Scilab Textbook Companion for Engineering Physics by A. Marikani[1]

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May 25, 2016

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

Book Description

Title: Engineering Physics

Author: A. Marikani

Publisher: Phi Learning

Edition: 1

Year: 2009

ISBN: 978-81-203-3939-2

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

Contents

List of Scilab Codes

Chapter 1

Ultrasonics

Scilab code Exa 1.1 Fundamental frequency of vibration

```


// Example No.1.1.
// Page No.28.
clc;clear;
t = 0.15*10^(-2);//Thickness of the quartz crystal
    -[m].
Y = 7.9* 10^(10);//Young's modulus of quartz -[N/m
    ^2].
d = 2650;//Density of quartz -[kg/m^3].
f = (1/(2*t))*(sqrt(Y/d));//'f' is fndamental
    frequency of vibration.
f = f*10^(-6);//fundamental frequency of vibration.
printf("\nThe fundamental frequency of vibration of
    the crystal is %.4f MHz",f);
```

Scilab code Exa 1.2 Fundamental frequency and first overtone

```
// Example No.1.2.
// Page No. 28.
clc;clear;
t = 1*10^(-3);//Thickness of the quartz crystal -[m
    ].
Y = 7.9* 10^(10);//Young's modulus of quartz -[N/m
    ^2].
d = 2650;//Density of quartz -[kg/m^3].
p = 1;
f1 = (p/(2*t))*(sqroot(Y/d));//For fundamental
    frequency  p=1.
printf("\nThe fundamental frequency of vibration of
    the crystal is %3.3e Hz",f1);
p = 2;
f2 = (p/(2*t))*(sqroot(Y/d));// f2 is frequency of
    first overtone and for the first overtone P=2.
printf("\nThe frequency of the first overtone of the
     crystal is %3.3e Hz",f2);
```

Scilab code Exa 1.3 Velocity of ultrasonic wave

```
// Example No.1.3.
// Page No.29.
clc;clear;
w = 5.893*10^(-7);//Wavelength of the light -[m].
f = 1*10^(8);//Frequency of the ultrasonic
    transducer -[Hz].
n = 1;//Order of diffraction.
d = 7.505*10^(-6);
w = 2*d;//wavelength of the ultrasonic wave.
printf("\nThe wavelength of the ultrasonic wave is
```

```
%3.3e m",w);
v = f*w;//Velocity of the ultrasonic wave.
printf("\nThe velocity of ultrasonic wave is %.f m/s
",v);
```

Scilab code Exa 1.4 Doppler shifted frequency

```

// Example No.1.4.
// Page No.29.
clc;clear;
f = 2*10^(6);//frequency of transducer -[Hz].
cosq = cosd(30);//Angle of inclination of the probe
-[degree].
c = 800;//Velocity of ultrasonic wave -[m/s].
v = 3;//Speed of blood -[m/s].
delf = ((2*f*v*cosq)/c);//Doppler shifted frequency.
printf("\nThe Doppler shifted frequency is %3.3e Hz"
,delf);
```

Scilab code Exa 1.5 Velocity of ultrasonic waves

```

// Example No.1.5.
// Page No.30.
clc;clear;
Y = 7.9*10^(10);//Young's modulus of quartz -[N/m
^2].
d = 2650;//Density of quartz -[kg/m^3].
v = sqroot(Y/d);//Velocity of ultrasonic wave.
printf("\nThe velocity of the ultrasonic waves is %
.2f m/s",v);
```

Chapter 2

Laser

Scilab code Exa 2.1 number of photons emitted per second

```

//Example No.2.1.
// Page No.59.
clc;clear;
p = 5*10^(-3);// output power —[W].
w = 632.8*10^(-9);//wavelength —[m].
h = 6.626*10^(-34);//Planck's constant.
c = (3*10^(8));//Velocity of light.
hv = ((h*c)/(w));// Energy of one photon
printf("\nThe energy of one photon in joules is %3.3
    e J", hv);
hv = hv/(1.6*10^(-19));
printf("\nThe energy of one photon in eV is %.2f eV"
    ,hv);
Np = (p/(3.14*10^(-19)));//Number of photons emitted
printf("\nThe number of photons emitted per second
    by He—Ne laser are %3.3e photons per second",Np);
```

Scilab code Exa 2.2 Energy of the photon

```

//Example No.2.2.
// Page No.60.
clc;clear;
w = 632.8*10^(-9);//wavelength -[m].
h = 6.626*10^(-34);//Planck's constant.
c = (3*10^(8));//Velocity of light.
E = ((h*c)/(w));// Energy of one photon
printf("\nThe energy of emitted photon in joules is
   %3.3e J",E);
E = E/(1.6*10^(-19));
printf("\nThe energy of emitted photon in eV is %.2f
    eV",E);
```

Scilab code Exa 2.3 Energy of E3

```

//Example No.2.3.
// Page No.60.
clc;clear;
w = 1.15*10^(-6);//wavelength -[m].
h = 6.626*10^(-34);
c = (3*10^(8));
hv = ((h*c)/(w));// Energy of one photon
printf("\n The energy of emitted photon is  %3.3e J"
   ,hv);
E = ((hv)/(1.6*10^(-19)));
printf("\n The energy of emitted photon is  %.3f eV"
   ,E);
E1 = 0,'eV';//Value of first energy level.
E2 = 1.4,'eV';//Value of second energy level.
E3 = (E2+E);//Energy value of 'E3'.
E3 = ((1.4)+E);
printf("\n The value of E3 energy level is %.3f eV",
   E3);
```

Scilab code Exa 2.4 wavelength of the photon

```

//Example No.2.4;
//Page No.60;
clc;clear;
E1 = 3.2;//Value of higher energy level E1 -[eV].
E2 = 1.6;//Value of lower energy level E2 -[eV].
E = (E1-E2);//Energy difference.
printf("\nThe energy difference is %.1f eV", E);
h = 6.626*10^(-34);//Planck's constant
c = 3*10^(8);//Velocity of light.
E = 1.6*1.6*10^(-19);
w = ((h*c)/(E));
printf("\nThe wavelength of the photon is %3.3e m",
    w);
```

Scilab code Exa 2.5 wavelength of the laser

```

//Example No.2.5.
// Page No.60.
clc;clear;
E = 1.42;//Bandgap of Ga-As -[eV]
h = 6.626*10^(-34);//Planck's constant.
c = 3*10^(8);//Velocity of light.
w = ((h*c)/(E*1.6*10^(-19)));
printf("\nThe wavelength of the laser emitted by
    GaAs is %3.3e m",w);
```

Scilab code Exa 2.6 Relative population between

```

//Example No.2.6.
// Page No.61.
clc;clear;
T = 300;//Temperature -[K]
K = 1.38*10^(-23);//Boltzman's constant.
w = 500*10^(-9);//wavelength -[m].
h = 6.626*10^(-34);//Planck's constant.
c = (3*10^(8));//velocity of light.
//By Maxwell's and Boltzman's law.
N = exp((h*c)/(w*K*T)); //Relative population.
printf("\nThe relative population between energy
    levels N1 and N2 is %3.3e",N);//(Relative
    population between N1 & N2).
```

Scilab code Exa 2.7 Ratio between stimulated and spontaneous emission

```

//Example No.2.7.
// Page No.61.
clc;clear;
T = 300;//Temperature -[K]
K = 1.38*10^(-23);//Boltzman's constant
w = 600*10^(-9);//wavelength -[m]
h = 6.626*10^(-34);
v = (3*10^(8));//velocity.
S = (1/((exp((h*v)/(w*K*T))-1));//Se=stimulated
    emission & SPe= spontaneous emission
printf("\nThe ratio between stimulated emission and
    spontaneous emission is %3.3e.\nTherefore, the
    stimulated emission is not possible in this
    condition.",S);
```

