.s
T=300//K
ni=2*(2*%pi*m*k*T/(h^(2)))^(1.5)
ni=ni*%e^(-eg/(2*k*T))

sig=ni*e*(mue+muh)
printf("\nThe carrier concentration of an intrinsic
    semiconductor is = %.2f*10^16 per m^3\n the
    electrical conductiivity od Si is %.3f*10^-3 per
    Ohm-m",ni*10^-16,sig*10^3)
```

**Scilab code Exa 10.11** Fermi energy of Silicon

```
// Example 10.11, page no-275
clear
clc
e=1.6*10^-19//C
eg=1.12
me=0.12
mh=0.28
T=300
k=1.38*10^-23

ef=(eg/2)+(3*k*T/4)*log(mh/me)
printf("The Fermi energy of Si at 300 K is %.3f eV",
    ef)
```

**Scilab code Exa 10.12** effect of temperature on Fermi level

```
// Example 10.12, page no-275
clear
```

```
clc

e=1.60*10^-19//C
eg=1*e
k=1.38*10^-23
m=4
T=0.1*e*4/(3*k*log(m))
printf("Temperature at which Fermi level is shifted
    10%% is %.f K",T)
```

**Scilab code Exa 10.13** Conductivity of Ge

```
// Example 10.13, page no-276
clear
clc

e=1.6*10^-19//C
ni=2.4*10^19 //m^-3
mue=0.39//m^2/V-s
muh=0.19//m^2/V-s
sig=ni*e*(mue+muh)
printf("The conductivity of Ge at 300 K is %.2f per
    Ohm-m",sig)
```

**Scilab code Exa 10.14** Fermi Energy level

```
// Example 10.14, page no-277
clear
clc

e=1.6*10^-19//C
T1=300//K
T2=330//K
```

```
eg=0.3
eg2=eg*T2/T1
printf("E_c-E_f330=%.2f eV\n\nAt 330 K, the Fermi
   energy level lies %.2f eV, bellow the conduction
   band.",eg2,eg2)
```

**Scilab code Exa 10.15** Conductivity of Ge

```
// Example 10.15, page no-277
clear
clc
e=1.6*10^-19 //C
eg=0.72*e//eV
t1=293//K
t2=313//K
k=1.38*10^-23
sig1=2
n=(t2/t1)*%e^((eg/(2*k))*((1/t1)-(1/t2)))
sig2=sig1*n
printf("The conductivity of Ge at 40 C is %.3f per
   Ohm-m",sig2)
```

**Scilab code Exa 10.16** Intrinsic concentration of Si

```
// Example 10.16, page no-278
clear
clc
e=1.6*10^-19//C
m=9.1*10^-31//kg
mm=0.31*m//kg
h=6.626*10^-34
k=1.38*10^-23
eg=1.1*e
```

```
T=300//K
ni=2*(2*%pi*mm*k*T/(h^(2)))^(1.5)
ni=ni*%e^(-eg/(2*k*T))
printf("The intrinsic concentration of Si at %d K is
    %.4f * 10^15 electrons per m^3",T,ni*10^-15)
```

**Scilab code Exa 10.17** Drift Velocity

```
// Example 10.17, page no-279
clear
clc
hc=0.55*10^-10//m^3//A-s
cc=5.9*10^7//per Ohm-m
T=300//K
dm=hc*cc
printf("The drift mobility is given by mu_d = %.1f *
    10^-3 m^2/V-s",dm*10^3)
```

**Scilab code Exa 10.18** average no of electron per Cu atom

```
// Example 10.18, page no-279
clear
clc

sig=5.9*10^7//per Ohm-m
e=1.6*10^-19//C
mu=3.2*10^-3//m^2/V-s
d=8900//density
avg=6.022*10^23
ni=sig/(e*mu)
awt=63.5
n=avg*d*1000/awt
k=ni/n
```

```
printf("Concentration of free electron in pure Cu is
    %.2f*10^28\nThe average number of electrons
    contributed per Cu atom is %.2f i.e. %.0f",n
    *10^-28,k,k)
```

**Scilab code Exa 10.19** Mobility of Ge

```
// Example 10.19, page no-280
clear
clc
i=5*10^-3//A
v=1.35//v
l=0.01//m
b=5*10^-3
t=10^-3//m
a=5*10^-6//m^2
vy=20*10^-3
H=0.45//Wb/m^2

rho=v*a/(l*i)
Ey=vy/t
j=i/a
k=Ey/(H*j)
Rh=3*%pi*k/8
mu=Rh/rho
printf("The mobility of the Ge sample is %.2f m^2/V-
    s",mu)
```

**Scilab code Exa 10.20** Hall Potential Difference

