Scilab Textbook Companion for Applied Physics-i by I. A. Shaikh[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

Crystallography

Scilab code Exa 1.3.1 calculate Unit cell dimension

```
1 //Chapter-1,Example1_3_1,pg 1-14
2
3 A=26.98                                   //atomic
    weight of Al
4
5 N=6.023*10^26                             //Avogadro's
     number
6
7 p=2700                                    //Density
8
9 n=4                                       //FCC
    structure
10
11 a=(n*A/(N*p))^(1/3)
12
13 printf("Unit cell dimension of Al=")
14
15 disp(a)
16
17 printf("m")
```

Scilab code Exa 1.3.2 calculate density

```
1 //Chapter-1,Example1_3_2,pg 1-15
2
3 As=28.1                                   //atomic
     weight of Si
4
5 Ag=69.7                                   //atomic
     weight of Ga
6
7 Aa=74.9                                   //atomic
     weight of As
8
9 as=5.43*10^-8                             //lattice
     constant of Si
10
11 aga=5.65*10^-8                           //lattice
     constant of GaAs
12
13 ns=8                                     //no of
     atoms/unit cell in Si
14
15 nga=4                                    //no of
     atoms/unit cell in GaAs
16
17 N=6.023*10^23                            //Avogadro's
     number
18
19 //p=(n*A)/(N*a^3) this is formula for density
20
21 //for Si
22
23 ps=(ns*As)/(N*as^3)
24
```

```
25 printf("            1) Density of Si=")
26
27 disp(ps)
28
29 printf("gm/cm^3")
30
31 //for GaAs
32
33 Aga=Ag+Aa                                    //molecular
      wt of GaAs
34
35 pga=(nga*Aga)/(N*aga^3)
36
37 printf("     2) Density of GaAs=")
38
39 disp(pga)
40
41 printf("gm/cm^3")
```

Scilab code Exa 1.3.3 calculate density

```
1 //Chapter-1,Example1_3_3,pg 1-16
2
3 A=63.5                                       //atomic
      weight of Cu
4
5 N=6.023*10^23                                //Avogadro's
      number
6
7 n=4                                          //FCC
      structure
8
9 r=1.28*10^-8                                 //atomic
      radius of Cu
10
```

```
11 //for FCC
12
13 a=4*r/(sqrt(2))                                    //lattice
      constant
14
15 p=(n*A)/(N*a^3)
16
17 printf("Density of Cu=")
18
19 disp(p)
20
21 printf("gm/cm^3")
```

Scilab code Exa 1.3.4 calculate APF

```
1 //Chapter-1,Example1_3_4,pg 1-17
2
3 A=50                                               //atomic
      weight of chromium
4
5 N=6.023*10^23                                     //Avogadro's
      number
6
7 p=5.96                                            //Density
8
9 n=2                                               //BCC
      structure
10
11 //step 1 : claculation for lattice constant (a)
12
13 a=(n*A/(N*p))^(1/3)
14
15 //step 2 : radius of an atom in BCC
16
17 r=sqrt(3)*a/4
```

```
18
19 //step 3 : Atomic packing factor (APF)
20
21 APF=n*((4/3)*%pi*r^3)/a^3
22
23 printf("Atomic packing factor (APF)=")
24
25 disp(APF)
```

Scilab code Exa 1.3.5 calculate no of unit cell

```
1  //Chapter-1,Example1_3_5,pg 1-17
2
3  A=120                                    //atomic
       weight of chromium
4
5  N=6.023*10^23                            //Avogadro's
       number
6
7  p=5.2                                    //Density
8
9  n=2                                      //BCC
       structure
10
11 m=20                                     //mass
12
13 //step 1 : claculation for volume of unit cell(a^3)
14
15 a=(n*A/(N*p))
16
17 //step 2 : volume of 20 gm of the element
18
19 v=m/p
20
21 //step 3 :no of unit cell
```

```
22
23 x=v/a
24
25 printf("no of unit cell=")
26
27 disp(x)
```

Scilab code Exa 1.3.6 calculate no of atoms per meter cube

```
1  //Chapter-1,Example1_3_6,pg 1-18
2
3  A=132.91                                    //atomic
       weight of chromium
4
5  N=6.023*10^26                               //Avogadro's
       number
6
7  p=1900                                      //Density
8
9  a=6.14*10^-10                               //lattice
       constant
10
11 //step 1 : type of structure
12
13 n=(p*N*a^3)/A
14
15 printf("n =")
16
17 disp(round(n))
18
19 printf("BCC structure")
20
21 //step 2: no of atoms/m^3
22
23 x=n/a^3
```

```
24
25 printf("          no of atoms/m^3=")
26
27 disp(x)
```

Scilab code Exa 1.3.7 calculate no of unit cell

```
1 //Chapter-1,Example1_3_6,pg 1-18
2
3 a=0.4049*10^-9                          //lattice
     constant
4
5 t=0.006*10^-2                           //thickness
     of Al foil
6
7 A=50*10^-4                              //Area of
     foil
8
9 V1=a^3                                  //volume of
     unit cell
10
11 V=A*t                                  //volume of
     the foil
12
13 N=V/V1                                 //no of unit
      cell in the foil
14
15 printf("no of unit cell in the foil=")
16
17 disp(N)
```

Scilab code Exa 1.5.1 calcukate critical radius ratio of ligancy three

```
1  //Chapter-1,Example1_5_1,pg 1-29
2
3  //refer diagram from textbook
4
5  //on joining centre of 3 anions,an equilateral
       triangle is formed and on joining centres of any
       anion and cation  a right angle triangle ABC os
       formed
6
7  //where AC=rc+ra
8
9  //and BC=ra
10
11 //m(angle (ACB))=30 degree
12
13 //therefore cos (30)=ra/(rc+ra)
14
15 //assume rc/ra=r
16
17 r=(1-cosd(30))/cosd(30)                    //by
       arrangimg terms we get value of r
18
19 printf("critical radius ratio of ligancy 3=")
20
21 disp(r)
```

Scilab code Exa 1.5.2 calculate critical radius ratio for ligancy six

```
1  //Chapter-1,Example1_5_2,pg 1-30
2
3  //refer diagram from textbook
4
5  //in the said arrangement a cation is squeezed into
       4 anions in a plane and 5th anion is in upper
       layer and 6th in bottom layer
```

```
6
7 //join cation anion centres E and B and complete the
      triangle EBF
8
9 //in triangle EBF m(angle F)=90 and EF=BF
10
11 //m(angle B)=m(angle E)=45
12
13 //and EB=rc+ra and BF=ra
14
15 //cos(45)=ra/(rc+ra)
16
17 //assume rc/ra=r
18
19 r=(1-cosd(45))/cosd(45)                    //by
     arrangimg terms we get value of r
20
21 printf("critical radius ratio for ligancy 6 =")
22
23 disp(r)
```

Scilab code Exa 1.5.3 calculate critical radius ratio for octohedral

```
1 //Chapter-1,Example1_5_3,pg 1-30
2
3 //refer diagram from textbook
4
5 //since plane is square hence it is same as ligancy
     6
6
7 //in the said arrangement a cation is squeezed into
     4 anions in a plane and 5th anion is in upper
     layer and 6th in bottom layer
8
9 //join cation anion centres E and B and complete the
```

```
    triangle EBF
10
11 //in triangle EBF m(angle F)=90 and EF=BF
12
13 //m(angle B)=m(angle E)=45
14
15 //and EB=rc+ra and BF=ra
16
17 //cos(45)=ra/(rc+ra)
18
19 //assume rc/ra=r
20
21 r=(1-cosd(45))/cosd(45)                    //by
    arrangimg terms we get value of r
22
23 printf("critical radius ratio for ligancy 8 =")
24
25 disp(r)
```

Scilab code Exa 1.5.4 calculate critical radius ratio for ligancy 4

```
1 //Chapter-1,Example1_5_4,pg 1-31
2
3 //a tetrahedron CAEH can be considered with C as the
    apex of the tetrahedron.
4
5 //the edges AE,AH and EH of the tetrahedron will
    then be the face of the cube faces ABEF,ADHF,EFHG
    resp.
6
7 //from fig
8
9 //AO=ra+rc and AJ=ra
10
11 //AE=root(2)*a and AG=root(3)*a
```

```
12
13 //AO/AJ=AG/AE=(ra+rc)/ra=root(3)*a/root(2)*a
14
15 //assume rc/ra=r
16
17 r=(sqrt(3)-sqrt(2))/sqrt(2)
18
19 printf("critical radius ratio for ligancy 4 =")
20
21 disp(r)
```

Scilab code Exa 1.5.5 calculate critical radius ratio for ligancy 8

```
1 //Chapter-1,Example1_5_5,pg 1-32
2
3 //ligancy 8 represents cubic arrangment .8 anions
    are at the corners and touch along cube edgs.
    Along the body diagonal the central cation and
    the corner anion are in contact.
4
5 //cube edge=2*ra
6
7 //refer diagram from textbook
8
9 //and body diagonal=root(3)*cube edge=root(3)[2*(rc+
    ra)]
10
11 //assume rc/ra=r
12
13 r=sqrt(3)-1
14
15 printf("critical radius ratio of ligancy 8=")
16
17 disp(r)
```