Scilab code Exa 2.8 Efficiency of laser

```

//Example No.2.8.
// Page No.62.
clc;clear;
Op = 5*10^(-3);//Output power -[W].
I = 10*10^(-3);//Current -[A].
V = 3*10^(3);//Voltage -[V].
Ip = (10*10^(-3)*3*10^(3));//Input power.
Eff = (((Op)/(Ip))*(100));//Efficiency of the laser.
printf("\nThe efficiency of the laser is %.6f
    percent",Eff);
```

Scilab code Exa 2.9 Intensity of the laser

```

//Example No.2.9.
// Page No.62.
clc;clear;
P = 1*10^(-3);//Output power -[W].
D = 1*10^(-6);//Diameter -[m].
r = 0.5*10^(-6);//Radius -[m]
I = (P/(%pi*r^(2)));// Intensity of laser.
printf("\nThe intensity of the laser is %3.3e W/m^2"
    ,I);
```

Scilab code Exa 2.10 angular spread and divergence

```
//Example No.2.10.
// Page No.62.
clc;clear;
w = 632.8*10^(-9);//wavelength -[m]
D = 5;//Distance -[m].
d = 1*10^(-3);//Diameter -[m].
deltheta = (w/d);//Angular Spread.
printf("\nThe angular spread is %3.3e radian",deltheta);
r = (D*(deltheta));
r = (5*(deltheta));//Radius of the spread
printf("\nThe radius of the spread is %3.3e m",r);//Radius of the spread.
As = ((%pi)*r^(2));//Area of the spread
printf("\nThe area of the spread is %3.3e m^2",As);//Area of the spread.
```

Chapter 3

Fibre optics

Scilab code Exa 3.1 Numerical aperture of the fibre

```

//Example No. 3.1.
//Page No.98.
//To find numerical aperture.
clc;clear;
n1 = 1.6;//Refractive index of core.
n2 = 1.5;// Refractive index of cladding.
NA = sqroot((n1^(2))-(n2^(2)));//Numerical Aperture.
printf("\nThe numerical aperture of the fibre is %.4
   f",NA);
```

Scilab code Exa 3.2 Numerical aperture and acceptance angle

```

//Example No.3.2.
// Page No.98.
//To calculate numerical aperture and acceptance
   angle.
```

```
clc;clear;
n1 = 1.54;//Refractive index of core.
n2 = 1.5;// Refractive index of cladding.
no = 1;
NA = sqroot((n1^(2))-(n2^(2)));//Numerical Aperture.
printf("\nThe numerical aperture of the fibre is %.4f",NA);
t = asind(NA/no);// Acceptance angle.
printf("\nThe acceptance angle of the fibre is %.4f degree",t);
```

Scilab code Exa 3.3 critical angle

```
//Example No.3.3.
//Page No. 99.
//To find critical angle.
clc;clear;
n1 = 1.6;//Refractive index of core.
n2 = 1.49;// Refractive index of cladding.
Qc = asind((n2)/(n1));//Critical angle.
printf("\nThe critical angle of the fibre is %.2f degree",Qc);
```

Scilab code Exa 3.4 Refractive index and acceptance angle

```
//Example No.3.4.
//Page No. 99.
//To find refractive index of core and acceptance angle.
```

```
clc;clear;
NA = 0.15;//Numerical aperture.
n2 = 1.55;//Refractive index of cladding.
n0 = 1.33;//Refractive index of water.
n1 = sqroot((NA^(2))+(n2^(2)));// Refractive index
    of core.
printf("\nThe refractive index of the core is %.4f",
    n1);
t = asind(NA/n0);// Acceptance angle.
mprintf("\nThe acceptance angle of the fibre is %.3f
    degree",t);
```

Scilab code Exa 3.5 Refractive index of the core

```


//Example No.3.5.
//Page No. 100.
//To find refractive index of cladding.
clc;clear;
d = 100;//Core diameter.
NA = 0.26;//Numerical aperture.
n1 = 1.5;//Refractive index of core.
n2 = sqroot((n1^(2))-(NA^(2)));// Refractive index
    of cladding.
printf("\nThe refractive index of the cladding is %
    .3f",n2);
```

Scilab code Exa 3.6 Refractive indices of core and cladding

```


//Example No.3.6.
```

```
// Page No.100.
//To find refractive idex.
clc;clear;
NA = 0.26;//Numerical aperture.
del = 0.015;//Refractive index difference of the
    fibre.
n1 = sqroot((((NA)^(2))/(2*del)));//Refractive index
     of the core
printf("\nThe refractive index of the core is %.2f",
    n1);
n2 = sqroot((n1^(2))-(NA^(2)));// Refractive index
    of cladding.
printf("\nThe refractive index of cladding is %.3f",
    n2);
```

Chapter 4

Quantum physics

Scilab code Exa 4.1 change in wavelength

```


//Example No 133.
//Page No 4.1.
//To find change in wavelength.
clc;clear;
h = 6.63*10^(-34);//Planck's constant -[J-s].
m0 = 9.1*10^(-31);//mass of electron -[kg].
c = 3*10^(8);//Velocity of ligth -[m/s].
cosq = cosd(135);//Angle of scattering -[degree].
delW = (h/(m0*c))*(1-cosq);//change in wavelength.
printf("\nThe change in wavelength is %3.3e m",delW)
    ;
```

Scilab code Exa 4.2 comptom shift and w and energy

```


```

```
//Example No.4.2.
//Page No.134.
clc;clear;
h = 6.626*10^(-34);//Planck's constant.
m0 = 9.1*10^(-31);//mass of electron.
c = 3*10^(8);//Velocity of ligth.
cosq = cosd(90);//Scattering angle -[degree].
delW = (h/(m0*c))*(1-cosq);//Compton's shift
delW = delW*10^(10);
printf("\na)The Comptons  shift is  %.5f A",delW);
w = 2;//Wavelength -[A]
W = (delW+w);// Wavelength of the scattered photon.
printf("\nb)The wavelength of the scattered photon
    is % 5f A",W);
E = (h*c)*((1/(w*10^(-10)))-(1/(W*10^(-10))));//
    Energy of the recoiling electron in joules.
printf("\nc)The energy of the recoiling electron in
    joules is %3.3e J",E);
E = (E/(1.6*10^(-19)));//Energy of the recoiling
    electron in eV.
printf("\nc)The energy of the recoiling electron in
    eV is %3.3e eV",E);
sinq = sind(90);
Q = (((h*c)/w)*sinq)/(((h*c)/w)-((h*c)/W)*cosq);
theta = atand(Q);
printf("\ne)The angle at which the recoiling
    electron appears is %.0f degree",theta);
```

Scilab code Exa 4.3 comptom shift and wavelength

```


//Example No.4.3.
//Page NO.135.
clc;clear;
```

```
h = 6.626*10^(-34);//Planck's constant.
mo = 9.1*10^(-31);//mass of electron.
c = 3*10^(8);//Velocity of ligth.
w = (1*1.6*10^(-19)*10^(6));//wavelength.
cosq = cosd(60);
delw = ((h/(mo*c))*(1-cosq));//Compton shift
delw = delw*10^(10);
printf("\n1)The Comptons shift = %.3f A",delw);
E = ((h*c)/w);//energy of the incident photon.
W = (delw+E);//Wavelength of the scattered photon.
W = (0.012)+(1.242);
printf("\n3)The wavelength of the scattered photon = %.3f A",W);
```

