Scilab Textbook Companion for Engineering Physics by M. R. Srinivasan[1]

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Book Description

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

Contents

List of Scilab Codes

Chapter 1

INTERFERENCE

Scilab code Exa 1.1.u1 To calculate the location of screen from slits

```
//Example 1_1_u1
clc();
clear;
//To calculate the location of screen from slits
d=0.08              //units in cm
d=d*10^-2           //units in mts
betaa=6*10^-4         //units in mts
v=8*10^11             //units in kHz
c=3*10^8              //units in mts
lamda=c/(v*10^3)             //units in mts
d=(betaa*d)/lamda              //units in mts
printf("The distance of the screen from the slits is
    %.2fmts",d)
```

Scilab code Exa 1.2.u1 To calculate the wavelength

```
//Example 1_2_u1
clc();
clear;
//To calculate the wavelength
//First case to calculte the wavelengths of the light source to obtain fringes 0.46*10^-2 mts
lamda1=4200    //units in armstrongs
lamda1=lamda1*10^-10   //units in mts
betaa=0.64*10^-2     //units in mts
D_d=betaa/lamda1      //units in mts
//Second caseDistance between slits and screen is reduced to half
beeta1=0.46*10^-2     //units in mts
lamdaD_d=beeta1*2               //units in mts
lamda=(lamda1*lamdaD_d)/betaa            //units in mts
lamda=lamda*10^10      //units in armstrongs
printf("The wavelength of the Light source is %.1fArmstrongs",lamda)
```

Scilab code Exa 1.3.u1 To compare the intensity at a point distance 1mm from the center to that at its center and to find minimum dist from center of point

```
//Example 1_3_u1
clc();
clear;
//To compare the intensity at a point distance 1mm from the center to that at its center and to find minimum dist from center of point
//Path difference=(Y*d)/D
y=1     //units in mm
y=y*10^-3     //units in mts
```

```
D=1        //units in mts
d=1      //units in mm
d=d*10^-3       //units in mts
pathdifference=(y*d)/D          //units in mts
lamda=5893      //units in armstrongs
lamda=lamda*10^-10    //units in mts
phasedifference=(2*pathdifference)/lamda
    //units in pi radiand
ratioofintensity=(cos((phasedifference/2)*%pi))^2
    //units in
printf("The ratio of intensity with central maximum
    is %.4f\n",ratioofintensity)
pathdifference=lamda/4
distance=(pathdifference*D)/d          //units in mts
printf("The Distance of the point on the screen from
     center is %fmts",distance)
```

Scilab code Exa 1.4.u1 To calculate thickness of plate

```
//Example 1_4_u1
clc();
clear;
//To calculate thickness of plate
//t=(n*lamda)/(u-u1)
n=5
u=1.7
u1=1.4
lamda=4800          //units in armstrongs
lamda=lamda*10^-10    //units in mts
t=(n*lamda)/(u-u1)        //units in mts
printf("Thickness of glass plate is %.6fmts",t)
//In text book the answer is printed wrong as
    8*10^-8 mts
```

```
//the correct answer is 8*10^-6   mts
```

Scilab code Exa 1.5.u1 To find the refractive index of coil

```
//Example 1_5_u1
clc();
clear;
//To find the refractive index of coil
volume=0.2       //units in CC
thickness=volume/(100*100)       //units in cm
n=1
lamda=5.5*10^-5        //units in cm
r=0
u=(n*lamda)/(2*thickness*cos(r))
printf("Refractive index of oil is %.3f",u)
```

Scilab code Exa 1.6.U1 Calculate the wavelengths of light in visible spectrum

```
//Example 1_6_u1
clc();
clear;
//Calculate the wavelengths of light in visible
   spectrum
i=35            //units in degrees
u=1.33
d=5*10^-5       //units in cm
r=asin(sin(i*%pi/180)/u)       //units in radians
r=r*180/%pi                    //units in degrees
```

```
//For n=1
n=1
lamda1=(2*u*d*cos(r*%pi/180))/n        //units in cm
printf("For n=1 lamda=%.6fcm which lies in infrared region",lamda1)
//For n=2
n=2
lamda2=(2*u*d*cos(r*%pi/180))/n       //units in cm
printf("\nFor n=2 lamda=%.6fcm which lies in visible region",lamda2)
//For n=3
n=3
lamda3=(2*u*d*cos(r*%pi/180))/n           //units in cm
printf("\nFor n=3 lamda=%.6fcm which lies in visible region",lamda3)
//For n=4
n=4
lamda4=(2*u*d*cos(r*%pi/180))/n        //units in cm
printf("\nFor n=4 lamda=%.6fcm which lies in ultraviolet region",lamda4)
printf("\nHence absent wavelengths in reflected region are %.6fcm and %.6fcm",lamda2,lamda3)
```

Scilab code Exa 1.7.u1 To calculate the fring width

```
//Example 1_7_u1
clc();
clear;
//To calculate the fring width
//betaa=(lamda)/(2*alpha)
lamda=6000          //units in armstrongs
lamda=lamda*10^-8    //units in cm
```

```
diameter=0.05           //units in mm
distance=15             //units in cm
alpha=(diameter/distance)*10^-1      //units in radians
betaa=lamda/(2*alpha)              //units in cm
printf("The fringe width is %.2fcm",betaa)
```

Scilab code Exa 1.8.u1 To calculate the distance from the edge of wedge

```
//Example 1_8_u1
clc();
clear;
//To calculate the distance from the edge of wedge
alpha=0.01            //units in radians
n=10
lamda=6000           //units in armstrongs
lamda=lamda*10^-10   //units in mts
x=((2*n-1)*lamda)/(4*alpha)         //units in mts
printf("Distance from the edge of the wedge is %.6fmts",x)
```

Scilab code Exa 1.9.u1 To calculate diameter of the fifth bright ring

```
//Example 1_9_u1
clc();
clear;
//To calculate diameter of the fifth bright ring
n=5
lamda=5460     //units in armstrongs
```

```
lamda=lamda*10^-6      //units in cm
f=400          //units in cm
u=1.5
R=(u-1)*2*f       //units in cm
diameter=sqrt(2*(2*n-1)*lamda*R)
printf("Diameter of the 5th bright ring is %.4fcm",diameter)
//In text book the answer is printed wrong as 0.627 cm
//The correct answer is 6.269 cms
```

Scilab code Exa 1.10.u1 To find the diameter of the 20th dark ring

```
//Example 1_10_u1
clc();
clear;
//To find the diameter of the 20th dark ring
D4=0.4            //units in cm
D12=0.7            //units in cm
//As we have (D20^2-D4^2)/(D12^2-D4^2)=(4*16)/(4*8)
ans=(4*16)/(4*8)
D20_2=(ans*((D12)^2-(D4)^2))+(D4)^2            //units in cm^2
D20=sqrt(D20_2)                                //units in cm
printf("Diameter of the 20th dark ring is %.3fcm",D20)
```

Scilab code Exa 1.11.u1 To calculate refractive Index of liquid

```
//Example 1_11_u1
clc();
clear;
//To calculate refractive Index of liquid
  d10=1.40
  d_10=1.27
  u=(d10/d_10)^2
  printf("The refractive index of liquid is %.3f",u)
```

Scilab code Exa 1.12.u1 To calculate the wavelength of the light used

```
//Example 1_12_u1
clc();
clear;
//To calculate the wavelength of the light used
Dnp=0.8    //units in cm
Dn=0.3       //units in cm
n1=25
n2=5
p=n1-n2
R=100           //units in cm
lamda=(Dnp^2-Dn^2)/(4*p*R)                //units in cm
printf("The wavelength of light used is %.8fcm",lamda)
//In text book the answer is printed wrong as 4.87*10^-5cm
//correct Answer is 6.875*10^-5cm
```

Chapter 2

DIFFRACTION

Scilab code Exa 2.1.u1 To calculate the no of lines in one cm of grating surface

```
//Example 2_1_u1
clc();
clear;
//To calculate the no of lines in one cm of grating surface
k=2
lamda=5*10^-5       //units in cm
theta=30            //units in degrees
//We have nooflines=1/e=(k*lamda)/sin(theta)
nooflines=sin(theta*%pi/180)/(k*lamda)              //units in cm
printf("No of lines per centimeter is %.f",nooflines)
//In text book the answer is printed wrong as 10^3
//The correct answer is 5*10^3
```