Scilab code Exa 1.5.6 calculate critical radius ratio for ligancy

```
1 //Chapter-1,Example1_5_6,pg 1-32
2
3 //for an ionic crystal exibiting HCP structure the
    arrangment of ions refere from textbook
4
5 //at centre we have a cation with radius rc=OA
6
7 //it is an touch with 6 anions with radius ra=AB
8
9 //OB=OC=ra+rc
10
11 //intrangle ODB ,m(angle (OBC))=60 degree ,m(angle (
    ODB))=90 degree
12
13 //therefore cos(60)=BD/OB=AB/(OA+OB)=ra/(rc+ra)
14
15 //assume rc/ra=r
16
17 r=(1-cosd(60))/cosd(60)                    //by
    arrangimg terms we get value of r
18
19 printf("critical radius ratio 0f HCP structure=")
20
21 disp(r)
```

Scilab code Exa 1.6.2 calculate miller indices of plane

```
1 //Chapter-1,Example1_6_2,pg 1-35
2
3 //intercept of planeare in proportion a,b/3,2*c
```

```
4
5 //as a,b and c are basic vectors the proportin of
    intercepts 1:1/3:2
6
7 //therefore reciprocal
8
9 r1=1
10
11 r2=3
12
13 r3=1/2
14
15 //taking LCM
16
17 v=int32([2,1])
18
19 l=double(lcm(v))
20
21 m1=(l*r1)
22
23 m2=(l*r2)
24
25 m3=(l*r3)
26
27 printf("miler indices=")
28
29 disp(m3,m2,m1)
```

Scilab code Exa 1.6.4 calculate interplanar spacing

```
1 //Chapter-1,Example1_6_4,pg 1-38
2
3 r=1.414                                    //atomic
    radius in amstrong unit
4
```

```
5  //for FCC structure
6
7  a=4*r/sqrt(2)
8
9  //part 1: plane(2,0,0)
10
11 //the interplanar spacing of plane
12
13 h1=2
14
15 k1=0
16
17 l1=0
18
19 //we know that d=a/sqrt(h^2+k^2+l^2)
20
21 d1=a/sqrt(h1^2+k1^2+l1^2)
22
23 printf("              1)interplanar spacing for
      (2,0,0) plane=")
24
25 disp(d1)
26
27 printf("amstrong")
28
29 //part 2: plane(1,1,1)
30
31 //the interplanar spacing of plane
32
33 h2=1
34
35 k2=1
36
37 l2=1
38
39 //we know that d=a/sqrt(h^2+k^2+l^2)
40
41 d2=a/sqrt(h2^2+k2^2+l2^2)
```

```
42
43 printf("     2)interplanar spacing for(1,1,1) plane="
   )
44
45 disp(d2)
46
47 printf("amstrong")
```

Scilab code Exa 1.14.1 calculate lattice constant

```
1 //Chapter-1,Example1_14_1,pg 1-58
2
3 n=4                                          //FCC
   structure
4
5 ro=2180                                      //density of
    NaCl
6
7 M=23+35.5                                    //molecular
   weight of NaCl
8
9 N=6.023*10^26                                //Avogadro's
    number
10
11 a=((n*M)/(N*ro))^(1/3)
12
13 printf("Lattice constant=")
14
15 disp(a)
16
17 printf("m")
```

Scilab code Exa 1.14.2 calculate Lattice constant and diameter

```
1  //Chapter-1,Example1_14_2,pg 1-58
2
3  n=4                                          //FCC
       structure
4
5  ro=8.9                                       //density of
       Cu atom
6
7  A=63.55                                      //atomic
       weight of Cu atom
8
9  N=6.023*10^23                                //Avogadro's
       number
10
11 a=((n*A)/(N*ro))^(1/3)
12
13 printf("          1) Lattice constant=")
14
15 disp(a)
16
17 printf("cm")
18
19 r=sqrt(2)*a/4                                //radius of
       Cu atom
20
21 d=2*r                                        //diameter
       of Cu atom
22
23 printf("        2) Diameter of Cu atom=")
24
25 disp(d)
26
27 printf("cm")
```

Scilab code Exa 1.14.3 calculate Density of diamond

```
1 //Chapter-1,Example1_14_3,pg 1-59
2
3 n=8                                          //diamond
     structure
4
5 A=12.01                                     //atomic wt
6
7 N=6.023*10^23                               //Avogadro's
     number
8
9 a=3.75*10^-8                                //lattice
     constant of diamond
10
11 ro=(n*A)/(N*(a^3))
12
13 printf("Density of diamond=")
14
15 disp(ro)
16
17 printf("gm/cc")
```

Scilab code Exa 1.14.4 calculate miller indices

```
1 //Chapter-1,Example1_14_4,pg 1-59
2
3 //intercept of planeare in proportion 3a:4b:infinity
     (plane parallel to z axis)
4
5 //as a,b and c are basic vectors the proportin of
     intercepts 3:4:infinity
6
7 //therefore reciprocal
8
9 r1=1/3
10
```

```
11 r2=1/4
12
13 r3=0
14
15 //taking LCM
16
17 v=int32([3,4])
18
19 l=double(lcm(v))
20
21 m1=(l*r1)
22
23 m2=(l*r2)
24
25 m3=(l*r3)
26
27 printf("miler indices=")
28
29 disp(m3,m2,m1)
```

Scilab code Exa 1.14.5 calculate miller indices

```
1 //Chapter-1,Example1_14_5,pg 1-59
2
3 //intercept of planeare in proportion 3a:-2b:3/2c
4
5 //as a,b and c are basic vectors the proportin of
    intercepts 3:-2:3/2
6
7 //therefore reciprocal
8
9 r1=1/3
10
11 r2=-1/2
12
```

```
13 r3=2/3
14
15 //taking LCM
16
17 v=int32([3,2,3/2])
18
19 l=double(lcm(v))
20
21 m1=(l*r1)
22
23 m2=(l*r2)
24
25 m3=(l*r3)
26
27 printf("miler indices=")
28
29 disp(m3,m2,m1)
```

Scilab code Exa 1.14.6 calculate ratio of intercepts

```
1 //Chapter-1,Example1_14_6,pg 1-59
2
3 //if a plane cut at length m,n,p on the three
    crystal axes,then
4
5 //m:n:p=xa:yb:zc
6
7 //when primitive vectors of unit cell and numbers x,
    y,z,are related to miller indices (h,k,l)of the
    plane by relation
8
9 //1/x:1/y:1/z=h:k:l
10
11 //since a=b=c (crystal is simple cubic)
12
```

```
13 //and (h,k,l)=(1,2,3)
14
15 //therefore reciprocal
16
17 r1=1/1
18
19 r2=1/2
20
21 r3=1/3
22
23 //taking LCM
24
25 v=int32([1,2,3])
26
27 l=double(lcm(v))
28
29 m=(l*r1)
30
31 n=(l*r2)
32
33 p=(l*r3)
34
35 printf("ratio of intercepts=")
36
37 disp(m)
38
39 disp(n)
40
41 disp(p)
```

Scilab code Exa 1.14.7 calculate y and z intercepts

```
1 //Chapter-1,Example1_14_7,pg 1-60
2
3 //primitive vectors
```

```
4
5 a=1.2                                          //in
     amstrong unit
6
7 b=1.8                                          //in
     amstrong unit
8
9 c=2                                           //in amstrong
      unit
10
11 //miller indices of the plane
12
13 h=2
14
15 k=3
16
17 l=1
18
19 //therefore intercepts are a/h,b/k,c/l
20
21 x=a/h
22
23 y=b/k
24
25 z=c/l
26
27 //this gives intercepts along x axis as x amstrong
     but it is given tthat plane cut x axis at 1.2
     amstrong .
28
29 t=1.2/x
30
31 //this shows that the plane under consideration is
     another plane which is parallel to it(to keep
     miller indices same)
32
33 n=t*y                                           //Y
     intercept
```

```
34
35 p=t*z                                          //Z
       intercept
36
37 printf("            1) Y intercept=")
38
39 disp(n)
40
41 printf("amstrong")
42
43 printf("    2)Z intercept=")
44
45 disp(p)
46
47 printf("amstrong")
```

Scilab code Exa 1.14.8 calculate radius

```
1 //Chapter-1,Example1_14_8,pg 1-61
2
3 //the interplanar spacing of plane
4
5 h=1
6
7 k=1
8
9 l=0
10
11 d=2                                           //interpanar
       spacing in amstrong unit
12
13 //we know that d=a/sqrt(h^2+k^2+l^2) therefore
14
15 a=d*sqrt(h^2+k^2+l^2)
16
```

```
17 //for FCC structure
18
19 r=sqrt(2)*a/4
20
21 printf("radius r=")
22
23 disp(r)
24
25 printf("amstrong")
```