Scilab code Exa 4.4 Number of photons emitted

```


//Example No 135.
//Page No 4.4.
//To find number of photons.
clc;clear;
h = 6.63*10^(-34);//Planck's constant.
c = 3*10^(8);//Velocity of ligth.
w = 5893*10^(-10);//wavelength.
Op = 60;//output power -[W].
E  =((h*c)/w);
printf("\nEnergy of photon in joules is %3.3e J",E);//Energy of photon in joules.
hv = (E/(1.6*10^(-19)));//Energy of photon in eV.
printf("\nEnergy of photon in eV is %.3f eV",hv);
Ps = ((Op)/(E));
Ps = ((60)/(E));// Number of photons emitted per second.
printf("\nThe number of photons emitted per second
```

```
    is %3.3e photons per second",Ps);
```

Scilab code Exa 4.5 Mass and energy

```


//Example No 136.
//Page No 4.5.
//To find mass,momentum & energy of photon.
clc;clear;
h = 6.63*10^(-34);//Planck's constant.
c = 3*10^(8);//Velocity of ligth.
w = 10*10^(-10);//wavelength.
E = ((h*c)/w);//Energy.
printf("\n1)The energy of photon in joules is %3.3e
    J",E);
E = E/(1.6*10^(-19)*10^(3));
printf("\n2)The energy of photon in eV is %.3f Kev",
    E);
p = (h/w);//Momentum.
p = ((6.63*10^(-34))/(10*10^(-10)));
printf("\n3)The momentum of the photon is %3.3e kg.m
    /s",p)
m = (h/(w*c));
printf("\n4)The mass of the photon is %3.3e kg",m);
```

Scilab code Exa 4.6 DeBroglie wavelength

```


//Example No 136.
//Page No 4.6.
//To find de-Broglie wavelength.
```

```
clc;clear;
V=1.25*10^(3);//Potential difference applied -[V].
w=((12.27)/sqroot(V));//de-Broglie wavelength of electron.
printf("\nThe de-Broglie wavelength of electron is %.3f A",w);
```

Scilab code Exa 4.7 wavelength

```


//Example No.136 .
//Page No. 4.7.
//To find de-Broglie wavelength.
clc;clear;
E = 45*1.6*10^(-19);//Energy of the electron.
h = 6.63*10^(-34);//Planck's constant
m = 9.1*10^(-31);//Mass of the electron.
w = h/(sqrt(2*m*E));//de-Broglie wavelength.
printf("\nThe de-Broglie wavelength of the photon is %3.3e m",w);
```

Scilab code Exa 4.8 De Broglie wavelength

```


//Example No.4.8.
//Page No.137.
//To find de-Broglie wavelength.
clc;clear;
h=6.626*10^(-34);//Planck's constant.
v=10^(7);//Velocity of the electron -[m/s].
m=9.1*10^(-31);//Mass of the electron.
```

```
w=(h/(m*v));//de-Broglie wavelength
printf("\nThe de-Broglie wavelength is %3.3e m",w);
```

Scilab code Exa 4.9 Wavelength of alpha practical

```


//Example No 137.
//Page No 4.9.
//The de-Broglie wavelength of alpha particle.
clc;clear;
V = 1000;//Potential difference applied -[V].
h = (6.626*10^(-34));//Planck's constant -[J-s].
m = (1.67*10^(-27));//Mass of a proton -[kg].
e = (1.6*10^(-19));//charge of electron -[J].
w = h/sqrt(2*m*e*V);//de-Broglie wavelength
printf("\nThe de-Broglie wavelength of alpha
    particle = %3.3e m",w);
```

Scilab code Exa 4.10 Probability of finding the practicle

```


//Example No.4.10
// Page No.138.
//To find the probability.
clc;clear;
L = 25*10^(-10);//Width of the potential well -[m].
delx = 0.05*10^(-10);//Interval -[m].
x = int(1);
P = (((2*delx)/L)*x);//'P' is the probability of
    finding the practicle at an interval of 0.05 .
```

```
printf("\nThe probability of finding the particle is
    %.3f",P);
```

Scilab code Exa 4.11 Lowest energy of the electron

```

//Example No.4.11.
//Page No.138.
clc;clear;
n = 1;//For the lowest energy value n=1.
h = 6.626*10^(-34);//Planck's constant.
L = 1*10^(-10);//Width of the potential well -[m].
m = 9.1*10^(-31);//Mass of the electron.
E = ((n^(2)*h^(2))/(8*m*L^(2)));
E = ((h^(2))/(8*m*L^(2)));// For the lowest energy
    value n=1.
printf("\nThe lowest energy of the electron in
    joules is %3.3e J",E);;// Lowest energy of the
    electron in joules.
E = (E/(1.6*10^(-19)));
printf("\nThe lowest energy of the electron in eV is
    %.2f eV",E);// Lowest energy of the electron in
    eV.
```

Scilab code Exa 4.12 Lowest energy of the electron

```


//Example No.4.12.
//Page No.139.
//To find lowest energy of the electron.
clc;clear;
n = 1;//For the lowest energy value n=1.
```

```
h = 6.626*10^(-34);//Planck's constant.
L = 1*10^(-10);//Width of the potential well -[m].
m = 9.1*10^(-31);//Mass of the electron.
E = (2*(n^(2)*h^(2))/(8*m*L^(2)));
//'E' is the Lowest energy of the system.
printf("\nThe lowest energy of the system in joules
    is %3.3e J",E);
E = (E/(1.6*10^(-19)));
printf("\nThe lowest energy of the system in eV is %
    .2f eV",E);// Lowest energy of the electron in eV
    .
```

Scilab code Exa 4.13 Lowest energy of the system

```


//Example No.4.13.
//Page No.139.
clc;clear;
h = 6.626*10^(-34);//Planck's constant.
L = 1*10^(-10);//Width of the potential well -[m].
m = 9.1*10^(-31);//Mass of the electron.
E = ((6*h^(2))/(8*m*L^(2)));
printf("\n 1) The lowest energy of the system in
    joules is %3.3e eV",E);
E = (E/(1.6*10^(-19)));
printf("\n 2) The lowest energy of the system is %
    .2f eV",E);
disp('3) Quantum numbers are,');
n = 1;
l = 0;
ml = 0;
ms = 0.5;
ms1 = -0.5;
printf("\ni)n = %.0f",n);
```

```
printf("   , l = %.0f",l);
printf("   , ml = %.0f",ml);
printf("   , ms = %.1f",ms);
printf("\nii)n = %.0f",n);
printf("   , l = %.0f",l);
printf("   , ml = %.0f",ml);
printf("   , ms1 = %.1f",ms1);
n=2;
printf("\niii)n = %.0f",n);
printf("   , l = %.0f",l);
printf("   , ml = %.0f",ml);
printf("   , ms = %.1f",ms);
```

Scilab code Exa 4.14 mass of the alpha practical

```


//Example No.4.14.
//Page No.140.
//The mass of the particle.
clc;clear;
E = 0.025*1.6*10^(-19);//Lowest energy.
h = 6.626*10^(-34);//Planck's constant.
L = 100*10^(-10);//Width of the well -[m].
m = ((h^(2))/(8*E*L^(2)));
printf("\nThe mass of the particle is %3.3e kg",m);
```

Scilab code Exa 4.15 Energy density

```


//Example No.4.15.
//Page No.141.
```

```
//To find energy density.
clc;clear;
T = 6000;//Temperature -[K].
k = 1.38*10^(-23);//Boltzman's constant.
w1 = 450*10^(-9);//wavelength -[m].
w2 = 460*10^(-9);//wavelength -[m].
c = 3*10^(8);//Velcity of light.
v1=(c/w1);
printf("\nThe velocity for wavelength 450 nm is %3.3
    e Hz",v1);
v2 = (c/w2);
printf("\nThe velocity for wavelength 460 nm is %3.3
    e Hz",v2);
v = ((v1+v2)/2);
printf("\nThe average value of v is %3.3e Hz",v);
h = 6.626*10^(-34);//Planck's constant.
d = (8*%pi*h*v^(3))/(c^(3));
dv = d*(1/(exp((h*v)/(k*T))-1));//Energy density.
printf("\nThe energy density of the black body is %3
    .3e J/m^3",dv);
```