Scilab code Exa 2.2.u1 To Find the difference in angles of deviation in first and third order spectra

```
//Example 2_2_u1
clc();
clear;
//To Find the difference in angles of deviation in first and third order spectra
lamda=5000        //units in armstrongs
lamda=lamda*10^-8                  //units in cm
e=1/6000
//For first order e*sin(theta1)=1*lamda
theta1=asin(lamda/e)    //units in radians
theta1=theta1*180/%pi    //units in degrees
printf("For First order spectra theta1=%.1f degrees",theta1)
//For third order e*sin(theta3)=3*lamda
theta3=asin(3*lamda/e)    //units in radians
theta3=theta3*180/%pi    //units in degrees
printf("\nFor Third order spectra theta3=%.1f degrees",theta3)
diffe=theta3-theta1         //units in degrees
printf("\nDifference in Angles of deviation in first and third order spectra is theta3-theta1=%.2fdegrees",diffe)
```

Scilab code Exa 2.3.u1 To calculate minimum no of lines per centimeter

```
//Example 2_3_u1
clc();
clear;
//To calculate minimum no of lines per centimeter
lamda1=5890        //units in armstrongs
```

```
lamda2=5896         //units in armstrongs
dlamda=lamda2-lamda1        //units in armstrongs
k=2
n=lamda1/(k*dlamda)
width=2.5         //units in cm
nooflines=n/width
printf("No of lines per cm=%.1f",nooflines)
```

Scilab code Exa 2.4.u1 To examine two spectral lines are clearly resolved in first order and second order

```
//Example 2_4_u1
clc();
clear;
//To examine two spectral lines are clearly resolved in first order and second order
n=425
tno=2*n
lamda1=5890            //units in armstrongs
lamda2=5896            //units in armstrongs
dlamda=lamda2-lamda1
//For first order
n=lamda1/dlamda
printf("As total no of lines required for resolution in first order is %.f and total no of lines in grating is %d the lines will not be resolved in first order",n,tno)
//For second order
n=lamda1/(2*dlamda)
printf("\nAs total no of lines required for resolution in first order is %.f and total no of lines in grating is %d the lines will be resolved in second order",n,tno)
```

Scilab code Exa 2.5.u1 To find the angle of separation

```
//Example 2_5_u1
clc();
clear;
//To find the angle of separation
lamda1=5016          //units in armstrongs
lamda2=5048          //units in armstrongs
lamda1=lamda1*10^-8     //units in cm
lamda2=lamda2*10^-8     //units in cm
k=2
n=15000
e=2.54/n              //units in cm
theta1=asin((2*lamda1)/e)*(180/%pi)           //units
    in degrees
theta2=asin((2*lamda2)/e)*(180/%pi)           //units
    in degrees
diffe=theta2-theta1                           //units
    in degrees
diffe=diffe*60                                  //
   units in minutes
printf("Angle of separation is %.f minutes",diffe)
```

Scilab code Exa 2.6.u1 To Calculate the dispersive power of the grating

```
//Example 2_6_u1
clc();
```

```
clear;
//To Calculate the dispersive power of the grating
n=4000
e=1/n           //units in cm
k=3
lamda=5000       //units in armstrongs
lamda=lamda*10^-8          //units in cm
theta=asin((k*lamda)/e)*(180/%pi)          //units in degrees
costheta=cos(theta*%pi/180)
disppower=(k*n)/costheta
printf("The dispersive power of the grating is %.f",disppower)
```

Scilab code Exa 2.7.u1 To Calculate highest power of spectrum seen with mono chromaic light

```
//Example 2_7_u1
clc();
clear;
//To Calculate highest power of spectrum seen with mono chromaic light
lamda=6000          //units in armstrongs
lamda=lamda*10^-8        //units in cm
n=5000
e=1/n            //units in cm
k=e/lamda
printf("The highest order spectrum Seen with monochromatic light is %.2f",k)
```

Scilab code Exa 2.8.u1 To calculate the wavelength

```
//Example 2_8_u1
clc();
clear;
//To calculate the wavelength
k=2
theta1=10            //units in degrees
dtheta=3             //units in degrees
dlamda=5*10^-9       //units in cm
lamda=(sin((theta1*%pi)/180)*dlamda*60*60)/(cos((
   theta1*%pi)/180)*dtheta*(%pi/180))   //units in
   cm
printf("Wavelength of the lines is %.7f cms",lamda)
lamda_dlamda=lamda+dlamda          //units in cm
N=6063
Ne=(N*k*lamda)/sin((theta1*%pi)/180)         //units
   in cm
printf("\nMinimum grating width required is %.1fcm",
   Ne)
```

Scilab code Exa 2.9.u1 To calculate resolving power in second order

```
//Example 2_9_u1
clc();
clear;
//To calculate resolving power in second order
//We have e*sin(theta)=k*lamda
```

```
//We have e*0.2=k*lamda         ->1
//And e*0.3=(k+1)*lamda          ->2
//Subtracting one and two 3*0.1=lamda
lamda=5000           //units in armstrongs
lamda=lamda*10^-8    //units in cm
e=lamda/0.1       //units in cm
width=2.5         //units in cm
N=width/e
respower=2*N
printf("Resolving power is %.f",respower)
```

Chapter 3

POLARIZATION OF LIGHT

Scilab code Exa 3.1.u1 To calculate the polarising angle

```
//Example 3_1_u1
clc();
clear;
//To calculate the polarising angle
u=1.5
ip=atan(u)*(180/%pi)        //units in degrees
printf("The Polarising angle is %.2fdegrees or 56
    degrees.18minutes",ip)
//in text book the answer is printed wrong as 56
    degrees.18minutes
//the correct answer is 56.31degrees or 56 degrees
    18minutes
```

Scilab code Exa 3.2.u1 To calculate the thickness of quarter wave plate

```
//Example 3_2_u1
clc();
```

```
clear;
//To calculate the thickness of quarter wave plate
lamda=6000        //units in armstrongs
lamda=lamda*10^-10          //units in mts
n0=1.554
ne=1.544
d=(lamda)/(4*(n0-ne))          //units in mts
printf("Thickness of quarter wave plate is %.6fmts",d)
```

Scilab code Exa 3.3.u1 To calculate the wavelength

```
//Example 3_3_u1
clc();
clear;
//To calculate the wavelength
d=12.5       //units in microns
d=d*10^-6    //units in mts
u0_ue=0.01
lamda=4*d*u0_ue
printf("The wavelength is %.7fmts",lamda)
//In text book the answer is printed wrong as 4*10^-7mts
//The correct answer is 5*10^-7 mts
```

Scilab code Exa 3.4.u1 To calculate the thickness of the plate

```
//Example 3_4_u1
clc();
```

```
clear;
//To calculate the thickness of the plate
lamda=5.5*10^-5          //units in cm
u0=1.553
ue=1.542
d=lamda/(2*(u0-ue))      //units in cm
d=d*10^-2                //units in mts
printf("The thickness of the plate is %.7fmts",d)
```

Chapter 5

X RAY DIFFRACTION

Scilab code Exa 5.1.u1 To determine the miller indices of the plane

```
//Example 5_1_u1
clc();
clear;
//To determine the miller indices of the plane
//Given Intercepts are 2a,-3b,6c
a=1
b=1
c=1
intercepts1=2*a
intercepts2=-3*b
intercepts3=6*c
unitcell1=intercepts1/a
unitcell2=intercepts2/b
unitcell3=intercepts3/c
resiprocal1=1/unitcell1
resiprocal2=1/unitcell2
resiprocal3=1/unitcell3
lcms=int32([unitcell1 unitcell2 unitcell3]);
v=lcm(lcms)
lcm1=3
lcm2=-2
```

```
lcm3=1
printf("Co-ordinates of A,B,C are (%.2f,0,0),(0,%.1f,0)(0,0,%d)",1/lcm1,1/lcm2,lcm3)
printf("\n    Miller indices of the plane are(%d,%d,%d)",lcm1,lcm2,lcm3)
```