Scilab code Exa 1.14.9 calculate density and diameter

```
1 //Chapter-1,Example1_14_9,pg 1-61
2
3 n=4                                        //for FCC
    structure
4
5 //the interplanar spacing of plane
6
7 h=1
8
9 k=1
10
11 l=1
12
13 d=2.08*10^-10                            //distance
14
15 A=63.54                                  //atomic
    weight of Cu
16
17 N=6.023*10^26                            //amstrong
    no
18
19 //we know that d=a/sqrt(h^2+k^2+l^2) therefore
20
```

```
21 a=d*sqrt(h^2+k^2+l^2)
22
23 //also (a^3*q)=n*A/N
24
25 q=n*A/(N*a^3)
26
27 printf("                1) density=")
28
29 disp(q)
30
31 printf("kg/m^3")
32
33 //for FCC structure
34
35 r=sqrt(2)*a/4
36
37 d=r*2
38
39 printf("          2) radius r=")
40
41 disp(r)
42
43 printf("m")
44
45 printf("              3) diameter d=")
46
47 disp(d)
48
49 printf("m")
```

Scilab code Exa 1.14.10 calculate free electron concentration

```
1 //Chapter-1,Example1_14_10,pg 1-62
2
3 A=63.546                                    //atomic
```

```
    weight of Cu
4
5 N=6.023*10^26                                    //Avogadro's
     number
6
7 p=8930                                           //Density
8
9 n=1.23                                           //no.of
    electron per atom
10
11 //density=mass/volume
12
13 //therfore 1/volume=density/mass
14
15 //since electron concentration is needed, let us
    find out no of atoms/volume(x)
16
17 x=N*p/A
18
19 //now one atom contribute n=1.23 electron
20
21 //therefore x atoms contribute  y no of free
    electron
22
23 y=x*n
24
25 printf("free electron concentration=")
26
27 disp(y)
28
29 printf("electron/m^3")
```

Scilab code Exa 1.14.11 calculate Y and Z intercept

```
1 //Chapter-1,Example1_14_11,pg 1-62
```

```
2
3 //primitive vectors
4
5 a=1.5                                          //in
     amstrong unit
6
7 b=2                                            //in
     amstrong unit
8
9 c=4                                           //in amstrong
      unit
10
11 //miller indices of the plane
12
13 h=3
14
15 k=2
16
17 l=6
18
19 //therefore intercepts are a/h,b/k,c/l
20
21 x=a/h
22
23 y=b/k
24
25 z=c/l
26
27 //this gives intercepts along x axis as x amstrong
     but it is given that plane cut x axis at 1.2
     amstrong .
28
29 t=1.5/x
30
31 //this shows that the plane under consideration is
     another plane which is parallel to it(to keep
     miller indices same)
32
```

```
33 n=t*y                                          //Y
      intercept
34
35 p=t*z                                          //Z
      intercept
36
37 printf("          1) Y intercept=")
38
39 disp(n)
40
41 printf("amstrong")
42
43 printf("  2)Z intercept=")
44
45 disp(p)
46
47 printf("amstrong")
```

Scilab code Exa 1.14.12 calculate Number of atom per unit cell

```
1 //Chapter-1,Example1_14_12,pg 1-63
2
3 ro=7.87                                         //density of
      metal
4
5 A=55.85                                         //atomic wt
      of metal
6
7 N=6.023*10^23                                   //Avogadro's
      number
8
9 a=2.9*10^-8                                     //lattice
      constant of metal
10
11 n=(N*(a^3)*ro)/A
```

```
12
13 printf("Number of atom per unit cell of a metal=")
14
15 disp(int32(n))
```

Scilab code Exa 1.14.13 calculate Lattice constant

```
1 //Chapter-1,Example1_14_13,pg 1-63
2
3 n=2                                    //BCC
    structure
4
5 ro=9.6*10^2                           //density of
    sodium crystal
6
7 A=23                                  //atomic
    weight of sodium crystal
8
9 N=6.023*10^26                         //Avogadro's
    number
10
11 a=((n*A)/(N*ro))^(1/3)
12
13 printf("Lattice constant=")
14
15 disp(a)
16
17 printf("m")
```

Scilab code Exa 1.14.15 calculate Number of atom per unit cell and atomic radius

```
1 //Chapter-1,Example1_14_15,pg 1-64
2
```

```
3 ro=2.7*10^3                                   //density of
      metal
4
5 A=27                                          //atomic wt
     of metal
6
7 N=6.023*10^26                                 //Avogadro's
      number
8
9 a=4.05*10^-10                                 //lattice
     constant of metal
10
11 n=(N*(a^3)*ro)/A
12
13 printf("1) Number of atom per unit cell of a metal="
     )
14
15 disp(int32(n))
16
17 r=sqrt(2)*a/4                                 //radius of
     metal
18
19 printf("2) atomic radius of a metal=")
20
21 disp(r)
22
23 printf("m")
```

Scilab code Exa 1.14.16 calculate Lattice constant and APF

```
1 //Chapter-1,Example1_14_16,pg 1-64
2
3 n=2                                           //BCC
     structure
4
```

```
5 ro=5.98*10^3                                  //density of
      chromium
6
7 A=50                                          //atomic wt
     of chromium
8
9 N=6.023*10^26                                 //Avogadro's
      number
10
11 a=((n*A)/(N*ro))^(1/3)
12
13 printf("      1) Lattice constant=")
14
15 disp(a)
16
17 printf("m")
18
19 //for BCC
20
21 r=sqrt(3)*a/4                                 //radius of
     chromium
22
23 APF=(n*(4/3)*%pi*(r^3))/(a^3)
24
25 printf("     2) A.P.F. for chromium=")
26
27 disp(APF)
```

Scilab code Exa 1.14.17 calculate Lattice constant

```
1 //Chapter-1,Example1_14_17,pg 1-65
2
3 n=4                                           //FCC
     structure
4
```

```
ro=6250                                          //density

M=60.2                                           //molecular
    weight

N=6.023*10^26                                    //Avogadro's
     number

a=((n*M)/(N*ro))^(1/3)

printf("Lattice constant=")

disp(a)

printf("m")
```

Scilab code Exa 1.14.19 calculate wavlength

```
//Chapter-1,Example1_14_19,pg 1-66

a=2.82*10^-9                                     //lattice
    constant

n=2                                              //FCC
    crystal

t=17.167                                         //glancing
    angle in degree

q=%pi/180*t                                      //glancing
    angle in radians

//assuming reflection in (1,0,0) plane

h=1
```

```
14
15 k=0
16
17 l=0
18
19 d=a/sqrt(h^2+k^2+l^2)
20
21 //using Bragg's law , 2*d*sin(q)=n*la
22
23 la=2*d*sin(q)/n
24
25 printf("wavlength of X-ray=")
26
27 disp(la)
28
29 printf("m")
```

Scilab code Exa 1.14.20 calculate Lattice constant and atomic radius

```
1 //Chapter-1,Example1_14_20,pg 1-66
2
3 n=8                                    //Diamond
    structure
4
5 ro=2.33*10^3                          //density of
    diamond
6
7 M=28.9                                //atomic
    weight of diamond
8
9 N=6.023*10^26                         //Avogadro's
    number
10
11 a=((n*M)/(N*ro))^(1/3)
12
```

```
13 printf("      1) Lattice constant=")
14
15 disp(a)
16
17 printf("m")
18
19 r=sqrt(3)*a/8                              //radius of
     diamond structure
20
21 printf("     2) atomic radius of a metal=")
22
23 disp(r)
24
25 printf("m")
```

Scilab code Exa 1.14.21 calculate mass of one atom

```
1 //Chapter-1,Example1_14_21,pg 1-66
2
3 n=2                                          //BCC
     structure
4
5 ro=8.57*10^3                                 //density of
     chromium
6
7 d=2.86*10^-10                                //nearest
     atoms distance
8
9 //d=sqrt(3)/2*a
10
11 a=2*d/sqrt(3)
12
13 //now use formulae a^3*ro=n*A/N
14
15 //therefore a^3*ro/n=mass of unit cell/(no of atoms
```

```
    pre unit cell)=mass of one atom
16
17 m=a^3*ro/n
18
19 printf("mass of one atom=")
20
21 disp(m)
22
23 printf("kg")
```

Scilab code Exa 1.15.1 calculate glancing angle and highest order

```
1 //Chapter-1,Example1_15_1,pg 1-68
2
3 d=4.255*10^-10                              //
    interplaner spacing
4
5 l=1.549*10^-10                              //wavelength
     of x ray
6
7 //part 1: for smallest glancing angle(n=1)
8
9 n1=1
10
11 //using Bragg's law n*l=2*d*sin(q)
12
13 q=asind(n1*l/(2*d))
14
15 printf("         1)glancing angle=")
16
17 disp(q)
18
19 printf("degree")
20
21 //part 2: for highst order
```

```
22
23 //for highest order sin(q) not exceed one i.e
      maximum value is one
24
25 //using Bragg's law n*l=2*d*sin(q)
26
27 n2=2*d/l                                    //since sin(
      q)is one
28
29 printf("  2)highest order possible =")
30
31 disp(floor(n2))
```

