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

Created by
Laxman Ghanasham Sole
B.Tech
Electronics Engineering
Vishwakarma Institute of Technology, Pune
College Teacher
Prof. Vijay Mane
Cross-Checked by
Lavitha Pereira

July 31, 2019

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

Book Description

Title: Material Science

Author: V. Rajendran

Publisher: Tata Mcgraw Hill, New Delhi

Edition: 1

Year: 2012

ISBN: 0-07-132897-1

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

Contents

List of Scilab Codes

List of Figures

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 %.1
    f*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() ;
```

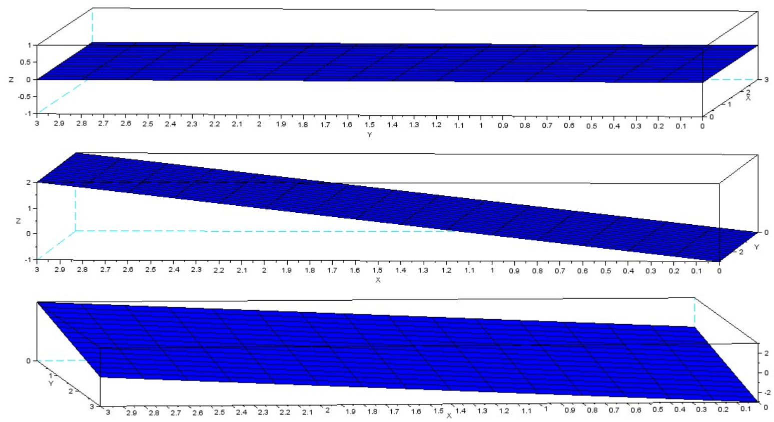

Figure 2.1: Plane Drawing

```
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`

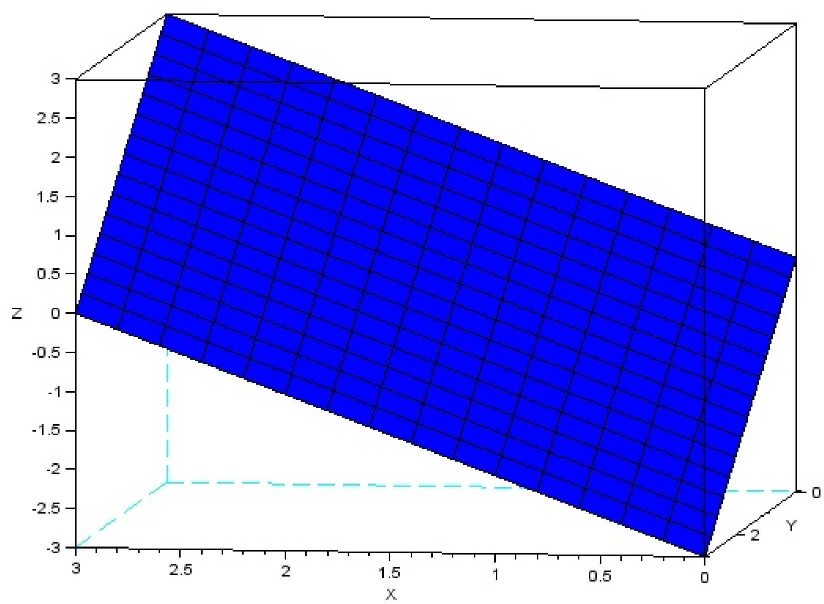

Figure 2.2: Plane Drawing

```
// 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")
```