Scilab code Exa 5.2.u1 To determine the miller indices of the plane

```
//Example 5_2_u1
clc();
clear;
//To determine the miller indices of the plane
//Given Intercepts are Infinity,OY,OZ
intercepts1="Infinity"
intercepts2="OY"
intercepts3="OZ"
unitcell1="Infinity"
unitcell2=1
unitcell3=(2/3)
resiprocal1=0
resiprocal2=1/unitcell2
resiprocal3=1/unitcell3
lcms=int32([unitcell2 unitcell3]);
v=lcm(lcms)
lcm1=0
lcm2=2
lcm3=3
printf("Co-ordinates of A,B,C are (Infinity,0,0),(0,%d,0)(0,0,%f)",unitcell2,unitcell3)
printf("\n    Miller indices of the plane are(%d,%d,%d)",lcm1,lcm2,lcm3)
```

Scilab code Exa 5.3.u1 To find the intercepts along the Y and Z axes

```
//Example 5_3_u1
clc();
clear;
//To find the intercepts along the Y and Z axes
a=0.121             //units in nm
b=0.184             //units in nm
c=0.197             //units in nm
//Given miller indices are (2,3,1)
OA_OB=3/2
OA_OC=1/2
OB=(2/3)*b //units in nm
OC=2*c     //units in nm
printf("The Intercepts along the Y and Z axes are OB
   =%.3fnm and OC=%.3fnm",OB,OC)
```

Scilab code Exa 5.4.u1 To calculate the inter planar distance

```
//Example 5_4_u1
clc();
clear;
//To calculate the inter planar distance
a=0.82      //units in nm
b=0.94       //units in nm
c=0.75        //units in nm
h=1
k=2
```

```
l=3
d=1/sqrt((((h/a)^2)+((k/b)^2)+((l/c)^2)))    //units in nm
printf("The Distance between (1,2,3) planes and (2,4,6) planes is d123=%.2fnm and d246=%.2fnm",d,d/2)
//In textbook the answer is printed wrong as d123=0.11nm and d246=0.055nm but the correct answers are d123=0.21nm and d246=0.11nm
```

Scilab code Exa 5.5.u1 To find out the interplanar spacing of the reflecting planes of the crystal

```
//Example 5_5_u1
clc();
clear;
//To find out the interplanar spacing of the reflecting planes of the crystal
theta=28        //units in degrees
lamda=0.12       //units in nm
n=2
d=(n*lamda)/(2*sin(theta*(%pi/180)))
printf("The interplanar spacing of the reflecting planes of the crystal is d=%.2fnm",d)
```

Scilab code Exa 5.6.u1 To calculate the interplanar spacing and wavelength

```
//Example 5_6_u1
```

```
clc();
clear;
//To calculate the interplanar spacing and wavelength
n1=1
theta1=23            //units in degrees
n2=3
theta2=60            //units in degrees
lamda1=97             //units in pm
lamda2=(n2*lamda1*sin(theta1*(%pi/180)))/(sin(theta2*(%pi/180)))            //units in pm
d=(n2*lamda1)/(2*sin(theta2*(%pi/180)))        //units in pm
printf("Wavelength lamda=%dpm \n Interplanar spacing d=%dpm",lamda2,d)
```

Scilab code Exa 5.7.u1 To find the wavelength whenthese planes give rise to maximum density in reflection

```
//Example 5_7_u1
clc();
clear;
//To find the wavelength whenthese planes give rise to maximum density in reflection
d=275     //units in pm
theta=45          //units in degrees
//For n=1
n=1
lamda=(2*d*sin(theta*(%pi/180)))/n        //units in pm
printf("Wavelength for n=1 is lamda=%.1fpm\n",lamda)
//For n=2
n=2
```

```
lamda=(2*d*sin(theta*(%pi/180)))/n        //units in pm
printf("Wavelength for n=1 is lamda=%.1fpm\n",lamda)
//For n=3
n=3
lamda=(2*d*sin(theta*(%pi/180)))/n        //units in pm
printf("Wavelength for n=1 is lamda=%.1fpm\n",lamda)
//For n=4
n=4
lamda=(2*d*sin(theta*(%pi/180)))/n        //units in pm
printf("Wavelength for n=1 is lamda=%.1fpm\n",lamda)
//For n=5
n=5
lamda=(2*d*sin(theta*(%pi/180)))/n        //units in pm
printf("Wavelength for n=1 is lamda=%.1fpm\n",lamda)
printf("For n=1,2,3 and >5 lamda lies beyond the range of wavelengths of polychromatic source")
```

Scilab code Exa 5.8.u1 To calculate the Bragg angle and the wavelength of X rays

```
//Example 5_8_u1
clc();
clear;
//To calculate the Bragg angle and the wavelength of X-rays
//Given plane indices are (1,1,1)
theta=87       //units in degrees
theta=theta/2    //units in degrees
a=0.2       //units in nm
```

```
h=1
k=1
l=1
d=a/sqrt(h^2+k^2+l^2)          //units in nm
lamda=2*d*sin(theta*(%pi/180))            //units in
    nm
printf("Bragg angle theta=%.1fdegrees \n wavelength
    lamda=%.3fnm",theta,lamda)
```

Scilab code Exa 5.9.u1 To determine the interplanar spacing

```
//Example 5_9_u1
clc();
clear;
//To determine the interplanar spacing
h=6.63*10^-34       //units in m^2 kg s^-1
m=9.1*10^-31         //units in Kgs
e=1.6*10^-19     //units in coulombs
v=844            //units in Volts
lamda=h/sqrt(2*m*e*v)              //units in meters
n=1
theta=58       //units in degrees
d=(n*lamda)/(2*sin(theta*(%pi/180)))             //
    units in meters
printf("The interplanar spacing d=")
disp(d)
printf("meters")
```

Scilab code Exa 5.10.u1 To calculate the lattice constant

```
//Example 5_10_u1
clc();
clear;
//To calculate the lattice constant
h=6.63*10^-34       //units in m^2 kg s^-1
m=1.804*10^-27       //units in Kgs
KB=1.38*10^-23        //units in m^2 kg s^-2 K^-1
T=300                //units in K
lamda=h/sqrt(3*m*KB*T)             //units in meters
n=2
a=(sqrt(3)*lamda)/2          //units in meters
printf("Lattice constant a=");
disp(a);
printf("meters")
```