Scilab code Exa 1.15.2 calculate glancing angle

```
1 //Chapter-1,Example1_15_2,pg 1-69
2
3 a=2.125*10^-10                              //lattice
      constant
4
5 d=a/2                                       //
      interplaner spacing
6
7 n=2                                         //second
      order maximum
8
9 l=0.592*10^-10                              //wavelength
       of rock salt crystal
10
11 //using Bragg's law
12
13 m=asin((n*l)/(2*d))                        //glancing
      angle
14
15 Q=m*180/%pi
```

```
16
17 printf("glancing angle=")
18
19 disp(Q)
20
21 printf("degree")
```

Scilab code Exa 1.15.3 calculate second order reflection angle

```
1  //Chapter-1,Example1_15_3,pg 1-69
2
3  n1=1                                    //for 1st
       order
4
5  n2=2                                    //for 2nd
       order
6
7  t=3.4                                   //angle
       where 1st order reflection done
8
9  t1=t*%pi/180                            //convert
       degree to radian
10
11 m=sin(t1)
12
13 //but from Bragg's law
14
15 //n*l=2*d*sin(t)
16
17 //for for constant distance(d) and wavelength(l)
18
19 //order(n) is directly proportionl to sine of angle
       i.e (sin(t))
20
21 //n1/n2=sin(t1)/sin(t2)
```

```
22
23 //assume sin(t2)=a
24
25 a=n2/n1*m
26
27 t2=asind(a)                                    //taking
      sin inverese in degree
28
29 printf("second order reflection take place at an
      angle=")
30
31 disp(t2)
32
33 printf("degree")
```

Scilab code Exa 1.15.4 calculate shortest wavelength and glancing angle

```
1 //Chapter-1,Example1_15_4,pg 1-70
2
3 V=50*10^3                                     //operating
      voltage of x-ray
4
5 M=74.6                                        //molecular
      weight
6
7 p=1.99*10^3                                   //density
8
9 n=4                                           //no of
      atoms per unit cell(for FCC structure)
10
11 h=6.63*10^-34                                //plank's
      constant
12
13 c=3*10^8                                     //velocity
14
```

```
e=1.6*10^-19                                    //charge on
   electron

N=6.023*10^26                                   //Avogadro's
    number

//step 1:clculating shortest wavelength

l=h*c/(e*V)

printf("        1)shortest wavelength=")

disp(l)

printf("m")

//step:2 calculating distance(d)

//now a^3*p=n*M/N therefore,

a=(n*M/(N*p))^(1/3)

//since KCl is ionic crystal herefore,

d=a/2

//step 3: calculaing glancing angle

//using Bragg's law

//n*l=2*d*sin(t)

//assume sin(t)=a, wavelength is minimum i.e l and n
   =1

n=1

a=n*l/(2*d)
```

```
50
51 t=asind(a)                                    //taking sin
       inverese in degree
52
53 printf("       2) glancing angle=")
54
55 disp(t)
56
57 printf("degree")
```

Scilab code Exa 1.15.5 find possible solution of planes

```
1 //Chapter-1,Example1_15_5,pg 1-70
2
3 n=1                                           //first
      order maximum
4
5 l=0.82*10^-10                                 //wavelength
       of X ray
6
7 qd=7                                          //glancing
      angle in degree
8
9 qm=51/60                                      //glancing
      angle in minute
10
11 qs=48/3600                                   //glancing
      angle in second
12
13 q=qd+qm+qs                                   //total
      glancin angle in degree
14
15 //using Bragg's law n*l=2*d*sin(q)
16
17 d=n*l/(2*sind(q))
```

```
18
19 a=3*10^-10                                    //lattice
       constant
20
21 //we know that d=a/root(h^2+k^2+l^2)
22
23 //assume root(h^2+k^2+l^2) =m
24
25 //arranging terms we get
26
27 m=a/d
28
29 printf("square root(h^2+k^2+l^2)=")
30
31 disp(int32(m))
32
33 printf("hence possible solutions are (100),(010)
       ,(001)")
```

Scilab code Exa 1.15.6 calculate cubic lattice structure

```
1 //Chapter-1,Example1_15_6,pg 1-71
2
3 n=1                                            //first
       order maximum
4
5 l=%i                                          //wavelength
       of X ray
6
7 //part 1:for(100)
8
9 //using Bragg's law n*l=2*d*sin(q)
10
11 q1=5.4                                        //glancing
       angle in degree
```

```
12
13 dl1=n*l/(2*sind(q1))
14
15 //part 2:for(110)
16
17 //using Bragg's law n*l=2*d*sin(q)
18
19 q2=7.6                                          //glancing
     angle in degree
20
21 dl2=n*l/(2*sind(q2))
22
23 //part 3:for(111)
24
25 //using Bragg's law n*l=2*d*sin(q)
26
27 q3=9.4                                          //glancing
     angle in degree
28
29 dl3=n*l/(2*sind(q3))
30
31 //for taking ratio divide all dl by dl1
32
33 d1=dl1/dl1
34
35 d2=dl2/dl1
36
37 d3=dl3/dl1
38
39 printf("cubic lattice structure is=")
40
41 disp(d3,d2,d1)
```

Scilab code Exa 1.15.7 calculate lattice constant

```
1 //Chapter-1,Example1_15_7,pg 1-71
2
3 n=1                                          //first
     order maximum
4
5 l=1.54*10^-10                               //wavelength
     of rock salt crystal
6
7 q=21.7                                      //glancing
     angle in degree
8
9 //using Bragg's law n*l=2*d*sin(q)
10
11 d=n*l/(2*sind(q))
12
13 printf("lattice constant of crystal=")
14
15 disp(d)
16
17 printf("meter")
```

Scilab code Exa 1.15.8 calculate glancing angle

```
1 //Chapter-1,Example1_15_8,pg 1-72
2
3 a=2.814*10^-10                              //lattice
     constant
4
5 //the interplanar spacing of plane
6
7 h=1
8
9 k=0
10
11 l=0
```

```
12
13 d=a/sqrt(h^2+k^2+l^2)
14
15 n=2                                          //first
      order maximum
16
17 l=0.714*10^-10                              //wavelength
       of X-ray crystal
18
19 //using Bragg's law
20
21 m=asin((n*l)/(2*d))                          //glancing
      angle
22
23 Q=m*180/%pi
24
25 printf("glancing angle=")
26
27 disp(Q)
28
29 printf("degree")
```

Scilab code Exa 1.15.9 calculate wavelength and glancing angle and highest order

```
1 //Chapter-1,Example1_15_9,pg 1-72
2
3 d=2.82*10^-10                                //
      interplaner spacing
4
5 t=10                                         //glancing
      angle
6
7 //for part 1
8
9 n=1                                          //first
```

```
    order maximum
10
11 //using Bragg's law n*l=2*d*sin(t)
12
13 l=2*d*sind(t)/n
14
15 printf("         1)wavelength=")
16
17 disp(l)
18
19 printf("meter")
20
21 //for part 2
22
23 n1=2
24
25 //using Bragg's law n*l=2*d*sin(q)
26
27 q=asind(n1*l/(2*d))
28
29 printf("    2)glancing angle=")
30
31 disp(q)
32
33 printf("degree")
34
35 //for part 3
36
37 //for highest order sin(q) not exceed one i.e
    maximum value is one
38
39 //using Bragg's law n*l=2*d*sin(q)
40
41 n2=2*d/l                                    //since sin(
    q)is one
42
43 printf("  3)highest order possible =")
44
```

```
45 disp(floor(n2))
```

Scilab code Exa 1.15.10 calculate wavelength

```
1  //Chapter-1,Example1_15_10,pg 1-73
2
3  //for line -A
4
5  n1=1                                          //1st order
       maximum
6
7  q1=30                                         //glancing
       angle in degree
8
9  //using Bragg's law for line A n1*l1=2*d1*sin(q1)
10
11 //d1=n1*l1/(2*sin(q1))
12
13 //for line B
14
15 l2=0.97                                       //wavelength
       in amstrong unit
16
17 n2=3                                          //1st order
       maximum
18
19 q2=60                                         //glancing
       angle in degree
20
21 //using Bragg's law for line B n2*l2=2*d2*sin(q2)
22
23 //since for both lines A and B we use same plane of
       same crystal,therefore
24
25 //d1=d2
```

```
26
27 //therefore equution became n2*l2=2*n1*l1/(2*sin(q1)
   )*sin(q2)
28
29 //by arranging terms we get
30
31
32 l1=n2*l2*2*sind(q1)/(2*n1*sind(q2))
33
34 printf("wavelength of the line A=")
35
36 disp(l1)
37
38 printf("amstrong")
```