Chapter 6

Crystallography

Scilab code Exa 6.1 Density of diamond

```
//Example No.6.1
//Page No.185.
clc;clear;
Mc = 12;// Mc is the mass of one carbon atom.
r = 0.071*10^(-9);//radius -[m].
D = ((8*Mc)/(6.022*10^(26)*((8*r)/(sqrt(3)))^(3)));
    //density of the diamond.
printf("\nThe density of diamond is %.1f kg/m^3",D);
```

Scilab code Exa 6.2 percentage volume

```
//Example No.6.2.
//Page No.185.
clc;clear;
a1 = 0.332*10^(-9);//Lattice parameter for BCC
    structure -[m].
```

```
a2 = 0.296*10^(-9);//Lattice parameter for HCP structure -[m].
c = 0.468*10^(-9);// -[m]
disp('BCCv is the volume of BCC unit cell');
BCCv = a1^(3);//Volume of BCC unit cell.
printf("\nThe volume of BCC unit cell is %3.3e m^-3",BCCv);
disp('HCPv is the volume of HCP unit cell');
HCPv = (6*(sqrt(3)/4)*a2^(2)*c);//Volume of HCP unit cell.
printf("\nThe volume of HCP unit cell is %3.3e m^3",HCPv);
Cv = (HCPv-BCCv);
printf("\nThe change in volume is %3.3e",Cv);
Vp = (Cv/BCCv)*100;
printf("\nThe volume change in percentage is %.1f percent",Vp);
```

Scilab code Exa 6.3 Atomic structure and density

```

//Example No.6.3
//Page No.186.
clc;clear;
r = 1.278*10^(-10);//Atomic radius of copper -[m].
A = 63.54;//Atomic weight of copper.
n = 4;
Na = 6.022*10^(26);
a = (2*sqrt(2)*r);
printf("\nThe lattice constant for FCC is %3.3e",a);
d = ((n*A)/(Na*a^(3)));//for FCCn=4.
d = ((n*A)/(Na*(3.61*10^(-10))^(3)));
printf("\nThe density of copper is %.0f kg/m^3",d);
```

Scilab code Exa 6.4 Interatomic distance of NACL

```
//Example No.6.4.
//Page No.186.
clc;clear;
Na = 23;//Atomic weight of Na
Cl = 35.5;//Atomic weight of Cl
d = 2180;//Density of Nacl -[kg/m^3].
nA = 6.022*10^(26);
NaCl = (Na+Cl)//Molecular weight of NaCl.
printf("\n1) Molecular weigth of NaCl is %.1f",NaCl)
    ;
n = 4;
A = 58.5;
a = (((n*A)/(nA*d))^(1/3));
printf("\n2) The interatomic distance of NaCl
    crystal is %3.3e m",a);
```

Scilab code Exa 6.5 Relation between interatomic and interplanar

```
//Example No.6.5.
//Page No.187.
clc;clear;
a = 0.42;//Lattice constant -[nm].
//(h1,k1,l1) are the miller indices of the plane
    (101).
h1 = 1;
k1 = 0;
l1 = 1;
```

```
d1 = (a/sqrt(h1^(2)+k1^(2)+l1^(2)));//interplanar and interatomic distance of plane (101)
printf("\nFor (101) plane, the interplanar and interatomic distance is %.4f nm",d1);
// (h2,k2,l2) are the miller indices of the plane (221).
h2 = 2;
k2 = 2;
l2 = 1;
d2 = (a/sqrt(h2^(2)+k2^(2)+l2^(2)));//interplanar and interatomic distance of plane (221)
printf("\nFor (221) plane, the interplanar and interatomic distance is %.2f nm",d2);
```

Scilab code Exa 6.6 Axial intercepts

```

// Example No.6.6.
// Page No.187.
clc;clear;
disp('For the plane (102),the intercepts are (a/1) = a,(b/0) = infinity ,c/2');
disp('For the plane (231),the intercepts are a/2 , b/3 and (c/1) = c');
disp('For the plane (312),the intercepts are a/3 ,(b/-1) = -b ,c/2');

//As there are no numerical steps available and hence the display statement has been typed directly.
```

Scilab code Exa 6.7 Angle between the planes

```
//Example No.6.7
//Page No.188.
//Find the angle between two planes (111) and (212)
    in a cubic lattice.
clc;clear;
// (u1,v1,w1) are the miller indices of the plane
    (111).
u1 = 1;
v1 = 1;
w1 = 1;
// (u2,v2,w2) are the miller indices of the plane
    (212).
u2 = 2;
v2 = 1;
w2 = 2;
u = acosd(((u1*u2)+(v1*v2)+(w1*w2))/((sqrt((u1^2)+(
    v1^2)+(w1^2))*sqrt((u2^2)+(v2^2)+(w2^2)))));//u
    is the angle between two planes.
printf("\n The angle between the planes (111) and
    (212) is %.3f degree",u);
```

Scilab code Exa 6.8 Crystallographic planes

```
// Example No.6.8.
// Page No.188.
clc;clear;
disp('The intercepts of the plane(100) are a ,
    infinity ,infinity.');
disp('The intercepts of the cubic plane(110) are a ,
    a ,infinity.');
disp('The intercepts of the plane(111) are a ,a ,a.'
    );
disp('The intercepts of the plane(200) are a/2 ,
```

```
infinity ,infinity.');
disp('The intercepts of the plane(120) are a ,a/2 ,
    infinity.');
disp('The intercepts of the plane(211) are a/2 ,a ,a
    .');

//As there are no numerical steps and hence the
    display statement has been typed directly.
```

Scilab code Exa 6.9 Lattice constant

```

//Example No.6.9.
//Page No.189.
clc;clear;
d = 0.2338;//'d' is the interplanar distance -[nm].
// (h,k,l) are the miller indices of the given plane
    .
h = (-1);
k = 1;
l = 1;
a = (d*sqrt(h^2+k^2+l^2));//'a' is the lattice
    constant
printf("\nThe lattice constant is %.4f nm",a);
```

Scilab code Exa 6.10 Ratio of cubic system

```


// Example No.6.10.
// Page No.189.
clc;clear;
h=1;k=0;l=0;
```

```
d100=1/sqrt(h^2+k^2+l^2);
disp('Interplanar spacing for d100 plane = a');
h=1;k=1;l=0;
d110=1/sqrt(h^2+k^2+l^2);
disp('Interplanar spacing for d110 plane = a/1.414')
    ;
h=1;k=1;l=1;
d111=1/sqrt(h^2+k^2+l^2);
disp('Interplanar spacing for d111 plane = a/1.732')
    ;
x = sqrt(6);
y = sqrt(3);
z = sqrt(2);
printf("\nx = %.3f",x);
printf("\ny = %.3f",y);
printf("\nz = %.3f",z);
printf("\nd100:d110:d111 = %.3f:%.3f:%.3f",x,y,z);
```

Scilab code Exa 6.11 Ratio of intercepts

```

// Example No.6.11.
// Page No.190.
clc;clear;
l1 = 6*(1/2);
l2 = 6*(1/3);
l3 = (6*1/6);
disp('For the plane (231) the intercepts are (a/2),(
    b/3),(c/1)');
disp('Ratio of the intercepts made by (231) plane in
     simple cubic crystal is as follows :');
disp('l1:l2:l3 = 3:2:6');

//As there are no numerical steps and hence the
    display statement has been typed directly.
```