Scilab code Exa 5.11.u1 To determine the unitcell and its dimensions

```
//Example 5_11_u1
clc();
clear;
//To determine the unitcell and its dimensions
//Experimental data
//We have relation sin^(theta)=(lamda/2*a)^2 and (h^2+k^2+l^2)=j*(lamda/2*a)^2
theta21=12.1         //units in degrees
theta22=17.1         //units in degrees
theta23=21          //units in degrees
theta24=24.3         //units in degrees
theta25=27.2         //units in degrees
theta26=29.9         //units in degrees
theta28=34.7         //units in degrees
theta29=36.9         //units in degrees
theta210=38.9         //units in degrees
```

```
theta211=40.9         //units in degrees
theta212=42.8         //units in degrees
theta1=theta21/2       //units in degrees
theta2=theta22/2       //units in degrees
theta3=theta23/2       //units in degrees
theta4=theta24/2       //units in degrees
theta5=theta25/2       //units in degrees
theta6=theta26/2       //units in degrees
theta8=theta28/2       //units in degrees
theta9=theta29/2       //units in degrees
theta10=theta210/2       //units in degrees
theta11=theta211/2       //units in degrees
theta12=theta212/2       //units in degrees
//sin^2(theta) values
sin1=(sin(theta1*%pi/180))^2
sin2=(sin(theta2*%pi/180))^2
sin3=(sin(theta3*%pi/180))^2
sin4=(sin(theta4*%pi/180))^2
sin5=(sin(theta5*%pi/180))^2
sin6=(sin(theta6*%pi/180))^2
sin8=(sin(theta8*%pi/180))^2
sin9=(sin(theta9*%pi/180))^2
sin10=(sin(theta10*%pi/180))^2
sin11=(sin(theta11*%pi/180))^2
sin12=(sin(theta12*%pi/180))^2
//sin^2(theta)/0.0111 value
temp1=sin1/sin1
temp2=sin2/sin1
temp3=sin3/sin1
temp4=sin4/sin1
temp5=sin5/sin1
temp6=sin6/sin1
temp8=sin8/sin1
temp9=sin9/sin1
temp10=sin10/sin1
temp11=sin11/sin1
temp12=sin12/sin1
//(h,k,l) values are determined such that the sum h
```

```
^2+k^2+l^2=temp value in that manner hence we have to select the (h,k,l) values
//(h,k,l) values
hkl1=100        //As h^2+k^2+l^2=1
hkl2=110        //As h^2+k^2+l^2=2
hkl3=111        //As h^2+k^2+l^2=3
hkl4=200        //As h^2+k^2+l^2=4
hkl5=210        //As h^2+k^2+l^2=5
hkl6=211        //As h^2+k^2+l^2=6
hkl8=220        //As h^2+k^2+l^2=8
hkl9=300        //As h^2+k^2+l^2=9
hkl10=310        //As h^2+k^2+l^2=10
hkl11=311        //As h^2+k^2+l^2=11
hkl12=222        //As h^2+k^2+l^2=12
printf("unit cell Dimensions when 2*theta=%.1f is (%d) where sin^2(theta)/0.0111 is %d\n",theta21,hkl1,temp1 )
printf("unit cell Dimensions when 2*theta=%.1f is (%d) where sin^2(theta)/0.0111 is %.1f\n",theta22,hkl2,temp2 )
printf("unit cell Dimensions when 2*theta=%.1f is (%d) where sin^2(theta)/0.0111 is %.1f\n",theta23,hkl3,temp3 )
printf("unit cell Dimensions when 2*theta=%.1f is (%d) where sin^2(theta)/0.0111 is %.1f\n",theta24,hkl4,temp4 )
printf("unit cell Dimensions when 2*theta=%.1f is (%d) where sin^2(theta)/0.0111 is%.1f\n",theta25,hkl5,temp5 )
printf("unit cell Dimensions when 2*theta=%.1f is (%d) where sin^2(theta)/0.0111 is %.1f\n",theta26,hkl6,temp6 )
printf("unit cell Dimensions when 2*theta=%.1f is (%d) where sin^2(theta)/0.0111 is %.1f\n",theta28,hkl8,temp8 )
printf("unit cell Dimensions when 2*theta=%.1f is (%d) where sin^2(theta)/0.0111 is %.1f\n",theta29,hkl9,temp9 )
```

```
printf("unit cell Dimensions when 2*theta=%.1f is (
    %d) where sin^2(theta)/0.0111 is %.1f\n",theta210
    ,hkl10,temp10 )
printf("unit cell Dimensions when 2*theta=%.1f is (
    %d) where sin^2(theta)/0.0111 is %.1f\n",theta211
    ,hkl11,temp11 )
printf("unit cell Dimensions when 2*theta=%.1f is (
    %d) where sin^2(theta)/0.0111 is %.1f\n",theta212
    ,hkl12,temp12 )
lamda=71            //units in pm
a=lamda/(2*sqrt(sin1))     //units in pm
printf("The unitcell and its dimensions are %dpm",a)
```

Scilab code Exa 5.12.u1 To determine the cubic structure of element and lattice constant and to identify element

```
//Example 5_12_u1
clc();
clear;
//To determine the cubic structure of element and
    lattice constant and to identify element
//Diffraction data
theta21=40          //units in degrees
theta22=58          //units in degrees
theta23=73          //units in degrees
theta24=86.8          //units in degrees
theta25=100.4          //units in degrees
theta26=114.7          //units in degrees
theta1=theta21/2          //units in degrees
theta2=theta22/2          //units in degrees
theta3=theta23/2          //units in degrees
theta4=theta24/2          //units in degrees
theta5=theta25/2          //units in degrees
```

```
theta6=theta26/2      //units in degrees
//sin^2(theta) values
sin1=(sin(theta1*%pi/180))^2
sin2=(sin(theta2*%pi/180))^2
sin3=(sin(theta3*%pi/180))^2
sin4=(sin(theta4*%pi/180))^2
sin5=(sin(theta5*%pi/180))^2
sin6=(sin(theta6*%pi/180))^2
//sin^2(theta)/0.111 value
temp1=sin1/sin1
temp2=sin2/sin1
temp3=sin3/sin1
temp4=sin4/sin1
temp5=sin5/sin1
temp6=sin6/sin1
//(h,k,l) values are determined such that the sum h^2+k^2+l^2=temp value in that manner hence we have to select the (h,k,l) values
//(h,k,l) values
hkl1=100    //As h^2+k^2+l^2=1
hkl2=110    //As h^2+k^2+l^2=2
hkl3=111    //As h^2+k^2+l^2=3
hkl4=200     //As h^2+k^2+l^2=4
hkl5=210       //As h^2+k^2+l^2=5
hkl6=211       //As h^2+k^2+l^2=6
printf("unit cell Dimensions when 2*theta=%.1f is (%d) where sin^2(theta)/0.0111 is %d\n",theta21,hkl1,temp1 )
printf("unit cell Dimensions when 2*theta=%.1f is (%d) where sin^2(theta)/0.0111 is %d\n",theta22,hkl2,temp2 )
printf("unit cell Dimensions when 2*theta=%.1f is (%d) where sin^2(theta)/0.0111 is %d\n",theta23,hkl3,temp3 )
printf("unit cell Dimensions when 2*theta=%.1f is (%d) where sin^2(theta)/0.0111 is %d\n",theta24,hkl4,temp4 )
printf("unit cell Dimensions when 2*theta=%.1f is (
```

```
%d) where sin^2(theta)/0.0111 is%d\n",theta25,hkl5,temp5 )
printf("unit cell Dimensions when 2*theta=%.1f is (%d) where sin^2(theta)/0.0111 is %d\n",theta26,hkl6,temp6 )

ratio=sin1/sin2
printf("The ratio of sin(theta)^2 values for first and second angles is %.2f\n Hence the crystal structure is bcc\n",ratio)
lamda=0.154    //units in nm
//As we have used ratio of angles of  2*theta=40 degrees and 58 degrees above we use h=1,k=1,l=0 and a^2=(lamda/2)*sqrt(sqrt(h^2+k^2+l^2)/sin^2(theta))
h=2
k=0
l=0
theta=20         //units in degrees
a=(lamda/2)*(sqrt(sqrt(h^2+k^2+l^2)/sin(theta*(%pi/180))^2))            //units in nm
printf("Lattice constant a=%.3fnm \n And the element  is tungsten Since Tungsten has lattice constant of %.3fnm and crystallizes in bcc structure",a,a)
//Given in textbook to find  lattice constant h=1,k=1,l=1 but the correct answer is h=2,k=0,l=0
```

Scilab code Exa 5.13.u1 To determine the crystal structure and indices of plane and lattice parameter of the material

```
//Example 5_13_u1
clc();
clear;
```

```
//To determine the crystal structure and indices of
   plane and lattice parameter of the material
theta21=20.7          //units in degrees
theta22=28.72          //units in degrees
theta23=35.36          //units in degrees
theta24=41.07          //units in degrees
theta25=46.19          //units in degrees
theta26=50.90          //units in degrees
theta28=55.28          //units in degrees
theta29=59.4          //units in degrees

theta1=theta21/2       //units in degrees
theta2=theta22/2       //units in degrees
theta3=theta23/2       //units in degrees
theta4=theta24/2       //units in degrees
theta5=theta25/2       //units in degrees
theta6=theta26/2       //units in degrees
theta8=theta28/2       //units in degrees
theta9=theta29/2       //units in degrees
//sin^2(theta) values
sin1=(sin(theta1*%pi/180))^2
sin2=(sin(theta2*%pi/180))^2
sin3=(sin(theta3*%pi/180))^2
sin4=(sin(theta4*%pi/180))^2
sin5=(sin(theta5*%pi/180))^2
sin6=(sin(theta6*%pi/180))^2
sin8=(sin(theta8*%pi/180))^2
sin9=(sin(theta9*%pi/180))^2
//sin^2(theta)/0.0308 values
temp1=sin1/sin1
temp2=sin2/sin1
temp3=sin3/sin1
temp4=sin4/sin1
temp5=sin5/sin1
temp6=sin6/sin1
temp8=sin8/sin1
temp9=sin9/sin1