```
// Example 10.20, page no-282
clear
clc
```

```
I=200//A
H=1.5//Wb/m^2
n=8.4*10^28//electronsper m^3
d=1.0*10^-3 //m
e=1.6*10^-19//C
v=I*H/(n*d*e)
printf("The Hall potential difference appearance
    between the ship is %.0f   v",v*10^6)
```

**Scilab code Exa 10.21** Mobility of Si

```
// Example 10.21, page no-283
clear
clc
rh=3.66*10^-4//m^3/C
rho=8.93*10^-3//Ohm-m
e=1.6*10^-19//C
ni=1/(rh*e)
muh=rh/rho
printf("the carrier concentration of Si doped
    specimen is %.3f *10^22 m^-3\n The mobility of Si
     doped specimen is %.5f m^2/V-s",ni*10^-22,muh)
```

**Scilab code Exa 10.22** Electron concentration and Mobility

```
// Example 10.22, page no-283
clear
clc
Rh=3.66*10^-11//m^2//A-s
sig=112*10^7//ohm-m
e=1.6*10^-19 //C
n=3*%pi/(8*Rh*e)
mu=sig/(n*e)
```

```
printf("\nThe concentration of electrons is %.0f
    *10^29 m^-3\nthe electron mobility at room
    temperature = %.3f m^2/V-s",n*10^-29,mu)
```

**Scilab code Exa 10.23** Hall voltage

```
// Example 10.23, page no-284
clear
clc
I=50//A
B=1.5//T
t=0.5*10^-2
e=1.6*10^-19//C
d=2*10^-2
N=8.4*10^28//m^-3
v=B*I/(N*e*d)
printf("The Hall voltage is %.2f *10^-7 V",v*10^7)
```

**Scilab code Exa 10.24** Relaxation time

```
// Example 10.24, page no-284
clear
clc
rho=1.54*10^-8//Ohm-m
ni=5.8*10^28//per m^3
m=9.1*10^-31//kg
e=1.6*10^-19//C
tau=m/(rho*ni*(e^2))
printf("The relaxation time of electrons in metal is
    %.2f*10^-14 s",tau*10^14)
```

**Scilab code Exa 10.25** Electron mobility in Silver

```
// Example 10.25, page no-285
clear
clc
sig=6.22*10^7//per ohm-m
n=5.9*10^28//m^3
e=1.6*10^-19//C
mu=sig/(n*e)
printf("The mobility of electrons in Si is %.2f
   *10^-3 m^2/V-s",mu*10^3)
```

---

**Scilab code Exa 10.26** Electron mobility and electric field

```
// Example 10.26, page no-285
clear
clc
rho=0.1//Ohm-m
ni=10^20//per m^3
vd=1//m/s
e=1.6*10^-19//C
mu=1/(rho*ni*e)
E=vd/mu
printf("\nThe mobility of the electrons in material
   is %.3f m^2/V-s\nThe electric field is %.1f V/m",
   mu,E)
```

---

**Scilab code Exa 10.27** Electron mobility

```
// Example 10.27, page no-286
clear
clc
sig=6.22*10^7//per Ohm-m
```

```
n=5.9*10^28
e=1.6*10^-19
mu=sig/(n*e)
printf("The mobility of electrons in silver is %.2f
    *10^-3 m^2/V-s",mu*10^3)
```

**Scilab code Exa 10.28** Electron mobility and electric field

```
// Example 10.28, page no-286
clear
clc
rho=0.1//Ohm-m
ni=10^20//per m^3
vd=1//m/s
e=1.6*10^-19//C
mu=1/(rho*ni*e)
E=vd/mu
printf("\nThe mobility of the electrons in material
    is %.3f m^2/V-s\nThe electric field is %.1f V/m",
    mu,E)
```

**Scilab code Exa 10.29** Electron mobility and conductivity

```
// Example 10.29, page no-287
clear
clc

avg=6.023*10^23
m=9.1*10^-31//kg
e=1.6*10^-19//C
d=8.92*10^3 //kg/m^3
rho=1.73*10^-8//Ohm-m
z=63.5
```

```
n=avg*d/z
sig=1/rho
tau=sig*m/(n*(e^2))
mu=sig/(e*n)
printf("\nThe relaxation time is %.2f *10^-11 s\nThe mobility of electrons in copper is %.2f m^2/V-s\nThe conductivity of coppper is %.2f * 10^7 per Ohm-m\n",tau*10^11,mu,sig*10^-7)
```

**Scilab code Exa 10.30** Drift Velocity

```
// Example 10.30, page no-288
clear
clc
rho=1.54*10^-8//ohm-m
E=100//V/m
ni=5.8*10^28//m^3
e=1.6*10^-19//C
mu=1/(rho*ni*e)
vd=mu*E
printf("The mobility of electrons in silver is %.4f *10^-3 m^2/V-s\nThe drift velocity id %.5f m/s",mu*10^3,vd)
```

**Scilab code Exa 10.31** Relaxation time