Scilab code Exa 1.15.11 calculate glancing angle

```
1 //Chapter-1,Example1_15_11,pg 1-74
2
3 n=1                                    //first
   order minimum
4
5 d=5.5*10^-11                          //atomic
   spacing
6
7 e=1.6*10^-19                          //charge on
   one electron
8
9 Ee=10*10^3                            //energy in
   eV
10
11 E=e*Ee                               //energy in
   Joule
12
13 m=9.1*10^-31                         //mass of
```

```
    elelctron
14
15 h=6.63*10^-34                                    //plank's
    constant
16
17 l=h/sqrt(2*m*E)                                  //wavelength
18
19 //using Bragg's law
20
21 Q=asind((n*l)/(2*d))                               //glancing
    angle
22
23 printf("glancing angle=")
24
25 disp(Q)
26
27 printf("degree")
```

Scilab code Exa 1.15.12 calculate glancing angle

```
1 //Chapter-1,Example1_15_12,pg 1-74
2
3 a=2.814*10^-10                                    //lattice
    constant
4
5 //for rock salt
6
7 d=a/2                                             //
    interplaner spacing
8
9 n=1                                               //first
    order maximum
10
11 l=1.541*10^-10                                   //wavelength
     of rock salt crystal
```

```
12
13 //using Bragg's law
14
15 m=asin((n*l)/(2*d))                          //glancing
      angle
16
17 Q=m*180/%pi
18
19 printf("glancing angle=")
20
21 disp(Q)
22
23 printf("degree")
```

Scilab code Exa 1.16.1 calculate ratio of vacancies

```
1 //Chapter-1,Example1_16_1,pg 1-75
2
3 Ev=1.08                                     //average
      energy required to creaet a vacancy
4
5 k=1.38*10^-23                               //boltzman
      constant in J/K
6
7 e=1.6*10^-19                                //charge on
      1 electron
8
9 K=k/e                                       //boltzman
      constant in eV/K
10
11 //for a low concentration of vacancies a relation is
12
13 //n=Nexp(-Ev/KT)
14
15 //since total no atom is 1 hence N=1
```

```
16
17 //at 1000k
18
19 T1=1000                                    //
      temperature
20
21 n1=exp(-Ev/(K*T1))
22
23 //at 500k
24
25 T2=500                                     //
      temperature
26
27 n2=exp(-Ev/(K*T2))
28
29 v=(n1)/(n2)                                 //ratio
      of vacancies
30
31 printf("ratio of vacancies=")
32
33 disp(v)
```

Scilab code Exa 1.16.2 calculate ratio of vacancies to no of atom

```
1 //Chapter-1,Example1_16_2,pg 1-75
2
3 Ev=1.95                                     //average
      energy required to creaet a vacancy
4
5 k=1.38*10^-23                               //boltzman
      constant in J/K
6
7 e=1.6*10^-19                                //charge on
      1 electron
8
```

```
9  K=k/e                                          //boltzman
       constant in eV/K
10
11 T=500                                          //
       temperature
12
13 //for a low concentration of vacancies a relation is
14
15 //n=Nexp(-Ev/KT)
16
17 m=exp(-Ev/(K*T))                                //ratio
       of no of vacancies to no of atoms n/N
18
19 printf("ratio of no of vacancies to no of atoms=")
20
21 disp(m)
```

Scilab code Exa 1.16.3 calculate ratio of vacancies

```
1  //Chapter-1,Example1_16_3,pg 1-76
2
3  Ev=1.8                                          //average
       energy required to creaet a vacancy
4
5  k=1.38*10^-23                                   //boltzman
       constant in J/K
6
7  e=1.6*10^-19                                    //charge on
       1 electron
8
9  K=k/e                                           //boltzman
       constant in eV/K
10
11 //for a low concentration of vacancies a relation is
12
```

```
13 //n=Nexp(-Ev/KT)
14
15 //ratio of vacancy is n/N assume be r=exp(-Ev/KT)
16
17 //since total no atom is 1 hence N=1
18
19 //at 1000k
20
21 t1=-119                                          //
      temperature in degree
22
23 T1=t1+273                                        //
      temperature in kelvine
24
25 r1=exp(-Ev/(K*T1))
26
27 printf("1)ratio of vacancies at -119 degree=")
28
29 disp(r1)
30
31 //at 500k
32
33 t2=80                                            //
      temperature in degree
34
35 T2=t2+273                                        //
      temperature in kelvine
36
37 r2=exp(-Ev/(K*T2))
38
39 v=(r1)/(r2)                                      //ratio
      of vacancies
40
41 printf("2)ratio of vacancies at 80 degree=")
42
43 disp(r2)
```

Scilab code Exa 1.16.4 calculate no of frankel defects

```
1 //Chapter-1,Example1_16_4,pg 1-76
2
3 Ev=1.5                                    //energy of
     formaton of frankel defect
4
5 k=1.38*10^-23                             //boltzman
     constant in J/K
6
7 e=1.6*10^-19                              //charge on
     1 electron
8
9 K=k/e                                     //boltzman
     constant in eV/K
10
11 T=700                                    //
     temperature
12
13 N=6.023*10^26                            //avogadro's
     no
14
15 //for a low concentration of vacancies a relation is
16
17 //n=Nexp(-Ev/KT)
18
19 m=exp(-Ev/(2*K*T))                        //ratio of
     no of vacancies to no of atoms n/N
20
21 qs=5.56                                   //specific
     density
22
23 q=5.56*10^3                               //real
     density ke/m^3
```

```
24
25 M=0.143                                          //molecular
       weight in kg/m^3
26
27 ma=M/N                                           //mass of
       one molecule
28
29 v=ma/q                                           //vol of
       one molecule
30
31 //v volume containe 1 molecule
32
33 //therefore 1 m^3 containe x molecule
34
35 x=1/v
36
37 d=m*x                                            //defect per
       m^3
38
39 dm=d*10^-9                                       //defect per
       mm^3
40
41 printf("number of frankel defects per mm^3=")
42
43 disp(dm)
```

Chapter 2

Semiconductor Physics

Scilab code Exa 2.21.1 calculate mobility of electron

```
1 //Chapter-2,Example2_21_1,pg 2-47
2
3 ro=1.72*10^-8                          //
    resistivity of Cu
4
5 s=1/ro                                 //
    conductivity of Cu
6
7 n=10.41*10^28                          //no of
    electron per unit volume
8
9 e=1.6*10^-19                           //charge on
    electron
10
11 u=s/(n*e)
12
13 printf("mobility of electron in Cu =")
14
15 disp(u)
16
17 printf("m^2/volt-sec")
```

Scilab code Exa 2.21.2 calculate Resistivity of Cu

```
1 //Chapter-2,Example2_21_2,pg 2-47
2
3 m=63.5                                    //atomic
    weight
4
5 u=43.3                                    //mobility
    of electron
6
7 e=1.6*10^-19                              //charge on
    electron
8
9 N=6.02*10^23                              //Avogadro's
     number
10
11 d=8.96                                   //density
12
13 Ad=N*d/m                                 //Atomic
    density
14
15 n=1*Ad
16
17 ro=1/(n*e*u)
18
19 printf("Resistivity of Cu =")
20
21 disp(ro)
22
23 printf("ohm-cm")
```

Scilab code Exa 2.21.3 calculate Resistivity of Ge

```
1 //Chapter-2,Example2_21_3,pg 2-47
2
3 e=1.6*10^-19                                    //charge on
     electron
4
5 ne=2.5*10^19                                   //density of
      carriers
6
7 nh=ne                                          //for
     intrinsic semiconductor
8
9 ue=0.39                                        //mobility
     of electron
10
11 uh=0.19                                       //mobility
     of hole
12
13 s=ne*e*ue+nh*e*uh                             //
     conductivity of Ge
14
15 ro=1/s                                        //
     resistivity of Ge
16
17 printf("Resistivity of Ge =")
18
19 disp(ro)
20
21 printf("ohm-m")
```

Scilab code Exa 2.21.5 calculate Ratio between conductivity

```
1 //Chapter-2,Example2_21_5,pg 2-48
2
3 Eg=1.2                                         //energy gap
4
```

```
5  T1=600                                          //
       temperature
6
7  T2=300                                          //
       temperature
8
9  //since ue>>uh for intrinsic semiconductor
10
11 //s=ni*e*ue
12
13 K=8.62*10^-5                                    //Boltzman
       constant
14
15 s=%s
16
17 s1=s*exp((-Eg)/(2*K*T1))
18
19 s2=s*exp((-Eg)/(2*K*T2))
20
21 m=(s1/s2)
22
23 printf('Ratio between conductivity =')
24
25 disp(m)
```

Scilab code Exa 2.21.6 calculate conductivity

```
1  //Chapter-2,Example2_21_6,pg 2-49
2
3  c=5*10^28                                       //
       concentration of Si atoms
4
5  e=1.6*10^-19                                    //charge on
       electron
6
```

```
u=0.048                                          //mobility
   of hole

s=4.4*10^-4                                      //
   conductivity of Si

//since millionth Si atom is replaced by an indium
   atom

n=c*10^-6

sp=u*e*n                                         //
   conductivity of resultant

printf("conductivity =")

disp(sp)

printf("mho/m")
```