Scilab code Exa 6.12 Length of the intercepts

```
// Example No.6.12.
// Page No.190.
//To find the lengths of the intercepts.
clc;clear;
a = 0.8;
b = 1.2;
c = 1.5;
disp('Ratio of the intercepts are as follows : ');
disp('I1:I2:I3 = a:b/2:c/3');
I1 = 0.8;
disp('0.8:I2:I3 = a:b/2:c/3');
disp('By substituting values');
I2=(1.2/2);
printf("\nI2 = %.1f A",I2);
I3=(1.5/3);
printf("\nI3 = %.1f A",I3);



//As there are no numerical steps and hence the
   display statement has been typed directly.
```

Scilab code Exa 6.13 Nearest neighbour distance

```
// Example No.6.13.
// Page No.191.
```

```
//To find the nearest neighbour distance.
clc;clear;
disp('i)Simple cubic unit cell');
disp('The nearest neighbour distance is a');//
   nearest neighbour distance.
disp('ii)Body-centered cubic unit cell');
disp('2r = (0.866)a');
disp('iii)Face-centered cubic unit cell');
disp('2r = (0.7071)a');

//As there are no numerical steps and hence the
   display statement has been typed directly.
```

Scilab code Exa 6.14 Interplanar distance

```

//Example No.6.14.
//Page No.191.
//To find interplanar distance.
clc;clear;
// (h,k,l) are the miller indices of the given
   lattice plane (212).
h = 2;
k = 1;
l = 2;
a = 2.04;//Lattice constant -[A].
d = (a/sqrt(h^2+k^2+l^2));
printf("\nThe interplanar distance is %.2f A",d);
```

Scilab code Exa 6.15 Number of atoms per unit cell

```
//Example No.6.15.
//Page No.191.
clc;clear;
r = 1.278*10^(-10),'m';
M = 63.54;//Atomic weight of copper.
Na = 6.022*10^(26);
d = 8980;//density
a = r*sqrt(8);//Interatomic distance.
printf("\n The interatomic distance is %3.3e m",a);
n = ((d*a^(3)*Na)/(M));//The number of atoms per
    unit cell.
printf("\n Number of atoms per Cu unit cell is %.f",
    n);
```

Scilab code Exa 6.16 Miller indices of the faces

```

// Example No.6.16.
// Page No.192.
//To find the miller indices.
clc;clear;
disp('i)Ratio of the intercepts are 0.214 : 1 :
    0.188');
disp('Miller indices for the given plane is (212)');
disp('ii)Ratio of the intercepts are 0.858 : 1 :
    0.754');
disp('Miller indices for the given plane is (121)');
disp('iii)Ratio of the intercepts are 0.429 :
    infinity : 0.126');
disp('Miller indices for the given plane is (103)');

//There are no numerical computations involved in
    this example and hence the display statement has
    been typed directly.
```

Scilab code Exa 6.17 Number of atoms present

```

// Example No.6.13.
// Page No.191.
//To find the number neighbour distance.
clc;clear;
disp('i)For (100) plane');
disp('Number of atoms per m^2 = 1/4r^2');
disp('i)For (110) plane');
c1 = 1/(8*sqrt(2));
printf("\nc1= %.4f",c1);
disp('Number of atoms per m^2 = (0.084/r^2)');
disp('i)For (111) plane');
c2 = 1/(2*sqrt(3));
printf("\nc2= %.4f",c2);
disp('Number of atoms per m^2 = (0.2887/r^2)');
```

Scilab code Exa 6.18 Ionic packing factor

```

//Example No.6.18
//Page No.194.
clc;clear;
r = 0.97*10^(-10);
R = 1.81*10^(-10);
Pd = ((%pi)/(3*sqrt(2)));
printf("\nThe packing density is %.2f",Pd);
//Ionic factor of NaCl//
IPF = (4*(4/3)*%pi*(r^(3)+R^(3)))/((2*(r+R))^(3));//
    Ionic packing factor of NaCl crystal.
```

```
printf("\nThe ionic packing factor of NaCl crystal
    is %.3f",IPF);
```

Chapter 7

Crystal imperfection

Scilab code Exa 7.1 Number of vacancies and vacancy fraction

```


//Example No.7.1
//Page No.207
//To find number of vacancies.
clc;clear;
Av = 6.022*10^(26);//Avogadro's constant.
d = 18630;//Density.
Aw = 196.9;//Atomic weight -[g/mol].
k = 1.38*10^(-23);//Boltzman's constant.
T = 900;//Temperature.
Ev = 0.98*1.6*10^(-19);//Energy of formation.
N = ((Av*d)/Aw);//Concentration of atoms.
printf("\nConcentration of atoms = %3.3e m^-3",N);
n = N*exp(-(Ev)/(k*T));//'n' is number of vacancy.
printf("\nThe number of vacancies for gold at 900
    degree celcius is %3.3e vacancies per m^3",n);
T1 = 1000;
Vf = exp((-Ev)/(k*T1));//p=(n/N) is the vacancy
    fraction.
printf("\nVacancy fraction = %3.3e",Vf);
```

Scilab code Exa 7.2 Energy for vacancy information

```


//Example No.7.2
//Page No.208.
//To find energy for vacancy information.
clc;clear;
Av = 6.022*10^(26);//Avogadro's constant.
d = 9500;//Density.
Aw = 107.9;//Atomic weight -[g/mol].
k = 1.38*10^(-23);//Boltzman's constant.
T = 1073;//Temperature -[K]
n = 3.6*10^(23);//Number of vacancies -[per m^3].
N = ((Av*d)/Aw);//Concentration of atoms.
printf("\nConcentration of atoms is %3.3e m^-3",N);
Ev = k*T*log(N/n);
printf("\nThe energy for vacancy formation in joules
    is %3.3e J",Ev);
Ev = Ev/1.6*10^(19);
printf("\nThe energy for vacancy formation in eV is
    %3.3e eV",Ev);
```

Scilab code Exa 7.3 number of schottky defected

```


//Example No.7.3
//Page No.209.
//To find number of Schottky defected.
clc;clear;
```

```
Av = 6.022*10^(26);//Avogadro's constant.
d = 1955;//Density.
Aw = (39.1+35.45);//Atomic weight.
k = 1.38*10^(-23);//Boltzman's constant.
T = 773;//Temperature -[K]
Es = 2.6*1.6*10^(-19);//Energy formation.
N = ((Av*d)/Aw);//Concentration of atoms.
printf("\nConcentration of atoms is %3.3e m^-3",N);
n = N*exp(-(Es)/(2*k*T));
printf("\nThe number of Schottky defect for KCl at
   500 degree celcius is %3.3e Schottky defect per m
   ^-3",n);
```

Chapter 8

Conducting materials

Scilab code Exa 8.1 Resistivity of sodium

```

//Example No.8.1
//Page No.231.
clc;clear;
m = 9.1*10^(-31);//mass
n = 2.533*10^(28);//concentration of electrons -[per
    m^3]
e = 1.6*10^(-19);//Value of electron.
Tr = 3.1*10^(-14);//Relaxation time -[s].
d = m/(n*e^(2)*Tr);//The resistivity of sodium at 0
   degree celcius.
printf("\nThe resistivity of sodium at 0 degree
   celcius is %3.3e ohm m",d);
```

Scilab code Exa 8.2 Band gap

```

//Example No.8.2.
```

```
//Page No.231.
clc;clear;
k = 1.38*10^(-23);//Boltzman's constant.
slope = 3.75*10^(3);
Eg = ((2*k)*slope)/(1.6*10^(-19));//The band gap of the semiconductor.
printf("\nThe band gap of the semiconductor is %.3f eV",Eg);
```