```
// Example 10.31, page no-288
clear
clc
rho=1.43*10^-8//Ohm-m
ni=6.5*10^28//per m^3
e=1.6*10^-19//C
```

```
m=9.1*10^-31//Kg
tau=m/(rho*ni*e^2)
printf("The relaxation time for electrons in the
    metal is %.2f *10^-14 s",tau*10^14)
```

**Scilab code Exa 10.32** Electron mobility in Al

```
// Example 10.32, page no-289
clear
clc

R=60
rho=2.7*10^-8//Ohm-m
i=15//A.
l=5//m
m=3
e=1.6*10^-19//C
d=2.7*10^3//kg/m^3
awt=26.98
avg=6.023*10^23
n=m*avg*1000*d/awt
printf("Free electron concentration is %.3f * 10^29"
    ,n*10^-29)
mu=1/(rho*n*e)
printf("\nThe mobility of electron in aluminium is %
    .4f*10^-3 m^2/v-s",mu*10^3)
vd=mu*i*R*10^-3/l
printf("\nThe drift velocity of the electron in Al
    is %.1f*10^-4 m/s",vd*10^4)
```

**Scilab code Exa 10.33** drift and thermal velocity

```
// Example 10.33, page no-290
```

```
clear
clc
R=0.02//Ohm-m
i=15//A
mu=4.3*10^-3//m^2/V-s
l=2//m
k=1.38*10^-23
m=9.1*10^-31//kg
T=300//K
v=i*R
E=v/l
vd=E*mu
vth=sqrt(3*k*T/m)
printf("\nThe thermal velocity of the free electrons
    in copper is %.3f mm/s\nThe drift velocity of
   electrons in copper is %.3f mm/s",vth*10^-5,vd
   *10^3)
```

# Chapter 11

# Mechanical Properties

**Scilab code Exa 11.1** Stress produced in an Al

```
// Example 11.1, page no-332
clear
clc

ld=2000//kg
g=9.8//m/s^2
r=0.005
force=ld*g
stress= force/(%pi*r^2)
printf("The stress produce in an aluminium alloy is
    %.1f MPa",stress*10^-6)
```

---

**Scilab code Exa 11.2** perentage elongation and reduction

```
// Example 11.2, page no-332
clear
clc
lf=53.75*10^-3
```

```
l0=50*10^-3
df=9.4*10^-3
d0=8.8*10^-3
pl=(lf-l0)*100/l0
pa=((%pi*df^2)-(%pi*d0^2))*100/(%pi*df^2)
printf("\nThe %% elongation is %.1f%% and \nthe %%
    reduction in area is %.3f%%",pl,pa)
```

**Scilab code Exa 11.3** Brinell Hardness Number

```
// Example 11.3, page no-332
clear
clc
ts=937//MPa
bhn=ts/3.45
printf("The Brinell Hardness Number is %.2f",bhn)
```

**Scilab code Exa 11.4** Tensile strength and fatigue limit of Steel plate

```
// Example 11.4, page no-333
clear
clc
p=3000
D=10
d=2.2
Hb=2*p/(%pi*D*(D-sqrt(D^2-d^2)))
printf("\nBrinell Hardness Number of steel Plate, Hb
    =%.1f\n",Hb)
ts=3.45*Hb
fl=0.5*ts
printf("\nThe Tensile strength of steel plate is %.3
    f MPa\n",ts)
```

```
printf("\nThe Fatigue limit of steel plate is %.4f
    MPa",fl)
```

# Chapter 12

# Thermal Properties

**Scilab code Exa 12.1** Change in length due to heating

```
// Example 12.1, page no-350
clear
clc

alfe=8.8*10^-6//per k
lo=0.1//m
delT=973//K
delL=alfe*lo*delT
printf("The change in length produced by heating is
   %.3f mm",delL*10^3)
```

---

**Scilab code Exa 12.2** Change in length due to heating

```
// Example 12.2, page no-350
clear
clc

alfe=5.3*10^-6//per k
```

```
lo=0.1//m
delT=973//K
delL=alfe*lo*delT
printf("The change in length produced by heating is
   %.3f mm",delL*10^3)
```

**Scilab code Exa 12.3** Steady state heat Transfer

```
// Example 12.3, page no-351
clear
clc
k=371//J/msk
delT=50//in degrees
delx=10*10^-3
ht=k*delT/delx
printf("The steady state heat transfer of 10 mm
   copper sheet is %.3f *10^6 J.m^-2.s^-1",ht*10^-6)
```

**Scilab code Exa 12.4** Compression Stress due to Heating