Scilab code Exa 2.21.7 calculate hole concentration and mobility

```
//Chapter-2,Example2_21_7,pg 2-49

m=28.1                                           //atomic
   weight of Si

e=1.6*10^-19                                     //charge on
   electron

N=6.02*10^26                                     //Avogadro's
    number

d=2.4*10^3                                       //density of
    Si
```

```
10
11 p=0.25                                        //
      resistivity
12
13 //no. of Si atom/m^3
14
15 Ad=N*d/m                                       //Atomic
      density
16
17 //impurity level is 0.01 ppm i.e. 1 atom in every
      10^8 atoms of Si
18
19 n=Ad/10^8                                      //no of
      impurity atoms
20
21 //since each impurity produce 1 hole
22
23 nh=n
24
25 printf("1) hole concentration =")
26
27 disp(n)
28
29 printf("holes/m^3")
30
31 up=1/(e*p*nh)
32
33 printf("      2) mobility =")
34
35 disp(up)
36
37 printf("m^2/volt.sec")
```

Scilab code Exa 2.22.1 calculate probability of an electron

```
1  //Chapter-2,Example2_22_1,pg 2-50
2
3  t=27                                          //temp in
       degree
4
5  T=t+273                                       //temp in
       kelvin
6
7  K=8.62*10^-5                                  //Boltzman
       constant in eV
8
9  Eg=1.12                                       //Energy
       band gap
10
11 //For intrensic semiconductor (Ec-Ev)=Eg/2
12
13 //let (Ec-Ev)=m
14
15 m=Eg/2
16
17 a=(m/(K*T))
18
19 //probability f(Ec)=1/(1+exp((Ec-Ev)/(K*T))
20
21 p=1/(1+exp(a))
22
23
24 printf("probability of an electron being thermally
       excited to conduction band=")
25
26 disp(p)
```

Scilab code Exa 2.22.2 calculate probability of an electron

```
1  //Chapter-2,Example2_22_2,pg 2-50
```

```
2
3 T=300                                          //temp in
     kelvin
4
5 K=8.62*10^-5                                   //Boltzman
     constant in eV
6
7 m=0.012                                        //energy
     level(Ef-E)
8
9 a=(m/(K*T))
10
11 //probability f(Ec)=1/(1+exp((Ec-Ev)/(K*T)))
12
13 p=1/(1+exp(a))
14
15 p1=1-p
16
17 printf("probability of an energy level not being
     occupied by an electron=")
18
19 disp(p1)
```

Scilab code Exa 2.22.3 calculate probability of an electron

```
1 //Chapter-2,Example2_22_3,pg 2-51
2
3 t=20                                           //temp in
     degree
4
5 T=t+273                                        //temp in
     kelvin
6
7 K=8.62*10^-5                                   //Boltzman
     constant in eV
```

```
8
9  Eg=1.12                                          //Energy
       band gap
10
11 //For intrensic semiconductor (Ec-Ev)=Eg/2
12
13 //let (Ec-Ev)=m
14
15 m=Eg/2
16
17 a=(m/(K*T))
18
19 //probability f(Ec)=1/(1+exp((Ec-Ev)/(K*T))
20
21 p=1/(1+exp(a))
22
23
24 printf("probability of an electron being thermally
       excited to conduction band=")
25
26 disp(p)
```

Scilab code Exa 2.22.4 calculate energy for different probability

```
1  //Chapter-2,Example2_22_4,pg 2-51
2
3  T=300                                            //temp in
       kelvin
4
5  K=8.62*10^-5                                     //Boltzman
       constant in eV
6
7  Eg=2.1                                           //Energy
       band gap
8
```

```
9  //probability  f(Ec)=1/(1+exp((Ec-Ev)/(K*T))
10
11 m=K*T
12
13 //for  f(E)=0.99
14
15 p1=0.99
16
17 b=1-1/p1
18
19 a=log(b)                                    //a=(E-2.1)/m
20
21 E=2.1+m*a
22
23 printf("1) Energy for which probability  is 0.99=")
24
25 disp(real(E))
26
27 printf("eV")
28
29 //for  f(E)=0.01
30
31 p2=0.01
32
33 b2=1-1/p2
34
35 a1=log(b2)                                   //a=(E-2.1)/m
36
37 E1=2.1+m*a1
38
39 printf("2)Energy for which probability  is 0.01=")
40
41 disp(real(E1))
42
43 printf("eV")
```

Scilab code Exa 2.23.1 calculate Potential barrier for Ge

```
1 //Chapter-2,Example2_23_1,pg 2-52
2
3 ni=2.4*10^19                          //density of
      intrensic semiconductor
4
5 n=4.4*10^28                           //no atom in
      Ge crystal
6
7 Nd=n/10^6                             //density
8
9 Na=Nd
10
11 e=1.6*10^-19                         //charge on
     electron
12
13 T=300                                //temerature
      at N.T.P.
14
15 K=1.38*10^-23                        //Boltzman
     constant
16
17 Vo=(K*T/e)*log(Na*Nd/(ni^2))
18
19 printf("Potential barrier for Ge =")
20
21 disp(Vo)
22
23 printf("Volts")
```

Scilab code Exa 2.23.2 calculate Hall voltage

```
1 //Chapter-2,Example2_23_2,pg 2-52
2
3 B=0.6                                          //magnetic
     field
4
5 d=5*10^-3                                     //
     distancebetween surface
6
7 J=500                                         //current
     density
8
9 Nd=10^21                                      //density
10
11 e=1.6*10^-19                                 //charge on
     electron
12
13 Vh=(B*J*d)/(Nd*e)                            //due to
     Hall effect
14
15 printf("Hall voltage =")
16
17 disp(Vh)
18
19 printf("Volts")
```

Scilab code Exa 2.23.3 calculate Hall voltage

```
1 //Chapter-2,Example2_23_3,pg 2-53
2
3 Rh=6*10^-7                                    //Hall
     coefficient
4
5 B=1.5                                         //magnetic
     field
6
```

```
I=200                                          //current in
    strip

W=1*10^-3                                      //thickness
   of strip

Vh=Rh*(B*I)/W                                  //due to
   Hall effect

printf("Hall voltage =")

disp(Vh)

printf("Volt")
```

Scilab code Exa 2.23.4 calculate Resistivity of P type silicon

```
//Chapter-2,Example2_23_4,pg 2-53

Rh=2.25*10^-5                                  //Hall
   coefficient

u=0.025                                        //mobility
   of hole

r=Rh/u

printf("Resistivity of P type silicon =")

disp(r)

printf("ohm-m")
```

Scilab code Exa 2.23.5 calculate hall voltage hall coefficient and hall angle

```
1 //Chapter-2,Example2_23_5,pg 2-53
2
3 B=0.55                                    //magnetic
     field
4
5 d=4.5*10^-3                               //
     distancebetween surface
6
7 J=500                                     //current
     density
8
9 n=10^20                                   //density
10
11 e=1.6*10^-19                             //charge on
     electron
12
13 Rh=1/(n*e)                               //Hall
     coefficient
14
15 Vh=Rh*B*J*d                              //Hall
     voltage
16
17 printf("          1) Hall voltage =")
18
19 disp(Vh)
20
21 printf("Volts")
22
23 printf("      2) Hall coefficient =")
24
25 disp(Rh)
26
27 printf("m^3/C")
28
29 u=0.17                                   //mobility
     of electrom
```

```
30
31 m=atan(u*B)
32
33 a=m*180/%pi                                    //conversion
       randian into degree
34
35 printf("      3) Hall angle =")
36
37 disp(a)
38
39 printf("degree")
```

Scilab code Exa 2.23.6 calculate density and mobility

```
1 //Chapter-2,Example2_23_6,pg 2-54
2
3 Rh=3.66*10^-4                                  //Hall
      coefficient
4
5 r=8.93*10^-3                                   //
      resistivity
6
7 e=1.6*10^-19                                   //charge on
      electron
8
9 //Hall coefficient Rh=1/(n*e)
10
11 n=1/(Rh*e)                                    //density
12
13 printf("          1) density(n) =")
14
15 disp(n)
16
17 printf("/m^3")
18
```

```
19 u=Rh/r                                          //mobility
       of electron
20
21 printf("      2) mobility (u) =")
22
23 disp(u)
24
25 printf("m^2/v-s")
```

Scilab code Exa 2.23.7 calculate Hall voltage

```
1  //Chapter-2,Example2_23_7,pg 2-55
2
3  B=0.2                                           //magnetic
       field
4
5  e=1.6*10^-19                                    //charge on
       electron
6
7  ue=0.39                                         //mobility
       of electron
8
9  l=0.01                                          //length
10
11 A=0.001*0.001                                   //cross
       section area of bar
12
13 V=1*10^-3                                       //Applied
       voltage
14
15 d=0.001                                         //sample of
       width
16
17 r=1/(ue*e)                                      //
       resistivity
```

```
18
19 R=r*l/A                                    //resistance
       of Ge bar
20
21 //using ohm's law
22
23 I=V/R
24
25 Rh=r*ue                                    //hall
       coefficient
26
27 //using formulae for hall effect
28
29 J=I/A                                      //current
       density
30
31 Vh=Rh*B*J*d
32
33 printf("Hall voltage =")
34
35 disp(Vh)
```