```

```
h2k2l21=temp1*2

h2k2l22=temp2*2
h2k2l23=temp3*2
h2k2l24=temp4*2
h2k2l25=temp5*2
h2k2l26=temp6*2
h2k2l28=temp8*2
h2k2l29=temp9*2
//(h,k,l) values are determined such that the sum h^2+k^2+l^2=temp value in that manner hence we have to select the (h,k,l) values
//(h,k,l) values
hkl1=110       //As h^2+k^2+l^2=2
hkl2=200       //As h^2+k^2+l^2=4
hkl3=211       //As h^2+k^2+l^2=6
hkl4=220       //As h^2+k^2+l^2=8
hkl5=310       //As h^2+k^2+l^2=10
hkl6=232       //As h^2+k^2+l^2=12
hkl8=321               //As h^2+k^2+l^2=14
hkl9=400       //As h^2+k^2+l^2=16

printf("unit cell Dimensions for peak 1 when 2*theta=%.1f is (%d) where sin^2(theta)/0.0308 is %.2f\n",theta21,hkl1,ceil(h2k2l21) )
printf("unit cell Dimensions for peak 2 when 2*theta=%.1f is (%d) where sin^2(theta)/0.0308 is %.2f\n",theta22,hkl2,ceil(h2k2l22) )
printf("unit cell Dimensions for peak 3 when 2*theta=%.1f is (%d) where sin^2(theta)/0.0308 is%.2f\n",theta23,hkl3,ceil(h2k2l23))
printf("unit cell Dimensions for peak 4 when 2*theta=%.1f is (%d) where sin^2(theta)/0.0308 is %.2f\n",theta24,hkl4,ceil(h2k2l24))
printf("unit cell Dimensions for peak 5 when 2*theta=%.1f is (%d) where sin^2(theta)/0.0308 is%.2f\n",theta25,hkl5,ceil(h2k2l25))
printf("unit cell Dimensions for peak 6 when 2*theta
```

```
=%.1f is (%d) where sin^2(theta)/0.0308 is%.2f\n",theta26,hkl6,ceil(h2k2l26))
printf("unit cell Dimensions for peak 7 when 2*theta=%.1f is (%d) where sin^2(theta)/0.0308 is %.2f\n",theta28,hkl8,ceil(h2k2l28))
printf("unit cell Dimensions for peak 8 when 2*theta=%.1f is (%d) where sin^2(theta)/0.0308 is %.2f\n",theta29,hkl9,ceil(h2k2l29))

printf("The material corresonds to bcc structure\n")
//Consider peak no 8 where theta=29.71
lamda=0.07107         //units in nm
d400=lamda/(2*sin(theta9*(%pi/180)))         //units in nm
a=d400*sqrt(ceil(h2k2l29))          //units in nm
printf("Lattice parameter of the material a=%.4fnm",a)
```

Scilab code Exa 5.14.u1 To calculate the effective temprature of neutrons

```
//Example 5_14_u1
clc();
clear;
//To calculate the effective temprature of neutrons
a=0.352      //units in nm
h=1
k=1
l=1
d=a/sqrt(h^2+k^2+l^2)          //units in nm
theta=28.5          //units in degrees
lamda=2*d*sin(theta*(%pi/180))          //units in nm
h=6.63*10^-34       //units in m^2 kg s^-1
m=1.67*10^-27       //units in Kgs
```

```
KB=1.38*10^-23          //units in m^2 kg s^-2 K^-1
lamda=lamda*10^-9            //units in meters
T=h^2/(3*m*KB*lamda^2)          //units in K
printf("The effective temprature of neutrons is T=%dK",T)
```

Scilab code Exa 5.15.u1 To calculate the Braggs angle

```
//Example 5_15_u1
clc();
clear;
//To calculate the Braggs angle
h=6.63*10^-34        //units in m^2 kg s^-1
m=9.1*10^-31         //units in Kgs
e=1.6*10^-19          //units in coulombs
v=80                   //units in volts
lamda=h/sqrt(2*m*e*v)              //units in mts
lamda=lamda*10^9         //units in nm
a=0.35           //units in nm
h=1
k=1
l=1
d111=a/sqrt(h^2+k^2+l^2)         //units in nm              //units in nm
theta=asin(lamda/(2*d111))                //units in radians
theta=theta*180/%pi                      //units in degrees
printf("Braggs angle is theta=%.2fDegrees or 19 Degrees40Minutes",theta)
```

Scilab code Exa 5.16.u1 To calculate the difference between the samples

```
//Example 5_16_u1
clc();
clear;
//To calculate the difference between the samples
d=0.2552        //units in nm
a=d*sqrt(2)       //units in nm
lamda=0.152       //units in nm
theta=21          //units in degrees
//For sample A
d111=lamda/(2*sin(theta*%pi/180))      //units in nm
h=1
k=1
l=1
a1=d111*sqrt(h^2+k^2+l^2)            //units in nm
printf("For sample A a=%.4f nm",a1)
//For sample B
theta=21.38           //units in degrees
d111=lamda/(2*sin(theta*%pi/180))      //units in nm
h=1
k=1
l=1
a2=d111*sqrt(h^2+k^2+l^2)            //units in nm
change=((a1-a2)/a2)*100
printf("\nFor sample B a=%.4f nm",a2)
printf("\n Sample B is pure high purity copper as
   lattice parameter of A is %.2f percent greater
   than that of pure copper",change)
//Given in text book change in lattice parameter is
   1.75% greater  but it is 1.73%
```

Scilab code Exa 5.17.u1 To find the type of crystal and lattice parameter and atomic diameter

```
//Example 5_17_u1
clc();
clear;
//To find the type of crystal and lattice parameter
   and atomic diameter
lamda=0.171          //units in nm
theta=30             //units in degrees
//Assuming the metal is BCC
d110=lamda/(2*sin(theta*%pi/180))       //units in nm
h=1
k=1
l=0
a1=d110*sqrt(h^2+k^2+l^2)              //units in nm
a2=0.148*sqrt(4)
printf("The lattice parameter is a=%.3fnm but a=%.3
   fnm if we consider it as bcc hence it is not bcc"
   ,a1,a2)
//Assuming the metal is FCC
a1=0.171*sqrt(3)     //units in nm
a2=0.148*sqrt(4)     //units in nm
ad=a1/sqrt(2)        //units in nm
printf("\nIf we consider it as FCC a=%.3fnm hence it
    is FCC",a1)
printf("\n Atomic diameter is %.4fnm",ad)
```

Scilab code Exa 5.18.u1 To find out the planes which gives reflection

```
//Example 5_18_u1
clc();
clear;
//To find out the planes which gives reflection
lamda=0.154    //units in nm
theta=90                  //units in degrees  as sin(
    theta) is maximum at 90 degrees
d=lamda/(2*sin(theta*%pi/180))        //units in nm
D=0.228             //units in nm
hkl=(2*D)/(d*sqrt(3))
hkl2=hkl^2
printf("As h^2+k^2+l^2=%.2f \n The highest possible
    values of (h,k,l) are (2,2,2) Hence (2,2,2)
    planes give reflection",hkl2)
//Given in text book h^2+k^2+l^2=13.98 but the
    answer is h^2+k^2+l^2=11.69
```

Chapter 6

LASER

Scilab code Exa 6.1.u1 To calculate the Electric field of a laser beam

```
//Example 6_1_u1
clc();
clear;
//To calculate the Electric field of a laser beam
power=1            //units in milli Watts
power=power*10^-3        //units in Watts
area=3       //units in milli meter^2
area=area*10^-6       //units in meter^2
i=power/area          // units in Watts/meter^2
c=3*10^8    //units in meter/sec
u=4*10^-7        //units in SI
n=1
E0=sqrt((i*2*c*u)/n)     //units in V/meters
printf("The electric field is E0=%.2f V/m",E0)
//In text book answer is given E0=501 V/m but the
   correct answer is E0=282.84 V/m
```

Scilab code Exa 6.2.u1 To calculate the Electric field of a bulb

```
//Example 6_2_u1
clc();
clear;
//To calculate the Electric field of a bulb
power=10         //units in Watts
r=10             //units in meters
area=4*%pi*r^2          //units in meter^2
i=(100*power)/area          //Units in Watt/meter^2
c=3*10^8    //units in meter/sec
u=4*10^-7          //units in SI
n=1
E0=sqrt((i*2*c*u)/n)     //units in Volt/meter
printf("The electric field of the bulb is E0=%.2f
   Volt/meters",E0)
//In text book answer is given E0=2.4 V/m but the
   correct answer is E0=13.82 V/m
```