```
// Example 12.4, page no-351
clear
clc
alfe=8.8*10^-6//per K
t1=1300//K
t2=327//K
delT=t1-t2
E=370 //GPa
ep=alfe*delT
sig=ep*E
printf("\nThe unconstrained thermal expansion
   produced by the heating is %.4f *10^-3",ep*10^3)
```

```
printf("\nthe compression stress produced by heating
    is %.3f GPa",sig)
```

**Scilab code Exa 12.5** Heat flux transmitted

```
// Example 12.5, page no-352
clear
clc

K=120//W/m.K
t2=423
t1=323
delT=t2-t1
delx=7.5*10^-3//m
A=0.5//m^2
Q=K*A*(delT/delx)
hph=Q*3600
printf("The heat flux transmitted through a sheet
   per hour is %.2f *10^9 J.h^-1",hph*10^-9)
```

**Scilab code Exa 12.6** Youngs Modulus

```
// Example 12.6, page no-353
clear
clc

alfe=17*10^-6///per K
t2=293 //K
t1=233 //K
delT=t2-t1
st=119//MPa
k=alfe*delT
```

```
printf("\nThe strain produced in te rod is %.2f *
    10^-3",k*10^3)
E=(st*10^6)/k
printf("\nThe Youngs Modulus of the rod is %.1f GPa"
    ,E*10^-9)
```

**Scilab code Exa 12.7** temperature Change

```
// Example 12.7, page no-353
clear
clc

lo=11.6 //m
delx=5.4*10^-3//m
alfL=12*10^-6//per K
delT=delx/(lo*alfL)
printf("The maximum temperature cange can withstand
    without any thermal stress is %.2f K",delT)
```

**Scilab code Exa 12.8** compressive Sress

```
// Example 12.7, page no-354
clear
clc

lo=0.35//m
alfe=23.6*10^-6///per K
t2=358 //K
t1=288 //K
delT=t2-t1
ym=69//GPa
k=alfe*delT
```

```
printf("\nThe strain produced in te rod is %.3f *
    10^-3",k*10^3)
E=ym*k*10^9
printf("\nThe compressive stress produced in Al rod
    is %.3f GPa",E*10^-9)
```

**Scilab code Exa 12.9** limit to compression stress

```
// Example 12.9, page no-355
clear
clc
alfe=20*10^-6//per K
t1=293//K
sig=172///MPa
E=100 //GPa
delT=(sig*10^6)/(E*alfe*10^9)
printf("\nTf-Ti=%.0f",delT)
printf("\n\nthe maximum temperature at which the rod
     may be heated without\nexceeding a compresssive
    stress of %.0f MPa is %.0f K",sig,delT+t1)
```

**Scilab code Exa 12.10** Heat energy Requirement

```
// Example 12.10, page no-356
clear
clc
h_ir=444//J.kg^-1.K^-1
h_gr=711//J.kg^-1.K^-1
h_pl=1880//J.kg^-1.K^-1
t2=373//K
t1=300//K
delT=t2-t1
W=2 //Kg
```

```
//(a) For Iron
q=W*h_ir*delT

//(b)for Graphite
q1=W*h_gr*delT

//(b)for polypropylene
q2=W*h_pl*delT

printf("The heat energy required to raise
   temperature %.0f K from its temperature of \niron
   , graphite and polypropylene is %.0f,%.0f,%.0f J
   respectively",delT,q,q1,q2)
```

# Chapter 14

# Luminescence

**Scilab code Exa 14.1** Penetration depth of electron

```
// Example 14.1, page no-385
clear
clc
eb=10000//eV
k=1.2*10^-4
b=0.151
e=1.6*10^-19
rc=k*(eb*e)^b
printf("The penetration depth of the electron is %.4
   f  m",rc*10^6)
```

---

**Scilab code Exa 14.2** Luminescent lifetime

```
// Example 14.2, page no-386
clear
clc
ed=0.4//eV
e=1.6*10^-19//C
```

```
kT=0.025//eV
q=10^8
r=q*%e^(-(ed/kT))
printf("The escape rate per unit time = %2.1f per
   sec\n Therefore, the luminescent lifetime is
   nearly %.0f sec",r,r)
```

# Chapter 15

# Display Devices

**Scilab code Exa 15.1** wavelength of light

```
// Example 15.1, page no-406
clear
clc

e=1.6*10^-19//C
eg=1.8//eV
E=e*eg
h=6.626*10^-34
c=3*10^8//m/s
lam=h*c/E
printf("The wavelenth of light emitted from given
   LED is %.4f  m",lam*10^6)
```

**Scilab code Exa 15.2** Band Gap of GaAsP

```
// Example 15.2, page no-406
clear
clc
```

```

e=1.6*10^-19//C
h=6.626*10^-34
c=3*10^8//m/s
lam=6751*10^-10//m
E=h*c/lam
E=E/e
printf("The band gap of the given GaAsP is %.1f eV",
    E)
```

# Chapter 16

# Photoconductivity

**Scilab code Exa 16.1** Pairs generated per second