Scilab code Exa 2.24.1 calculate fermi level

```
1 //Chapter-2,Example2_24_1,pg 2-55
2
3 x1=0.4                                     //difference
      between fermi level and conduction band(Ec-Ef)
4
5 T=300                                      //temp in
      kelvin
6
7 K=8.62*10^-5                               //Boltzman
      constant in eV
8
```

```
9  //ne=N*e^(-(Ec-Ef)/(K*T))
10
11 //ne is no of electron in conduction band
12
13 //since concentration of donor electron is doubled
14
15 a=2                                          //ratio of
      no of electron
16
17 //let x2 be the difference between new fermi level
      and conduction band(Ec-Ef')
18
19 x2=-log(a)*(K*T)+x1                          //arranging
      equation ne=N*e^(-(Ec-Ef)/(K*T))
20
21 printf("Fermi level will be shifted towards
      conduction band by")
22
23 disp(x2)
24
25 printf("eV")
```

Chapter 3

Dielectric And Magnetic Materials

Scilab code Exa 3.17.1 calculate resultant voltage

```
1 //Chapter-3,Example3_17_1,pg 3-35
2
3 A=650*10^-6                                   //area
4
5 d=4*10^-3                                     //seperation
      of plate
6
7 Q=2*10^-10                                    //charge
8
9 er=3.5                                        //relative
     permitivity
10
11 e0=8.85*10^-12                               //absolute
     permitivity
12
13 V=(Q*d)/(e0*er*A)
14
15 printf("voltage across capacitor =")
16
```

```
17 disp(V)
18
19 printf("Volt")
```

Scilab code Exa 3.17.2 find capacitance of capacitor

```
1 //Chapter-3,Example3_17_2,pg 3-36
2
3 A=2000*10^-6                                  //area
4
5 d=0.5*10^-6                                   //seperation
      of plate
6
7 er=8                                          //relative
     permitivity
8
9 e0=8.85*10^-12                                //absolute
     permitivity
10
11 C=(e0*er*A)/d
12
13 printf("capacitance for capacitor =")
14
15 disp(C)
16
17 printf("Faraday")
```

Scilab code Exa 3.17.3 calculate relative permittivity

```
1 //Chapter-3,Example3_17_3,pg 3-36
2
3 E=1000                                         //electric
     field
```

```
4
5 P=4.3*10^-8                                    //
    polarization
6
7 e0=8.854*10^-12                                //absolute
    permitivity
8
9 er=(P/(e0*E))+1                                //as P/E=e0(
    er-1)
10
11 printf("relative permittivity =")
12
13 disp(er)
```

Scilab code Exa 3.17.4 ratio of two capacitor

```
1 //Chapter-3,Example3_17_4,pg 3-36
2
3 //As C=e0*er*A/d
4
5 e0=%e                                          //absolute
    permitivity
6
7 Ag=%s
8
9 Ap=Ag                                          //Assuming
    Area of glass plate and plastic film is same
10
11 //for glass
12
13 erg=6                                         //relative
    permitivity
14
15 dg=0.25                                       //thickness
16
```

```
17 Cg=e0*erg*Ag/dg
18
19 //for plastic film
20
21 erp=3                                          //relative
      permitivity
22
23 dp=0.1                                         //thickness
24
25 Cp=e0*erp*Ap/dp
26
27 m=Cg/Cp
28
29 printf("since Cg/Cp=")
30
31 disp(m)
32
33 printf("plastic film holds more charge")
```

Scilab code Exa 3.17.5 calculate electronic polarizability and radius of He atom

```
1 //Chapter-3,Example3_17_5,pg 3-37
2
3 N=2.7*10^25                                    //no of
      atoms per m^3
4
5 er=1.0000684                                   //dielectric
      constant of He atom at NTP
6
7 e0=8.854*10^-12                                //absolute
      permitivity
8
9 a=e0*(er-1)/N                                  //electronic
      polarizability
10
```

```
11 printf("1) electronic polarizability=")
12
13 disp(a)
14
15 R=(a/(4*%pi*e0))^(1/3)                    //radius of
      helium atom
16
17 printf("2) radius of He atoms =")
18
19 disp(R)
20
21 printf("meter")
```

Scilab code Exa 3.17.6 calculate electric susceptibility

```
1 //Chapter-3,Example3_17_6,pg 3-37
2
3 er=1.000014                                //dielectric
      constant of He atom at NTP
4
5 Xe=er-1                                    //electric
      susceptibility
6
7 printf("electric susceptibility =")
8
9 disp(Xe)
```

Scilab code Exa 3.17.7 calculate relative permeability

```
1 //Chapter-3,Example3_17_7,pg 3-37
2
3 T=300                                      //
      temperature of paramagnetic material
```

```
4
5 X=3.7*10^-3                                    //
    susceptibility of material
6
7 C=X*T                                          //using
    Curie's law
8
9 T1=250                                         //
    temperature
10
11 T2=600                                        //
    temperature
12
13 u1=C/T1                                       //relative
    permeability of material at 250k
14
15 u2=C/T2                                       //relative
    permeability of material at 350k
16
17 printf("relative permeability at temp 250K=")
18
19 disp(u1)
20
21 printf("relative permeability at temp 600K =")
22
23 disp(u2)
```

Scilab code Exa 3.17.8 calculate Temperature

```
1 //Chapter-3,Example3_17_8,pg 3-38
2
3 u=0.8*10^-23                                   //magnetic
    dipole moment of an atom
4
5 B=0.8                                          //magnetic
```

```
    field
6
7 K=1.38*10^-23                                    //boltzmann
    constant
8
9 T=(2*u*B)/(3*K)                                  //
    temperature
10
11 printf("Temperature at which average thermal energy
    of an atom is equal to magntic energy=")
12
13 disp(T)
14
15 printf("K")
```

Scilab code Exa 3.17.9 calculate magnetization of paramagnetic material

```
1 //Chapter-3,Example3_17_9,pg 3-38
2
3 B=0.5                                            //magnetic
    field
4
5 t=27                                             //
    temperature in degree celcius
6
7 T=273+t                                          //
    temperature in kelvin
8
9 u0=4*%pi*10^-7                                   //
    permeability of free space
10
11 C=2*10^-3                                       //Curie's
    constant
12
13 M=(C*B)/(u0*T)                                  //
```

```
    magnetization of material
14
15 printf("magnetization of paramagnetic material =")
16
17 disp(M)
18
19 printf("A/m")
```

Scilab code Exa 3.17.10 calculate Horizontal component of magnetic field

```
1 //Chapter-3,Example3_17_10,pg 3-38
2
3 u0=4*%pi*10^-7                          //
    permeability of free space
4
5 B=10.9*10^-5                            //flux
    density
6
7 H=B/u0                                  //magnetic
    field
8
9 printf("Horizontal component of magnetic field =")
10
11 disp(H)
12
13 printf("A-m")
```

Scilab code Exa 3.17.11 calculate current required

```
1 //Chapter-3,Example3_17_11,pg 3-39
2
3 phi=5.9*10^-3                           //magnetic
    flux
```

```
4
5  ur=900                                          //relative
       permeability of material
6
7  n=700                                           //number of
       turns
8
9  u0=4*%pi*10^-7                                  //
       permeability of free space
10
11 A=60*10^-4                                      //cross
       section area of ring
12
13 l=2                                             //mean
       circumference of ring
14
15 B=phi/A                                         //flux
       density
16
17 H=B/(u0*ur)                                     //magnetic
       field
18
19 At=H*l                                          //Amp-turns
       required
20
21 I=At/n                                          //current
       required
22
23 printf("Current required to produce a flux=")
24
25 disp(I)
26
27 printf("Amp")
```

Scilab code Exa 3.17.12 calculate Current required

```
1 //Chapter-3,Example3_17_12,pg 3-39
2
3 phi=2.7*10^-3                          //magnetic
     flux
4
5 A=25*10^-4                            //cross
     section area of ring
6
7 r=25*10^-2                            //mean
     circumference of ring
8
9 la=10^-3                               //air gap
10
11 ur=900                               //relative
     permeability of material
12
13 n=400                                //number of
     turns
14
15 u0=4*%pi*10^-7                       //
     permeability of free space
16
17 d=40*10^-2                           //mean
     diameter of ring
18
19 li=2*%pi*r                           //mean
     circumference of ring
20
21 B=phi/A                              //flux
     density
22
23 //for air gap
24
25 Ha=B/(u0)                            //magnetic
     field for air gap
26
27 //for iron ring
28
```

```
29 Hi=B/(u0*ur)                                    //magnetic
      field for iron ring
30
31 //therefore, Amp turn in air gap
32
33 Ata=Ha*la                                       //Amp-turns
      required
34
35 //therefore, Amp-turn in ring
36
37 Ati=Hi*li                                       //Amp-turns
      required
38
39 //therrfore total mmf required
40
41 mmf=Ata+Ati
42
43 //Current required
44
45 I=mmf/n                                         //current
      required
46
47 printf("Current required =")
48
49 disp(I)
50
51 printf("Amp")
```