Scilab code Exa 6.3.u1 To calculate the electric field intensity a a point

```
//Example 6_3_u1
clc();
clear;
//To calculate the electric field intensity a a
   point
power=1        //units in milli Watts
power=power*10^-3 //units in Watts
r=6          //units in milli meters
r=6*10^-6      //units in meters
area=%pi*r^2          //units in meter^2
i=power/area       //units in Watt/meter^2
c=3*10^8    //units in meter/sec
```

```
u=4*10^-7          //units in SI
n=1
E=sqrt((i*2*c*u)/n)     //units in Volt/meters
printf("The electric field intensity a a point is
    given by E=%.2f Volt/meters",E)
//In text book answer is given E=8.1*10^4 V/m but
    the correct answer is E=46065.89 V/m
```

Scilab code Exa 6.4.u1 To calculate the ratio of populations of two energy levels

```
//Example 6_4_u1
clc();
clear;
//To calculate the ratio of populations of two
    energy levels
h=6.63*10^-34        //units in m^2 kg s^-1
c=3*10^8             //units in meter/sec
lamda=694.3               //units in nm
lamda=lamda*10^-9         //units in meters
kb=1.38*10^-23                //units in m^2 kg s^-2
   K^-1
T=300                      //units in K
n1_n2=exp((h*c)/(lamda*kb*T))
printf("The ratio of Populations of two energy
    levels is N1/N2=")
disp(n1_n2);
```

Scilab code Exa 6.5.u1 To find the wavelength of the radiation emitted

```
//Example 6_5_u1
clc();
clear;
//To find the wavelength of the radiation emitted
h=6.63*10^-34        //units in m^2 kg s^-1
c=3*10^8             //units in meter/sec
kb=1.38*10^-23                    //units in m^2 kg s^-2 K^-1
T=300                                       //units in K
lamda=(h*c)/(kb*T)                //units in microns
lamda=lamda*10^6                  //units in micro meters
printf("The wavelength of the radiation emmitted is lamda=%.2f um",lamda)
```

Scilab code Exa 6.6.u1 To calculate the ratio of stimulated emission to Spontaneous emission

```
//Example 6_6_u1
clc();
clear;
//To calculate the ratio of stimulated emission to Spontaneous emission
h=6.63*10^-34                     //units in m^2 kg s^-1
c=3*10^8                                    //units in meter/sec
lamda=694.3                                    //units in nm
lamda=lamda*10^-9                          //units in meters
kb=1.38*10^-23                                  //units in m^2 kg s^-2 K^-1
```

```
T=300                                                  //units in K
constant=(h*c)/(lamda*kb*T)
R=1/(exp(constant)-1)
printf("The ratio of stimulated emission to Spontaneous emission is R=")
disp(R)
//In text book answer is given R=4.98*10^-14 but the correct answer is R=8.874D-31
```

Scilab code Exa 6.7.u1 To calculate the no of photons emitted by the ruby laser

```
//Example 6_7_u1
clc();
clear;
//To calculate the no of photons emitted by the ruby laser
p=1          //units in Watts
lamda=694.3              //units in nm
lamda=lamda*10^-9          //units in meters
h=6.63*10^-34              //units in m^2 kg s^-1
c=3*10^8                          //units in meter/sec
n=(p*lamda)/(h*c)
printf("The no of photons emitted by the ruby laser is n=")
disp(n)
```

Chapter 7

FIBER OPTICS

Scilab code Exa 7.1.u1 To determine the no of modes propogating in the fiber

```
//Example 7_1_u1
clc();
clear;
//To determine the no of modes propogating in the
   fiber
n1=1.48
n2=1.41
NA=sqrt(n1^2-n2^2)
d=60  //units in micro mts
lamda0=0.8        //units in micro mts
v=(%pi*d*NA)/lamda0
n=v^2/2
printf("Number of modes n=%.2f",n)
//In text book the answer given wrong as n=4.55*10^3
       the correct answer is n=5615.50
```

Scilab code Exa 7.2.u1 To find the fraction of initial intensity

```
//Example 7_2_u1
clc();
clear;
//To find the fraction of initial intensity
alpha=-2.2            //units in db/Kilo meters
//When l=2 Kilo meters
l=2    //units in Kilo meters
//Case (a) when L=2 Kilo meters
It_I0=10^(alpha*l/10)
printf("The fraction of initial intensity left when L=2 It/I0=%.3f\n",It_I0)
//Case (b) when L=6 Kilo meters
l=6    //units in Kilo meters
It_I0=10^(alpha*l/10)
printf("The fraction of initial intensity left when L=6 It/I0=%.3f\n",It_I0)
```

Scilab code Exa 7.3.u1 To calculate the numerical apperture and angle of acceptance

```
//Example 7_3_u1
clc();
clear;
//To calculate the numerical apperture and angle of acceptance
n1=1.48
delta=0.05
NA=n1*sqrt(2*delta)
printf("Numerical apperture is NA=%.3f\n",NA)
ia=asin(NA)*180/%pi              //units in degrees
printf("Angle of acceptance is ia=%.2f Degrees",ia)
```

Scilab code Exa 7.4.u1 To calculate the numerical apperture and angle of acceptance

```
//Example 7_4_u1
clc();
clear;
//To calculate the numerical apperture and angle of
    acceptance
n1=1.45
n2=1.40
NA=sqrt(n1^2-n2^2)
printf("Numerical apperture is NA=%.3f\n",NA)
ia=asin(NA)*180/%pi                    //units in degrees
printf("Angle of acceptance is ia=%.2f Degrees",ia)
```

Scilab code Exa 7.5.u1 To find the loss specification of a fiber

```
//Example 7_5_u1
clc();
clear;
//To find the loss specification of a fiber
l=0.5           //units in KM
it=7.5*10^-6        //units in micro mts
i0=8.6*10^-6         //units in micro mts
alpha=(10/l)*log10(it/i0) //units in db/Km
printf("The loss specification of the fiber is alpha
   =%.2f db/km",alpha)
```

Scilab code Exa 7.6.u1 To calculate the numerical aperture acceptance angle critical angle velocity of the light in core and cladding

```
//Example 7_6_u1
clc();
clear;
//To calculate the numerical aperture,acceptance angle,critical angle,velocity of the light in core and cladding
n1=1.5
delta=1.8*10^-2
NA=n1*sqrt(2*delta)
printf("Numerical apperture is NA=%.3f\n",NA)
ia=asin(NA)*180/%pi                    //units in degrees
printf("Angle of acceptance is ia=%.2f Degrees\n",ia)
n2=0.982*n1
n2_n1=0.982
ic=asin(n2_n1)*180/%pi                    //units in degrees
printf("Critical angle is ic=%.2f Degrees\n",ic)
c=3*10^8
vc=c/n1
printf("Velocity of light in core is vc=")
disp(vc)
vcc=c/n2
printf("Velocity of light in cladding is vcc=")
disp(vcc)
```

Scilab code Exa 7.7.u1 To calculate the fiber length

```
//Example 7_7_u1
clc();
clear;
//To calculate the fiber length
alpha=0.5    //units in db/KM
it=2*10^-6          //units in W
i0=1.5*10^-3            //units in W
l=-1*(10/alpha)*log10(it/i0)      //units in KM
printf("The length of the fiber is L=%.1f KM",l)
```

Chapter 9

QUANTUM MECHANICS AND QUANTUM COMPUTING

Scilab code Exa 1.1.u2 To calculate energy momentum and the probability of of finding the particle

```
//Example 1_1_u2
clc();
clear;
//To calculate energy momentum and the probability
   of of finding the particle
n=3
h=6.63*10^-34              //units in m^2 kg s^-1
m=1.67*10^-27         //units in Kgs
l=0.1           //units in nm
l=l*10^-9          //units in meters
e=(n^2*h^2)/(8*m*l^2)     //units in joules
printf("The energy of the particle is E=")
disp(e)
printf("Joules")
lamda=(2*l)/n         //units in meters
lamda=6.6*10^-11   //units in meters
```

```
p=h/lamda         //units in Kg meter s^-1
printf("\nMomentum is p=")
disp(p)
printf("Kg  meter s^-1")
prob=((1/3)-0)
printf("\nThe probability of finding the particle is =%.2f",prob)
```