```
// Example 16.1, page no-416
clear
clc

lam=0.4*10^-6//m
A=4*10^-6//m^2
in=200//W/m^2
h=6.626*10^-34
c=3*10^8//m/s
N=in*A*lam/(h*c)
printf("The number of pairs generated per second is
   %.3f * 10^14",N*10^-14)
```

---

**Scilab code Exa 16.2** Wavelength of emitted radiation

```
// Example 16.2, page no-417
clear
clc
```

```
e=1.6*10^-19//C
eg=1.43 //eV
E=e*eg
h=6.626*10^-34
c=3*10^8//m/s
lam=h*c/E
printf("The wavelength of emitted radiation is %.2f
    m",lam*10^6)
```

# Chapter 18

# Dielectric Materials

**Scilab code Exa 18.1** Dilectric constant of KCl

```
// Example 18.1, page no-460
clear
clc
atom=4
kci=0.629*10^-9//m
alfk=1.264*10^-40//m^2
alfCl=3.408*10^-40//m^2
eps0=8.854*10^-12
pol=alfk+alfCl
N=atom/kci^3
epsr=(N*pol/eps0)+1
printf("\nThe electronic polarisability for KCL = %.3f *10^-40 F m^2\n",pol*10^40)
printf("\nThe no of Dipoles per m^3 = %.3f * 10^28 atoms m^-3\n",N/10^28)
printf("\nThe dielectric constant of KCL is %.3f",epsr)
```

---

**Scilab code Exa 18.2** Electronic polarisability of Se atom

```
// Example 18.2, page no-460
clear
clc
r=0.12*10^-9//m
eps=8.854*10^-12
alf=4*%pi*eps*r^3
printf("The electronic polarisability of an isolated
    Se is %.4f * 10^-40 F m^2",alf*10^40)
```

**Scilab code Exa 18.3** ratio between electronic and ionic polarability

```
// Example 18.3, page no-461
clear
clc

n=2.69
er=4.94
alfi_by_alfe=(((n+2)*(er-1))/((er+2)*(n-1)))-1
printf("The ratio of the electronic to ionic
    polariability is %.4f",1/alfi_by_alfe)
```

**Scilab code Exa 18.4** Dielectric constant of Ne gas

```
// Example 18.4, page no-462
clear
clc
N= 2.7*10^25//atoms m^-3
alfe=0.35*10^-40 //F m^2
eps=8.854*10^-12
epsr=(1+(2*N*alfe)/(3*eps))/(1-(N*alfe)/(3*eps))
printf("The dielectric constant of Ne gas is %.8f",
    epsr)
```

**Scilab code Exa 18.5** Charge on Capacitor

```
// Example 18.5, page no-462
clear
clc

eps=8.85*10^-12//F m^-1
epsr=6
A=5*10^-4//m^2
d=1.5*10^-3
v=100
Q=eps*epsr*A*v/d
printf("The charge on the capacitor is %.2f * 10^-9
   C",Q*10^9)
```

**Scilab code Exa 18.6** Dielectric constant of Ar gas

```
// Example 18.6, page no-463
clear
clc
N=2.7*10^25//m^-3
d=0.384*10^-9//m
eps=8.854*10^-12
alfe=4*%pi*eps*d^3
epsr=(1+(2*N*alfe)/(3*eps))/(1-(N*alfe)/(3*eps))
printf("The dielectric constant of Ar  is %.8f",epsr
   )
```

**Scilab code Exa 18.7** Energy stored in capacitor and polarising the capacitor

```
// Example 18.7, page no-464
clear
clc
c=2*10^-6//F
epsr=80
v=1000 //v
E1=(c*v^2)/2
c0=c/epsr
E2=(c0*v^2)/2
E=E1-E2
printf("\nThe Energy stored in capacitor =%.0f J",E1
   )
printf("\nThe energy stored in polarising the
   capacitor = %.4f J",E)
```

**Scilab code Exa 18.8** ratio of internal field to the applied field

```
// Example 18.8, page no-464
clear
clc
N=5*10^28 //m^-3
alfe=2*10^-40 //F m^2
eps=8.854*10^-12
P=N*alfe
E_ratio=1/(1-(P/(3*eps)))
printf("The ratio of the internal field to the
   applied field = %.4f",E_ratio)
```

**Scilab code Exa 18.9** Relative permittivity of NaCl

```
// Example 18.9, page no-465
clear
clc
```

```
E=1000//V.m^-1
P=4.3*10^-8 //C.m^-2
eps=8.854*10^-12 //F.m^-1
epsr=1+P/(eps*E)
printf("The relative permittivity of NaCl is %.2f",
   epsr)
```

**Scilab code Exa 18.10** Polarisability of Ar