Scilab code Exa 8.3 Probability of electron

```

//Example No.8.3.
//Page No.231.
clc;clear;
T = 1262;//Temperature -[K].
k = 1.38*10^(-23);//Boltzman's constant.
E = 0.5*1.6*10^(-19);//Here E= E-Ef.
f = 1/(1+exp(E/(k*T)));//'f' is the probability of occupation of electron at 989 degree celcius.
printf("\nThe probability of occupation of electron at 989 degree celcius is %.2f",f);
```

Scilab code Exa 8.4 Drift velocity

```
//Example No.8.4.
//Page No.232.
clc;clear;
ue = 0.0035*10^(3);// mobility of electron
E = 0.5;//Electric field strength
vd = ue*E;
printf("\nThe drift velocity of the electron is %.2f m/s",vd);
```

Scilab code Exa 8.5 mobility of electron

```
//Example No.8.6.
//Page No.232.
clc;clear;
n = 18.1*10^(28);
h = 6.62*10^(-34);//Planck's constant.
m = 9.1*10^(-31);//mass
Efo = (h^(2)/(8*m))*(((3*n)/(%pi))^(2/3));//The
    fermi energy level at 0 k.
printf("\nThe Fermi energy of Al at 0 k in joules is
     %3.3e J",Efo);
Efo = (Efo/(1.6*10^(-19)));
printf("\nThe Fermi energy of Al at 0 k in eV is %3
    .3e eV",Efo);
```

Scilab code Exa 8.6 Fermi energy level

```

//Example No.8.6.
//Page No.232.
clc;clear;
n = 18.1*10^(28);
h = 6.62*10^(-34);//Planck's constant.
m = 9.1*10^(-31);//mass of electron
Efo = (h^(2)/(8*m))*(((3*n)/(%pi))^(2/3));//The
    fermi energy level at 0 k.
printf("\nFermi energy of Al at 0 k in joules = %3.3
    e J",Efo);
Efo = (Efo/(1.6*10^(-19)));
printf("\nFermi energy of Al at 0 k in eV = %.2fe eV
    ",Efo);
```

Scilab code Exa 8.7 concentration of electrons

```
//Example No.8.7.
//Page No.233.
clc;clear;
h = 6.62*10^(-34);//Planck's constant -[J s].
m = 9.1*10^(-31);//mass -[kg].
Efo = 5.5*1.6*10^(-19);//Fermi energy.
n = ((2*m*Efo)^(3/2))*(8*(%pi))/(3*(h^(3)));
printf("\nThe concentration of free electrons per
    unit volume of silver is %3.3e m^-3",n);
```

Scilab code Exa 8.8 probability of electron

```
//Example No.8.8.
//Page No.233.
clc;clear;
T = 298;//Temperature -[K].
k = 1.38*10^(-23);//Boltzman's constant.
Eg = 1.07*1.6*10^(-19);//Here E= E-Eg.
f = 1/(1+exp(Eg/(2*k*T)));//probability of an
    electron to the conduction band at 25 degree
    celcius.
printf("\nThe probability of an electron thermlly
    excited to the conduction band at 25 degree
    celcius is %3.3e",f);
```

Scilab code Exa 8.9 fermi energy and fermi temperature

```
//Example No.8.9.
//Page No.234.
clc;clear;
m = 9.1*10^(-31);//mass of electron.
k = 1.38*10^(-23);//Boltzman's constant.
vf = 0.86*10^(6);//Fermi velocity -[m s^-1].
Ef = 0.5*m*vf^(2);//Fermi energy
printf("\nThe Fermi energy of the metal in joules is %3.3e J",Ef);
Ef = Ef/(1.6*10^(-19));
printf("\nThe Fermi energy o the metal in eV is %.2f eV",Ef);
Tf = ((Ef)/k);//Fermi temperature.
Tf = ((3.365*10^(-19))/k);
printf("\nThe Fermi temperature of the metal is %3.3e K",Tf);
```

Scilab code Exa 8.10 Lorentz number

```
//Example No.8.10.
//Page No.234.
clc;clear;
K = 387;//Thermal conductivity of copper -[W m^-1 K^-1].
d = 5.82*10^(7);//Electrical conductivity of copper -[ohm^-1 m^-1].
T = 300;//Temperature -[K].
L = (K/(d*T));
printf("\nThe Lorentz number is %3.3e W ohm K^-2",L);
```

Scilab code Exa 8.11 conductivity and Larentz number

```

//Example No.8.11.
//Page No.235.
clc;clear;
n = 8.49*10^(28);//Concentration of electrons in copper -[m^-3].
e = 1.6*10^(-19);//Value of electron.
Tr = 2.44*10^(-14);//Relaxation time of electron -[s]
m = 9.1*10^(-31);//mass of electron.
k = 1.38*10^(-23);//Boltzman's constant.
T = 293;//Temperature -[K].
d = ((n*e^(2)*Tr)/(m));
printf("\n1)The electrical conductivity is %3.3e per ohm meter",d);
K = ((n*(%pi)^(2)*k^(2)*T*Tr)/(3*m));
printf("\n 2)The thermal conductivity is %.2f W m^-1.K^-1",K);
L = K/(d*T);
printf("\n3)The Lorentz number is %3.3e W ohm K^-2",L);
```

Chapter 9

Semiconducting materials

Scilab code Exa 9.1 Number of charge carrier

```

//Example No.9.1.
//Page No.266.
//To find number of charge carrier.
clc;clear;
d = 2.2;//Conductivity -[ohm^-1 m^-1].
e = 1.6*10^(-19);//Value of electron.
u1 = 0.36;//Mobility of the electrons -[m^2 V^-1 s^-1].
u2 = 0.14;//Mobility of the holes -[m^2 V^-1 s^-1].
T = 300;//Temperature -[K].
n = (d/(e*(u1+u2)));//Number of charge carriers
printf("\nThe carrier concentration of an intrinsic semiconductor is %3.3e m^3",n);
```

Scilab code Exa 9.2 Band gap

```

```

```
//Example No.9.2.
//Page No.266.
//To find conductivity of semiconductor.
clc;clear;
d20 = 250;//Conductivity at 20 degree celcius -[ohm^-1 m^-1].
d100 = 1100;//Conductivity at 100 degree celcius -[ohm^-1 m^-1].
k = 1.38*10^(-23);//Boltzman's constant.
Eg = (2*k*((1/373)-(1/293))^(-1)*log((d20/d100)*(373/293)^(3/2)));//Band gap in joules.
printf("\nBand gap of semiconductor in joules is %3.3e J",Eg);
Eg = Eg/(1.6*10^(-19));//band gap in eV.
printf("\nBand gap of semiconductor in eV is %.4f eV",Eg);
```

Scilab code Exa 9.3 Hall voltage

```

//Example No.9.3.
//Page No.267.
clc;clear;
B = 0.5;//Magnetic field -[Wb/m^2].
I = 10^(-2);//Current -[A].
l = 100;//Length -[mm].
d = 1;//Thickness -[mm].
Rh = 3.66*10^(-4);//Hall coefficient -[m^3/C].
w = 10*10^(-3);//Breadth -[mm].
Vh = ((B*I*Rh)/w);//Hall voltage.
printf("\nThe Hall voltage is %3.3e V",Vh);
```