Scilab code Exa 1.2.u2 To calculate the wavelength of the radiation emitted

```
//Example 1_2_u2
clc();
clear;
//To calculate the wavelength of the  radiation emitted
h=6.63*10^-34             //units in m^2 kg s^-1
m=9.1*10^-31          //units in Kgs
l=1               //units in nm
l=l*10^-9        //units in meters
c=3*10^8          //units in meters/sec
lamda=(8*m*c*l^2)/(27*h)   //units in meters
lamda=lamda*10^9          //units in nm
printf("The wavelength of the radiation is lamda=%.1fnm",lamda)
```

Scilab code Exa 1.3.u2 To calculate the uncertenity in momentum

```
//Example 1_3_u2
```

```
clc();
clear;
//To calculate the uncertenity in momentum
h=6.63e-34                    //units in m^2 kg s^-1
deltax=1            //units in nm
deltax=deltax*10^-9                    //units in meters
deltap=h/(4*%pi*deltax)              //units in Kg meter s^-1
printf("The uncertenity in momentum is delta p=")
disp(deltap)
printf("Kg ms^-1")
//In text book the answer is printed wrong as 0.53*10^-15 Kg ms^-1 the correct answer is  5.276 D-26  Kg ms^-1
```

Scilab code Exa 1.4.u2 To find out the no of states that can accomodate

```
//Example 1_4_u2
clc();
clear;
//To find out the no of states that can accomodate
h=6.63*10^-34                //units in m^2 kg s^-1
m=9.1*10^-31            //units in Kgs
l=0.5              //units in nm
l=l*10^-9              //units in meters
v=15           //units in eV
v=v*1.6*10^-19              //units in Volts
nmax=(4*l*sqrt(m*v))/h
printf("The maximum quantum number possible is n=%d",nmax)
```

Chapter 10

ELECTRON THEORY OF METALS

Scilab code Exa 2.1.u2 To calculate the density of electrons and mobility of electrons in silver

```
//Example 2_1_u2
clc();
clear;
//To calculate the density of electrons and mobility
    of electrons in silver
row=10.5*10^3        //units in Kg/m^3
NA=6.023*10^23            //Avagadro number
Z=1
MA=107.9*10^-3          //units in Kg
n=(row*NA*Z)/MA         //units in m^-3
printf("The number density of electrons is n=")
disp(n)
printf("m^-3")
row=6.8*10^7            //units in ohm^-1 metre^-1
n=5.86*10^28            //units in m^-3
e=1.6*10^-19            //units in  coulombs
u=(row)/(n*e)               //units in m^2 V^-1 sec^-1
printf("\nThe conductivity is u=")
```

```
disp(u)
printf("m^2 V^-1 sec^-1")
```

Scilab code Exa 2.2.u2 To corresponding mean free path and compare with experimental value

```
//Example 2_2_u2
clc();
clear;
//To corresponding mean free path and compare with experimental value
row=6.87*10^7                    //units in Kg/m^3
m=9.11*10^-31                  //units in Kgs
n=5.86*10^28                            //units in m^-3
e=1.6*10^-19                       //units in coulombs
t=(row*m)/(n*e^2)          //units in s
printf("The mean free path is t=")
disp(t)
printf("sec")
kb=1.381*10^-23            //units in m^2 kg s^-2 K^-1
T=300                    //units in K
m=9.11*10^-31                         //units in Kgs
v=(sqrt(3*kb*T))/sqrt(m)           //units in m/s
printf("\nVelocity v=%.2f m/s\n",v)
lamda=t*v //units in meters
printf("Wavelength is lamda=")
disp(lamda)
printf("meters")
printf("\nThe experimental value is ten times higher than predicted value")
```

```
//In textbook the answer is printed wrong as t=2.84*10^-14 s and lamda=3.28*10^-9 meters but correct answer is t=4.172D-14sec and lamda=4.873D-09 meters
```

Scilab code Exa 2.3.u2 To calculate the drift velocity and their mobility

```
//Example 2_3_u2
clc();
clear;
//To calculate the drift velocity and their mobility
rowm=2700     //units in kg/m^3
NA=6.023*10^23                    //Avagadro number
MA=26.98*10^-3          //units in Kg
n=(rowm*NA)/MA              //units in m^-3
row=2.52*10^-6            //units in ohm metre
e=1.6*10^-19                      //units in  coulombs
u=(row/(n*e))*10^13         //units in meter^2 V^-1 s^-1
E=50         //units in Volt/meter
vd=u*E                //units in meter/sec
printf("The drift velocity of conduction electrons is vd=%.4f meter/sec",vd)
printf("\nMobility of conduction electrons is n=")
disp(n)
printf("meter^-3")
//Given in text book mobility is n=18.07*10^28 meter^-3 but the correct answer is n=6.027D+28 meter^-3
//Given in text book vd=0.066 meter/sec which is wrong and the correct one is vd=0.1307 meter/sec
```

Scilab code Exa 2.4.u2 To calculate the current density in each wire and drift speed of electrons

```
//Example 2_4_u2
clc();
clear;
//To calculate the current density in each wire and drift speed of electrons
dcu=1.8*10^-3      //units in meters
dAl=2.5*10^-3      //units in meters
Acu=(%pi*dcu^2)/4       //units in meter^2
AAl=(%pi*dAl^2)/4       //units in meter^2
ia=1.3     //units in amperes
jcu=ia/Acu              //units in A/meter^2
jAl=ia/AAl              //units in A/meter^2
printf("Current density in Copper is jcu=%.2f A/meter^2\n",jcu)
printf("Current density in Aluminium is jal=%.2f A/meter^2\n",jAl)
d1=8.49*10^28      //units in meter^-3
d2=18*10^28      //units in meter^-3
e=1.6*10^-19                    //units in  coulombs
vdcu=jcu/(d1*e)      //units in meter/sec
vdal=jAl/(d2*e)      //units in meter/sec
printf("Drift speed of electrons in copper vdcu=%.6f meter/sec\n",vdcu)
printf("Drift speed of electrons in Aluminium vdal=%.6f meter/sec\n",vdal)
```

Scilab code Exa 2.5.u2 To calculate the no of states for conduction electrons and the average energy interval

```
//Example 2_5_u2
clc();
clear;
//To calculate the no of states for conduction
   electrons and the average energy interval
n=9.11*10^-31                //units in Kg
E=5*1.6*10^-19           //units in J
v=10^-6         //units in meter^3
h=6.67*10^-34                    //units in m^2 kg s^-1
NE=(8*sqrt(2)*%pi*n^1.5*E^0.5*v)/h^3          //units
   in J^-1
no=NE*0.01*1.6*10^-19              //units in J
printf("Available number of energy states is ")
disp(no)
interval=0.01/no          //units in eV
printf("Average energy interval is")
disp(interval)
printf("eV")
//Given in text book available no of energy states
   is 1.52*10^20 but correct answer is 1.490D+20
   and for average energy interval is 7*10^-23 eV
   but correct answer is 6.709D-23 eV
```

Scilab code Exa 2.6.u2 To calculate the fermi energy level

```
//Example 2_6_u2
clc();
clear;
//To calculate the fermi energy level
h=4.14*10^-15       //units in m^2 kg s^-1
n=8.49*10^28          //units in m^-3
m=9.1*10^-31        //units in Kgs
Ef=(h^2*(3*n)^0.666)/(8*m*(%pi)^0.666)         //units in J
Ef=Ef*1.67*10^-19        //units in eV
printf("Fermi energy for copper is Ef=%.2f eV",Ef)
```

Scilab code Exa 2.7.u2 To calculate the probability for a state

```
//Example 2_7_u2
clc();
clear;
//To calculate the probability for a state
//When 0.1 eV above the fermi energy
e_ef=0.1        //units in eV
kb=8.62*10^-5            //units in eV/K
t=800          //units in kelvin
fE=1/(1+exp((e_ef)/(kb*t)))
printf("The probability of occupancy for a state whose energy is 0.1 eV above the fermi energy is f(E)=%.3f",fE)
//0.1 eV below the fermi energy level
e_ef=-0.1       //units in eV
fE=1/(1+exp((e_ef)/(kb*t)))
printf("\nThe probability of occupancy for a state whose energy is 0.1 eV below the fermi energy is f(E)=%.3f",fE)
//Equal to the fermi energy level
```

```
e_ef=0      //units in eV
fE=1/(1+exp((e_ef)/(kb*t)))
printf("\nThe probability of occupancy for a state whose energy is 0.1 eV and  equal to the fermi energy is f(E)=%.3f",fE)
```