```
// Example 18.10, page no-466
clear
clc

epsr=1.0024
N=2.7*10^25 //atoms.m^-3
eps=8.854*10^-12//F.m^-1
alfe=eps*(epsr-1)/N
printf("The polarisability of argon atom is %.1f *
   10^-40 F m^2",alfe*10^40)
```

**Scilab code Exa 18.11** Polarisability of He atom

```
// Example 18.11, page no-466
clear
clc

epsr=1.0000684
N=2.7*10^25 //atoms.m^-3
eps=8.854*10^-12//F.m^-1
alfe=eps*(epsr-1)/N
printf("The electronic polarisability of He atom at
   NTP is %.3f * 10^-41 F m^2",alfe*10^41)
```

**Scilab code Exa 18.12** Polarisability of Ar

```
// Example 18.12, page no-467
clear
clc
epsr=12
N=5*10^28 //atoms.m^-3
eps=8.854*10^-12//F.m^-1
alfe=eps*(epsr-1)/N
printf("The electronic polarisability of given
   element is %.3f * 10^-39 F m^2",alfe*10^39)
```

**Scilab code Exa 18.13** energy stored in dielectric

```
// Example 18.13, page no-467
clear
clc

c=2*10^-6//F
v=1000//V
epsr=100
E=(c*v^2)/2
c0=c/epsr
e2=(c0*v^2)/2
E1=E-e2
printf("The energy stored in dielectric is %.2f J",
   E1)
```

**Scilab code Exa 18.14** Electronic polarisability of Sulphur

```
// Example 18.14, page no-468
clear
clc
epsr=4.94
eps=8.854*10^-12
d=2.07*10^3//kg.m^-3
w=32.07
N=6.023*10^23*10^3*d/w
alfe=3*eps*(epsr-1)/(N*(epsr+2))
printf("The electronic polarisability of sulphur is
    %f * 10^-40 F.m^2",alfe*10^40)
```

**Scilab code Exa 18.15** energy stored in capacitor

```
// Example 18.15, page no-469
clear
clc
A=6.45*10^-4//m^2
d=2*10^-3//m
epsr=6
v=10//v
eps=8.85*10^-12//F/m
c=eps*epsr*A/d
printf("Capaccitance of Capacitor = %.3f pF",c
    *10^12)
q=c*v
E=v/d
p=eps*(epsr-1)*E
printf("\ncharge stored on the plate is %.3f *10^-11
     C",q*10^11)
printf("\nPolarisation produce in the plate is %.3f
    *10^-7 Cm^-2",p*10^7)
```

**Scilab code Exa 18.16** Polarisation produced in NaCl

```
// Example 18.16, page no-470
clear
clc
E=600*10^3 //V/m
eps=8.854*10^-12 //F/m
epsr=6
p=eps*(epsr-1)*E
printf("Polarisation produced in NaCl is %.3f *10^-5
    C.m^-2",p*10^5)
```

---

**Scilab code Exa 18.17** Relative permitivity of NaCl

```
// Example 18.17, page no-470
clear
clc
E=1000 //V/m
p=4.3*10^-8
eps=8.854*10^-12
epsr=1+p/(eps*E)
printf("Relative permitivity of NaCl is %.2f",epsr)
```

---

**Scilab code Exa 18.18** Electric field strength

```
// Example 18.18, page no-471
clear
clc
A=1000*10^-6 //m^2
d=5*10^-3
epsr=4
Q=3*10^-10
eps=8.854*10^-12
```

```
c=(eps*epsr*A)/d
v=Q/c
E=v/d
printf("The voltage across capacitor is %.2f V\nThe
    electric field strength is %.2f V/m",v,E)
```

**Scilab code Exa 18.19** Polarisability of He atom

```
// Example 18.19, page no-472
clear
clc
epsr=1.0000684
N=2.7*10^25//m^-3
eps=8.854*10^-12
alfe=eps*(epsr-1)/N
printf("The electronic polarisability of He atoms at
    NTP is %.3f *10^-41 F.m^2",alfe*10^41)
```

**Scilab code Exa 18.20** Electric field strength

```
// Example 18.20, page no-472
clear
clc
A=3*10^-3//m^2
d=1*10^-3 //m
epsr=3.5
Q=20*10^-9//C
eps=8.854*10^-12 //F.m^-1
c=eps*epsr*A/d
E=Q/(c*d)
printf("The capacitance of capacitor is %.2f pF\nThe
    electric field strength is %.2f*10^3 V/m",c
    *10^12,E*10^-3)
```

**Scilab code Exa 18.21** Dilectric Displacement