Scilab code Exa 9.4 Concentration of holes and electrons

```
//Example No.9.4.
//Page No.268.
clc;clear;
d = 3*10^(4);//Conductivity -[S/m].
e = 1.6*10^(-19);//Value of electron.
ue = 0.13;
uh = 0.05;
ni = 1.5*10^(16);
disp('For N-type semiconductor')
Nd = (d/(e*ue));
printf("\ni)The concentration of electron is %3.3e m
    ^-3",Nd);
p = ((ni)^(2)/(Nd));
printf("\nii)The concentration of holes is %3.3e m
    ^-3",p);
disp('For P-type semiconductor')
Na = (d/(e*uh));
printf("\ni)The concentration of holes is %3.3e m^-3
    ",Na);
n = ((ni)^(2)/(Na));
printf("\nii)The concentration of electron is %3.3e
    m^-3",n);
```

Scilab code Exa 9.5 carrier concentration and type of carrier

```
//Example No.9.5.
//Page No.269.
//To calculate carrier concentration.
clc;clear;
Rh = 3.68*10^(-5);//Hall coefficient -[m^3/C].
e = 1.6*10^(-19);//Electron charge -[C].
disp('1)Since the hall voltage is negative,charge
    carriers of the semiconductors are electrons')
```

```
n = ((3*%pi)/(8*Rh*e));//Carrier concentration.
printf("\n2)The carrier concentration is %3.3e m^-3"
    ,n);
```

Scilab code Exa 9.6 Intrinsic carrier densities

```

//Example No.9.6.
//Page No.269.
clc;clear;
Eg1 = 0.36;//Energy gap of the first material -[eV].
Eg2 = 0.72//Energy gap of the second material -[eV].
me = 9.1*10^(-31);// -[kg].
A = 0.052;//'A' is (2*k*T).
T = 300;//Temperature -[K].
a = -0.36;
b = 0.72;
N = (exp(a/A)*exp(b/A));//Ratio of intrinsic carrier
     densities of material A & B.
printf("\nThe ratio of intrinsic carrier densities
    of the materials A & B is %3.3e",N);
```

Scilab code Exa 9.7 Mobility of electron

```

//Example No.9.7.
//Page No.270.
//To find mobility of the electron.
clc;clear;
d = 112;//Conductivity -[ohm^-1 m^-1].
Nd = 2*10^(22);//Concentration of electrons -[m^-3].
e = 1.6*10^(-19);//Electron charge.
u = (d/(Nd*e));//Mobility of electrons.
```

```
printf("\nMobility of the electron is %.3f m^2 V^-1 s^-1",u);
```

Scilab code Exa 9.8 hall voltage

```

//Example No.9.8.
//Page No.270.
clc;clear;
Bz = 10*10^(-4);//Magnetic field -[Wb/m^2].
I = 1;//Current -[A].
W = 500*10^(-6);//Thickness of the sample -[m].
n = 10^(16);//Donor concentration.
e = 1.6*10^(-19);//Electron charge.
VH = ((Bz*I*3*%pi)/(8*n*e*W));//Hall voltage in the sample.
printf("\nThe Hall voltage in the sample is %3.3e V",VH);
```

Scilab code Exa 9.9 Ratio between the conductivity of the material

```

//Example No.9.9.
//Page No 271.
clc;clear;
Eg = 1.2*1.6*10^(-19);//Energy gap.
T1 = 300;//Temperature T1 -[K].
T2 = 600;//Temperature T2 -[K].
k = 1.38*10^(-23);//Boltzman's constant.
N = ((T2/T1)^(3/2))*exp((Eg/(2*k))*((1/T1)-(1/T2)))*10^(-3);//Ratio between the conductivity of the material.
```

```
printf("\nRatio between  the conductivity of the
    material at 600 K and 300 K is %.2f",N);
```

Scilab code Exa 9.10 Intrinsic carrier concentration

```

//Example No.9.10.
//Page No 272.
clc;clear;
d = 10^(-6);//Electrical conductivity -[ohm^-1 m
    ^-1].
e = 1.6*10^(-19);//Electron charge.
ue = 0.85;//Electron mobility -[m^2 V^-1 s^-1].
uh = 0.04;//hole mobility -[m^2 V^-1 s^-1].
Ni = (d/(e*(ue+uh)));//intrinsic carrier
    concentration
printf("\nThe intrinsic carrier concentration of
    GaAs is %3.3e m^-3",Ni);
```

Scilab code Exa 9.11 Concentrations

```



//Example No.9.11.
//Page No 272.
clc;clear;
p = 0.1;//Resistivity of P-type and N-type -[ohm m].
e = 1.6*10^(-19);//Electron charge.
Uh = 0.48;//Hole mobility -[m^2 V^-1 s^-1].
Ue = 1.35;//Electron mobility -[m^2 V^-1 s^-1].
ni = 1.5*10^(16);
d = (1/p);//Electrical conductivity
```

```
disp('For P-type material')
printf("\n1)The electrical conductivity is %.1f ohm
    ^-1 m^-1",d);
Na = (d/(e*Uh));//Acceptor concentration.
printf("\n2)The acceptor concentration is %3.3e m^-3
    ",Na);
n1 = (((ni)^(2))/(Na));//Minority carriers
    concentration.
printf("\n3)The minority carriers concentration is
    %3.3e m^-3",n1);
disp('For N-type semiconductor')
d = (1/p);//Electrical conductivity.
printf("\n2)The electrical conductivity is %.1f ohm
    ^-1 m^-1",d);
Nd = (d/(e*Ue));//Donor concentration.
printf("\n2)The donor concentration is %3.3e m^-3",
    Nd);
n2 = (((ni)^(2))/(Nd));//Minority carriers
    concentration.
printf("\n3)The minority carriers concentration  is
    %3.3e m^-3",n2);
```

Chapter 10

Magnetic materials

Scilab code Exa 10.1 Magnetization and flux density

```
//Example NO.10.1
//Page No.305
//To find magnetization & flux density.
clc;clear;
H = (10^6);//Magnetic field strength -[A/m].
x = (0.5*10^-5);//Magnetic suceptibility.
M = (x*H);//Magnetization.
printf("\nMagnetization of the material is %.0f A/m"
    ,M);
u0 = (4*%pi*10^-7);
B = (u0*(M+H));//Flux density.
printf("\nFlux density of the material is %.3f Wb/m
    ^2",B);
```

Scilab code Exa 10.2 Magnetic moment of nickel atom

```
//Example NO.10.2
//Page No.306
clc;clear;
B = 0.65;//Saturation magnetic induction -[Wb/m^2].
p = 8906;//Density -[kg/m^3].
Mat = 58.7;//Atomic weight of Ni
A = (6.022*10^26);//Avagadro's constant.
N = ((p*A)/Mat);//Number of atoms per m^-3.
printf("\nNumber of atoms per m^-3 are %3.3e m^-3",N
    );
u0 = (4*%pi*10^-7);
um = (B/(N*u0));
printf("\nMagnetic moment is %3.3e ",um);
Mni = (um/(9.27*10^-24));
printf("\nMagnetic moment of nickel atom is %.2f uB"
    ,Mni);
```

Scilab code Exa 10.3 Relative permiability

```
//Example NO.10.3
//Page No.306
clc;clear;
H = 1800;//Magnetic field -[A/m].
F = (3*10^-5);//Magnetic flux -[Wb].
A = 0.2*10^-4;//Area of cross section -[m].
u0 = (4*%pi*10^-7);
B = (F/A);//Magnetic flux density.
printf("\nMagnetic flux density is %.1f Wb/m^2",B);
ur = (B/(u0*H));//Relative permeability.
printf("\nRelative permeability of the material is %
    .2f",ur);
```

Scilab code Exa 10.4 Saturation magnetization

```
//Example NO.10.4
//Page No.307
clc;clear;
u = 18.4;//Magnetic moment -[uB].
uB = (9.27*10^-24);
a = (0.835*10^-9);//Lattice parameter -[m].
M = (u*uB/a^3);//Magnetization.
printf("\nSaturation magnetization for Ni ferrite is
    %3.3e A/m",M);
```