Scilab code Exa 2.8.u2 TO Find the energy at which probability of occupancy is point9 and density of states and the population density

```
//Example 2_8_u2
clc();
clear;
//TO Find the energy at which probability of occupancy is 0.9 and density of states and the population density
fe=0.9
k=(1/fe)-1
logk=log(k)
kb=8.62*10^-5                  //units in eV/K
t=1000       //units in K
E=logk*kb*t         //units in eV
ef=7.06       //units in eV
energy=E+ef       //units in eV
printf("The energy of this state is E=%.2f eV",energy)
n=9.1*10^-31                        //units in Kgs
EE=energy           //units in eV
h=4.14*10^-15       //units in eV sec
ZE=(8*sqrt(2)*%pi*n^1.5*sqrt(EE))/h^3         //units in meter^-3 (eV)^-1
ZE=ZE*1.56*10^28                         //units meter^-3 (eV)^-1
printf("\nThe density of the states for this energy
```

```
    is Z(E)=")
disp(ZE)
printf("meter^-3 (eV)^-1")
ne=ZE*fe    //units in meter^-3 (eV)^-1
printf("\nThe population density for this energy is
    N(E)=")
disp(ne)
printf("meter^-3 (eV)^-1")
```

Scilab code Exa 2.9.u2 To calculate the fermi energy and fermi factor

```
//Example 2_9_u2
clc();
clear;
//To calculate the fermi energy and fermi factor
ve=4*3           //No of Valence electrons
v=4.05*10^-10                    //units in meter^3
n=ve/v^3       //units in meter^-3
h=4.14*10^-15                //units in eV sec
m=9.1*10^-31                        //units in Kgs
Ef=(h^2*(3*n)^0.666)/(8*m*(%pi)^0.666)          //
    units in J
Ef=Ef*1.67*10^-19          //units in eV
printf("Fermi energy is Ef=%.2f eV",Ef)
e_ef=0.1         //units in eV
kb=8.62*10^-5                //units in eV/K
t=300          //units in kelvin
fE=1/(1+exp((e_ef)/(kb*t)))
printf("\nFermi factor f(E) is %.4f",fE)
```

Chapter 13

SUPERCONDUCTIVITY

Scilab code Exa 5.1.u2 To find the temprature where would be the critical field

```
//Example 5_1_u2
clc();
clear;
//To find the temprature where would be the critical
    field
hc=0.070        //units in K
ho=0.0803        //units in K
tc=7.22           //units in K
T=tc*sqrt(1-(hc/ho))         //units in K
printf("Temprature T=%.2f K",T)
//Given in textbook T=2.94K But the correct answer
   is T=2.59K
```

Scilab code Exa 5.2.u2 To calculate the maximum current density

```
//Example 5_2_u2
clc();
clear;
//To calculate the maximum current density
hc=7.9*10^3     //units in amp/meter
d=10^-3              //units in meter
ic=hc*%pi*d          //units in amp
critcurrentden=(ic*4)/(%pi*d^2) //units in amp/meter^2
printf("The critical current density is %d amp/meter^2",critcurrentden)
```

Scilab code Exa 5.3.u2 To calculate the transition temprature and critical field

```
//Example 5_3_u2
clc();
clear;
//To calculate the transition temprature and critical field
hc1=1.4*10^5        //units in amp/meter
hc2=4.2*10^5         //units in amp/meter
t1=14         //units in K
t2=13          //units in K
tc=sqrt((hc1*t2^2-hc2*t1^2)/(hc1-hc2))      //units in K
printf("Transition temprature is Tc=%.2f K",tc)
hc1_ho=1-(t1/tc)^2
ho=hc1/hc1_ho         //units in amp/meter
printf("\nCritical field Ho=%.1f amp/meter",ho)
```

Scilab code Exa 5.4.u2 To calculate its critical temprature

```
//Example 5_4_u2
clc();
clear;
//To calculate its critical temprature
tc1=4.185         //units in K
m1=199.5
m2=203.4
tc2=tc1*sqrt(m1/m2)       //units in K
printf("Critical temprature Tc2=%.3f K",tc2)
```

Chapter 14

DIELECTRIC PROPERTIES

Scilab code Exa 6.1.u2 To calculate the dielectric constant

```
//Example 6_1_u2
clc();
clear;
//To calculate the di-electric constant
eo=8.85*10^-12    //units in F/meter
alphae=36*10^-40     //units in meter^3
n=5*10^28    //units in meter^-3
er=((30*eo)+(2*n*alphae))/((30*eo)-(n*alphae))
printf("The di-electric constant is er=%.2f",er)
```

Scilab code Exa 6.2.u2 To calculate the atomic polarizability

```
//Example 6_2_u2
clc();
clear;
//To calculate the atomic polarizability
eo=8.85*10^-12         //units in F/meter
```

```
er=1.000435
n=2.7*10^25          //No of atoms/meter^3
alpha=(eo*(er-1))/n          //units in meter^3
printf("The atomic polarizability is aplha=")
disp(alpha)
printf("meter^3")
```

Chapter 15

SEMICONDUCTORS

Scilab code Exa 7.1.u2 To calculate the mean free path and mean free time

```
//Example 7_1_u2
clc();
clear;
//To calculate the mean free path and mean free time
mn=0.26*0.91*10^-30            //units in Kgs
un=1000*10^-4         //units in cm^2 V^-1 s^-1
e=1.6*10^-19           //units in coulombs
tc=(mn*un)/e          //units in s
tc1=tc*10^12          //units in ps
printf("The mean free time is %.3fps",tc1)
vth=10^7
meanfreepath=vth*tc*10^7         //units in nm
printf("\nThe mean free path is given by L=%.1f nm",meanfreepath)
```

Scilab code Exa 7.2.u2 To calculate the diffusion current density

```
//Example 7_2_u2
clc();
clear;
//To calculate the diffusion current density
Dn=22.5 //units in cm^2/sec
e=1.6*10^-19  //units in coulombs
dn=(1*10^18)-(7*10^17)
dx=0.1            //units in cm
Jndiff=e*Dn*(dn/dx)          //units in A/cm^2
printf("The diffusion current density is Jn,diff=%.1
   f A/cm^2",Jndiff)
```

Scilab code Exa 7.3.u2 To find the drift velocity and diffusivity

```
//Example 7_3_u2
clc();
clear;
//To find the drift velocity and diffusivity
vp=1/(100*10^-6)           //units in cm/sec
eapp=50                    //units in Volt cm^-1
up=vp/eapp          //units in cm^-2 V^-1 s^-1
k=0.0259              //units in eV
dp=(k*up)              //units in cm^2 s^-1
printf("The drift velocity is Vp=%d cm/sec\n",vp)
printf("The diffusivity of minority carriers is Dp=%
   .2f cm^2/sec",dp)
```

Scilab code Exa 7.4.u2 To find the charge in the minority carrier concentration

```
//Example 7_4_u2
clc();
clear;
//To find the charge in the minority carrier
   concentration
ni=9.65*10^9        //units in cm^-3
nno=10^14      //units in cm^-3
//Before illumination
pno=ni^2/nno      //units in cm^-3
//After illumination
tp=2           //units in us
tp=tp*10^-6        //units in sec
gl=(10^13/10^-6)          //units in No of electron
   hole pair for cm^-3
pn=pno+(tp*gl)        //units in cm^-3
printf("Change in the minority carrier concentration
    is Pn=")
disp(pn)
printf("cm^-3")
```

Scilab code Exa 7.5.u2 To find the hall voltage

```
//Example 7_5_u2
clc();
clear;
//To find the hall voltage
e=1.6*10^-19     //units in coulombs
n=10^16          //units in no of atoms for cm^-3
Rh=-1/(e*n)          //units in cm^3/C
i=1            //units in milli amperes
i=i*10^-3          //units in amperes
Bz=10^-4       //units in wb/cm^2
a=2.5*10^-3       //units in cm^2
```

```
w=500*10^-4                    //units in micro cm
Vh=((Rh*i*Bz)/a)*w               //units in V
Vh=Vh*10^3                        //units in mV
printf("The hall voltage is Vh=%.5f mV",Vh)
```