```
// Example 18.21, page no-473
clear
clc
A=7.54*10^-4 //m^2
d=2.45*10^-3 //m
epsr=6
v=10 //V
eps=8.854*10^-12//F/m
c=eps*epsr*A/d
printf("\nThe capacitance of the capacitor is %.3f
   pF",c*10^12)
Q=c*v
E=v/d
p=eps*(epsr-1)*E
D=eps*epsr*E
printf("\nCharge stored on capacitor = %.3f *10^-11
   C\nE=%.2f*10^3 V/m\nPolarisation=%.3f*10^-7 Cm
   ^-2\ndielectric displacement = %.3f*10^-7 cm",Q
   *10^11,E*10^-3,p*10^7,D*10^7)
```

**Scilab code Exa 18.22** Polarisation produced in NaCl

```
// Example 18.22, page no-475
clear
clc
E=500
epsr=6
eps=8.854*10^-12
p=eps*(epsr-1)*E
```

```
printf("The polarisation produced in NaCl is %.3f * 10^-8 C.m^-2",p*10^8)
```

**Scilab code Exa 18.23** Polarisation produced in NaCl

```
// Example 18.23, page no-475
clear
clc

E=500
epsr=15
eps=8.854*10^-12
p=eps*(epsr-1)*E
printf("The polarisation produced in NaCl is %.3f * 10^-8 C.m^-2",p*10^8)
```

**Scilab code Exa 18.24** Voltage across Capacitor

```
// Example 18.24, page no-475
clear
clc
A=650*10^-6 //mm^2
d=4 *10^-3//mm
epsr=3.5
eps=8.854*10^-12
q=2*10^-10//C
v=q*d/(eps*epsr*A)
printf("The voltage across capacitor is %.2f V",v)
```

**Scilab code Exa 18.25** Charge on Capacitor

```
// Example 18.25, page no-476
clear
clc
A=5*10^-4 //m^2
d=1.5*10^-3//m
epsr=6
v=100
eps=8.854*10^-12
q=eps*epsr*A*v/d
printf("The charge on the capacitor is %.2f *10^-9 C
    ",q*10^9)
```

**Scilab code Exa 18.26** Dilectric Constant

```
// Example 18.26, page no-476
clear
clc

d=2.08*10^3//kg-m^3
wt=32
ep=3.28*10^-40
eps=8.854*10^-15
k=(3*10^28*7*10^-40)/(3*eps)
epsr=2.5812/(1-0.7906)
printf("The dielectric constant of the given
    material is %.3f",epsr)
```

# Chapter 19

# Magnetic Materials

**Scilab code Exa 19.1** Relative permiability and magnetic force

```
// Example 19.1, page no-541
clear
clc
M=2300//A/m
B=0.00314// Wb/m^2
mu=4*%pi*10^-7
H=(B/mu)-M
mur=(M/H)+1
printf("The magnetic force H is %.4f A/m and the
   relative permeability mu_r is %.5f",H,mur)
```

---

**Scilab code Exa 19.2** magnetisation and flux density

```
// Example 19.2, page no-542
clear
clc
H=10^4 //A/m
sus=3.7*10^-3
```

```
mu=4*%pi*10^-7
M=sus*H
B=mu*(M+H)
printf("The magnetisation in the material is %.0f A/
    m and flux density in the material is %.2f *
    10^-2 Wb.m^-2",M,B*10^2)
```

**Scilab code Exa 19.3** Flux density

```
// Example 19.3, page no-542
clear
clc
H=10^4 //A/m
sus=-0.8*10^-5
mu=4*%pi*10^-7
M=sus*H
B=mu*(M+H)
printf("The flux density in the material is %.2f *
    10^-2 Wb.m^-2",B*10^2)
```

**Scilab code Exa 19.4** Permiability

```
// Example 19.4, page no-543
clear
clc

H=1800//A/m
fi=3*10^-5//Wb
A=0.2*10^-4//m^2

B=fi/A
mu=B/H
```

```
printf("\nThe magnetic flux is %.1f Wb/m^2\nThe
    permeability is %.3f*10^-4 H/m",B,mu*10^4)
```

**Scilab code Exa 19.5** Magnetic Moment

```
// Example 19.5, page no-544
clear
clc

B=0.65//Wb/m^2
r=8906//kg/m^3
M=58.7
avg=6.023*10^26
mu=4*%pi*10^-7
k=9.27*10^-24//A.m^2
N=r*avg/M
mu_m=B/(N*mu)
mu_m=mu_m/k

printf("The magnetic moment of nickel atom is %.2f
    Bohr magneton",mu_m)
```

**Scilab code Exa 19.6** Avrage magnetisation

```
// Example 19.6, page no-545
clear
clc
a=2.5*10^-10//m
M=1.8*10^6//A/m
e=1.6*10^-19//C
n=2/a^3
m=9.1*10^-31//kg
h=6.625*10^-34
```