Scilab code Exa 10.5 Magnetization and magnetic flux density

```
//Example NO.10.5
//Page No.307
clc;clear;
H = (2*10^5);//Magnetic field strength -[A/m].
ur = 1.01;//Relative permeability.
u0 = (4*%pi*10^-7);
B = (u0*ur*H);//Magnetic flux density.
printf("\nMagnetic flux density is %.4f Wb/m^2",B);
M = ((0.2538/u0)-(H));//Magnetization
printf("\nMagnetization of the material is %.2f A/m"
    ,M);
```

Scilab code Exa 10.6 Succeptibility and magnetic flux

```
//Example NO.10.6
//Page No.307
clc;clear;
H = (500);//Magnetic field strength -[A/m].
x = (1.2);//Suceptibility.
M = (x*H);//Magnetization.
printf("\nMagnetization of the material is %.0f A/m"
    ,M);
u0 = (4*%pi*10^-7);
B = (u0*(M+H));//Magnetic flux density.
printf("\nMagnetic flux density inside the material
    is %3.3e Wb/m^2",B);
```

Chapter 11

Dielectric materials

Scilab code Exa 11.1 Dielectric constant

```

//Example NO.11.1
//Page No.335
//To find dielectric constant of the material
clc;clear;
C = (10^-9);//Capacitance -[F].
d = (2*10^-3);//Distance of separation -[m].
E0 = (8.854*10^-12);
A = (10^-4);//Area of capacitor -[m^2]
Er = ((C*d)/(E0*A));//Dielectric constant.
printf("\nThe dielectric constant of the material is
    %.2f",Er);
```

Scilab code Exa 11.2 Electronic polarizability

```

//Example NO.11.2
//Page No.335
```

```
//To find electronic polarizability of He gas.
clc;clear;
E0 = (8.854*10^-12);
Er = (1.0000684);//Dielectric constant of He-gas
N = (2.7*10^25);//Concentration of dipoles -[per m
    ^3].
P = (E0*(Er-1));
a = (P/(N));
a = (P/(2.7*10^25));//Electronic polarizability.
printf("\nElectronic polarizability of He gas is %3
    .3e F m^2",a);
```

Scilab code Exa 11.3 Polarization

```


//Example NO.11.3
//Page No.336
clc;clear;
E0 = (8.854*10^-12);
Er = (6);//Dielectric constant.
E = 100;//Electric field intensity -[V/m].
P = (E0*(Er-1)*E);//Polarization.
printf("\nPolarization produced in a dielectric
    medium is %3.3e C/m^2",P);
```

Scilab code Exa 11.4 Electronic polarizability

```


//Example NO.11.4
//Page No.336
clc;clear;
```

```
E0 = (8.854*10^-12);
R = (0.158*10^-9);//Radius of neon -[m].
a = (4*%pi*E0*R^3);//Electronic polarizability.
printf("\nElectronic polarizability of neon is %3.3e
    F m^2",a);
```

Scilab code Exa 11.5 Area of metal sheet required

```

//Example NO.11.5
//Page No.336
clc;clear;
E0 = (8.854*10^-12);// [C^2/N.m^2].
Er = 6;//Dielectric constant.
C = (0.02*10^-6);//Capacitance -[F].
d = (0.002*10^-2);//Thickness of mica -[m].
A = ((C*d)/(E0*Er));//Area of the metal sheet.
printf("\nArea of the metal sheet required is %3.3e
    m^2",A);
```

Scilab code Exa 11.6 Relative permittivity of the crystal

```

//Example NO.11.6
//Page No.337
clc;clear;
E0 = (8.854*10^-12);
P = (4.3*10^-8);//polarization -[C/m^2].
E = 1000;//Electric field -[V/m].
Er = ((P/(E0*E))+1);//Relative permittivity of the
    crystal.
printf("\nRelative permittivity of the crystal is %
    .3f",Er);
```

```
//Last statement of this numerical is wrong in the
    textbook.Here we have to find relative
    permittivity of the crystal and not the
    dielectric constant.//
```

Scilab code Exa 11.7 Polarizability of the material

```

//Example NO.11.7
//Page No.337
clc;clear;
E0 = (8.854*10^-12);
x = (4.94);//Relative suceptibility.
N = (10^28);//Number of dipoles per unit volume [per
     m^3].
a = ((E0*x)/N);//Polarizability of the material
printf("\nPolarizability of the material is %3.3e F
    m^-2",a);
```

Chapter 12

Superconducting materials

Scilab code Exa 12.1 Critical field

```
//Example NO.12.1
//Page No.356
//To find critical field.
clc;clear;
Tc = 3.7;//Critical temperature of tin -[K].
Ho = 0.0306;//Magnetic field -[T].
T = 2;//Temperature -[K].
Hc = Ho*(1-((T^(2))/(Tc^(2))));//Critical magnetic
   field
printf("\nCritical field at 2K is %.4f T",Hc);
```

Scilab code Exa 12.2 Critical field

```


//Example NO.12.2
//Page No.356
```

```
//To find critical field.
clc;clear;
Tc = 7.26;//Critical temperature of lead -[K].
Ho = 6.4*10^3;//Magnetic field -[A/m^3].
T = 5;//Temperature -[K].
Hc = Ho*(1-((T^(2))/(Tc^(2))));//Critical magnetic field
printf("\nCritical field at 5K is %.2f T",Hc);
```

Scilab code Exa 12.3 value of Tc

```

//Example NO.12.3
//Page No.357
//To find the value of Tc.
clc;clear;
M1 = (199.5^(1/2));//Atomic mass.
M2 = (203.4^(1/2));//Atomic mass.
Tc1 = (4.185);//Critical temperature of Hg -[K].
Tc = (Tc1*M1/M2);//Critical temperature
printf("\nCritical temperature of Hg with atomic mass,203.4 is %.5f K",Tc);
```

Scilab code Exa 12.4 critical current density

```

//Example NO.12.4
//Page No.357
//To find critical current density.
clc;clear;
D=1*10^(-3);//Diameter of the wire -[m].
Tc = 7.18;//Critical temperature -[K].
Ho = 6.5*10^4;//Critical field -[A/m].
```

```
T = 4.2;//Temperature -[K].
R = 0.5*10^-3;//Radius.
I = 134.33;//Current.
Hc = Ho*(1-((T^(2))/(Tc^(2))));
printf("\nCritical magnetic field is %3.3e A/m",Hc);
ic = (2*%pi*R*Hc);
printf("\nCritical current is %.2f A",ic);
J = (I/(%pi*R^2));
printf("\nCritical current density is %3.3e A/m^2",J);
```

Scilab code Exa 12.5 frequency of radiation

```

//Example NO.12.5
//Page No.358
//To find frequency.
clc;clear;
e = (1.6*10^-19);//value of electron.
V = (6*10^-6);//Voltage applied across the junction -[V]
h = (6.626*10^-34);//Planck's constant
v = ((2*e*V)/h);//Frequency of ac signal
printf("\nFrequency of ac signal is %3.3e Hz",v);
```

Scilab code Exa 12.6 Band gap

```

//Example NO.12.6
//Page No.358
//To find band gap of superconducting lead
clc;clear;
KB = (1.38*10^-23);//Boltzman's constant.
```

```
Tc = (7.19);//Critical temperature of lead -[K].
Eg = (3.5*KB*Tc);//Energy gap of semiconductor.
printf("\nBand gap of superconducting lead is %3.3e
   J",Eg);
Eg = (Eg/(1.6*10^-19*10^(-3)));
printf("\nBand gap of superconducting lead is %.2f
   meV",Eg);
```