```
ma=M/n
beta1=e*h/(4*%pi*m)
printf("The average magnetisation contributed per
    atom = %.3f Bohr Magneton",ma/beta1)
```

**Scilab code Exa 19.7** System Temperature

```
// Example 19.7, page no-545
clear
clc

mu=9.4*10^-24
H=2
k=1.38*10^-23
T=2*mu*H/(k*log(2))
printf("The temperature of the system T is %.1f K",T
    )
```

**Scilab code Exa 19.8** Saturation Magnetic field of Gd

```
// Example 19.8, page no-547
clear
clc
ba=7.1//Bohr Magnetron
aw=1.8*10^6 //A/m
d=7.8*10^3
avg=6.023*10^26
M=157.26
mu=4*%pi*10^-7
k=9.27*10^-24 //Bohr Magnetron
N=d*avg/M
mm=N*ba*k
B=N*mu*k*7.1
```

```
printf("\nThe saturation magnetic field of Gd atom
    is %f Wb/m^2",B)
```

**Scilab code Exa 19.9** Saturation Magnetisation

```
// Example 19.9, page no-547
clear
clc
bet=9.27*10^-24
V=0.839*10^-9
M=32*bet/V^3
printf("The saturation magnetisation is %.3f *10^5 A
    /m",M*10^-5)
```

**Scilab code Exa 19.10** Saturation Magnetisation and saturation flux density

```
// Example 19.10, page no-548
clear
clc

d=8900//kg/m^3
wt=58.71
avg=6.022*10^26
bet=9.27*10^-24
mu=4*%pi*10^-7
mm=0.6*bet
N=d*avg/wt
ms=mm*N
bs=mu*ms
printf("\nThe saturation magnetisation is %.3f *10^5
     A/m\nThe saturation flux density is %.3f Wb/m^2"
    ,ms*10^-5,bs)
```

**Scilab code Exa 19.11** Saturation Magnetisationof Gadolinium

```
// Example 19.11, page no-548
clear
clc
awt=157.25//atomic weight
an=64//atomic number
d=7860//density
k=9.27*10^-24
avg=6.023*10^26
N=d*8*k*avg/awt
printf("The saturation magnetisation of gadolinium
   is %.2f*10^6 A/m",N*10^-6)
```

**Scilab code Exa 19.12** Magnetic Flux density

```
// Example 19.12, page no-549
clear
clc
H=1000 //A/m
sus=-0.3*10^-5
mu=4*%pi*10^-7
M=sus*H
B=mu*(M+H)
printf("The magnetic flux density inside the
   material is %.3f T or Wb.m^-2",B*10^3)
```

# Chapter 20

# Super Conducting Materials

**Scilab code Exa 20.2** Critical Field

```
// Example 20.1, page no-568
clear
clc
h0=0.0306
t1=2.0
t2=3.7
he=h0*(1-((t1^2)/t2^2))
printf("The critical field at %d K is %.5f T",t1,he)
```

**Scilab code Exa 20.3** Critical field through a wire

```
// Example 20.3, page no-569
clear
clc

t1=4.2
t2=7.18
h0=6.5*10^4//A/m
```

```
he=h0*(1-((t1^2)/t2^2))
r=0.5*10^-3
I=2*%pi*he*r
printf("The critical current through a wire of lead
    is %.2f A",I)
```

**Scilab code Exa 20.4** Critical Temperature for metal

```
// Example 20.4, page no-570
clear
clc

tc1=4.185
m1=199.5
m2=203.4
tc2=tc1* sqrt(m1/m2)
printf("The critical temperature for metal with
    isotopic mass of %.1f is %.3f K",m2,tc2)
```

# Chapter 23

# Polymer Materials

**Scilab code Exa 23.1** Sulphur required for final rubber product

```
// Example 23.1, page no-625
clear
clc
p_wt=500 //kg
s_req=32/(32+54)
printf("Therefore, sulphur required for %d *10^3 kg
   of final  rubber product = %d * 10^-3 kg",p_wt,
   s_req*p_wt)
```

---

**Scilab code Exa 23.2** Photon energy to break C C bond

```
// Example 23.2, page no-625
clear
clc
E=370*10^3//energy of c-c bond j/mol\
lam=3200*10^-10 //m
h=6.626*10^-34
c=3*10^8//m/s
```

```
E1=h*c/lam
Ec=E/(6.02*10^23)
printf("\nE=%.2f*10^-19 J",E1*10^19)
printf("\nThe Energy of c-c Bond = %.1f * 10^-19",Ec
    *10^19)
printf("\n\nThe UV light photon energy is sufficient
     to break a C-C bond.\nTherefore, the polymer
    deteriorates under the influence of UV light")
```