Scilab code Exa 3.17.13 calculate 1 magnetic intensity 2 magnetization 3 Relative

```
1 //Chapter-3,Example3_17_13,pg 3-40
2
3 n1=10                                           //no of
      turns per cm
4
```

```
5  i=2                                          //current
6
7  B=1                                          //flux
       density
8
9  u0=4*%pi*10^-7                               //
       permeability of free space
10
11 n=n1*100                                     //no turns
       per m
12
13 H=n*i
14
15 printf("                    1) magnetic intensity =")
16
17 disp(H)
18
19 printf("Amp-turn/meter")
20
21 //calculation for magnetization
22
23 I=B/u0-H
24
25 printf("      2) magnetization =")
26
27 disp(I)
28
29 printf("Amp-turn/meter")
30
31 //relative permeability
32
33 ur=B/(u0*H)
34
35 printf("      3) Relative Permeability of the ring ="
       )
36
37 disp(int(ur))
```

Scilab code Exa 3.17.14 calculate Loss of energy

```
1 //Chapter-3,Example3_17_14,pg 3-40
2
3 m=40                                          //wt of the
    core
4
5 d=7.5*10^3                                    //density of
     iron
6
7 n=100                                         //frequency
8
9 V=m/d                                         //volume of
    the iron core
10
11 E1=3800*10^-1                                //loss of
    energy in core per cycles/cc
12
13 E2=E1*V                                      //loss of
    energy in core per cycles
14
15 N=60*n                                       //no of
    cycles per minute
16
17 E=E2*N                                       //loss of
    energy per minute
18
19 printf("Loss of energy per minute =")
20
21 disp(E)
22
23 printf("Joule")
```

Scilab code Exa 3.17.15 calculate various parameter of magnetic field

```
1 //Chapter-3,Example3_17_15,pg 3-40
2
3 l=30*10^-2                                    //length of
     ring
4
5 A=1*10^-4                                     //cross
     section area of ring
6
7 i=0.032                                       //current
8
9 phi=2*10^-6                                   //magnetic
     flux
10
11 u0=4*%pi*10^-7                               //
     permeability of free space
12
13 N=300                                        //no of
     turns in the coil
14
15 //1) flux density
16
17 B=phi/A                                      //flux
     density
18
19 printf("1) Flux density in the ring =")
20
21 disp(B)
22
23 printf("Wb/m^2")
24
25 //2) magnetic intensity of ring
26
```

```
27 n=N/l                                          //no of
      turns per unit length
28
29 H=n*i                                          //magnetic
      intensity
30
31 printf("              2) magnetic intensity =")
32
33 disp(H)
34
35 printf("Amp-turn/meter")
36
37 //3) permeability and relative permeability of the
      ring
38
39 u=B/H
40
41 printf("       3) Permeability of the ring =")
42
43 disp(u)
44
45 printf("Wb/A-m")
46
47 ur=u/u0
48
49 printf("               4) Relative Permeability of
      the ring =")
50
51 disp(ur)
52
53 //4)Susceptibility
54
55 Xm=ur-1
56
57 printf("5) magnetic Susceptibility of the ring =")
58
59 disp(Xm)
```

Scilab code Exa 3.17.16 calculate loss of energy per hour

```
1 //Chapter-3,Example3_17_16,pg 3-41
2
3 E=3000                                    //loss of
    energy per cycle per cm^3
4
5 m=12*10^3                                 //wt of the
    core
6
7 d=7.5                                     //density of
     iron
8
9 n=50                                      //frequency
10
11 V=m/d                                    //volume of
    the core
12
13 El=E*V*n*60*60                           //loss of
    energy per hour
14
15 printf("Loss of energy per hour =")
16
17 disp(El)
18
19 printf("Erg")
```

Scilab code Exa 3.17.17 calculate Hysteresis power loss

```
1 //Chapter-3,Example3_17_17,pg 3-41
2
3 n=50                                      //frequency
```

```
4
5 V=10^-3                                   //volume of
    the specimen
6
7 //Area of B-H loop
8
9 A=0.5*10^3*1
10
11 P=n*V*A
12
13 printf("Hysteresis power loss =")
14
15 disp(P)
16
17 printf("Watt")
```

Scilab code Exa 3.17.18 calculate current required

```
1 //Chapter-3,Example3_17_18,pg 3-42
2
3 phi=1.5*10^-4                             //magnetic
    flux
4
5 ur=900                                    //relative
    permeability of material
6
7 n=600                                     //number of
    turns
8
9 u0=4*%pi*10^-7                            //
    permeability of free space
10
11 A=5.8*10^-4                              //cross
    section area of ring
12
```

```
13 d=40*10^-2                                    //mean
     diameter of ring
14
15 li=%pi*d                                      //mean
     circumference of ring
16
17 la=5*10^-3                                    //air gap
18
19 B=phi/A                                       //flux
     density
20
21 //for air gap
22
23 Ha=B/(u0)                                     //magnetic
     field for air gap
24
25 //for iron ring
26
27 Hi=B/(u0*ur)                                  //magnetic
     field for iron ring
28
29 //therefore, Amp turn in air gap
30
31 Ata=Ha*la                                     //Amp-turns
     required
32
33 //therefore, Amp-turn in ring
34
35 Ati=Hi*li                                     //Amp-turns
     required
36
37 //therrfore total mmf required
38
39 mmf=Ata+Ati
40
41 //Current required
42
43 I=mmf/n                                        //current
```

```
    required
44
45 printf("Current required =")
46
47 disp(I)
48
49 printf("Amp")
```

Scilab code Exa 3.17.19 calculate reluctance and mmf

```
1  //Chapter-3,Example3_17_19,pg 3-42
2
3  la=1*10^-2                                  //air gap
4
5  r=0.5                                       //radius of
       ring
6
7  A=5*10^-4                                   //cross
       section area of ring
8
9  i=5                                         //current
10
11 u=6*10^-3                                   //
       permeability of iron
12
13 u0=4*%pi*10^-7                              //
       permeability of free space
14
15 N=900                                       //no of
       turns in the coil
16
17 //let reluctance of iron ring with air gap be S
18
19 S=la/(u0*A)+(2*%pi*r-la)/(u*A)
20
```

```
21 printf("          1) Reluctance =")
22
23 disp(S)
24
25 printf("A-T/Wb")
26
27 mmf=N*i
28
29 printf("   2) m.m.f =")
30
31 disp(mmf)
32
33 printf("Amp-turn")
```

Scilab code Exa 3.17.20 calculate current

```
1 //Chapter-3,Example3_17_20,pg 3-43
2
3 //the magnetization force is given by,
4
5 //H=NI/l
6
7 H=5*10^3                                   //coercivity
      of bar magnet
8
9 l=10*10^-2                                //length of
     solenoid
10
11 N=50                                      //number of
     turns
12
13 I=l*H/N
14
15 printf("current =")
16
```

```
17 disp(I)
18
19 printf("Ampere")
```

Scilab code Exa 3.17.21 calculate Reluctance and current

```
1  //Chapter-3,Example3_17_21,pg 3-43
2
3  ur=380                                    //relative
       permeability of air
4
5  u0=4*%pi*10^-7                            //
       permeability of free space
6
7  A=5*10^-4                                 //cross
       section area of ring
8
9  n=200                                     //number of
       turns
10
11 d=20*10^-2                                //mean
       diameter of ring
12
13 l=%pi*d                                   //mean
       circumference of ring
14
15 phi=2*10^-3                               //magnetic
       flux
16
17 S=l/(u0*ur*A)                             //reluctance
18
19 //using ohm's law for magnetic circuit
20
21 //phi=N*I/S
22
```

```
I=S*phi/n

printf("          1) Reluctance =")

disp(S)

printf("A-T/Wb")


printf("    2) current =")

disp(I)

printf("Ampere")
```

Scilab code Exa 3.17.22 calculate various parameter of magnetic field

```
//Chapter-3,Example3_17_22,pg 3-43

ur=1                                    //relative
   permeability of air

u0=4*%pi*10^-7                          //
   permeability of free space

A=6*10^-4                               //cross
   section area of torroid

n=500                                   //number of
   turns

r=15*10^-2                              //radius of
   torroid

I=4                                     //current in
```

```
    coil
14
15 l=2*%pi*r                                    //mean
    circumference of torroid
16
17 MMF=n*I
18
19 printf("1) MMF (NI) =")
20
21 disp(MMF)
22
23 printf("AT")
24
25 R=l/(u0*ur*A)                                //Reluctance
26
27 printf("        2) Reluctance (R) =")
28
29 disp(R)
30
31 printf("AT/Wb")
32
33 phi=MMF/R                                    //flux
34
35 printf("     3) Magnetic flux =")
36
37 disp(phi)
38
39 printf("Wb")
40
41 B=phi/A                                      //flux
    density
42
43 printf("        4) Flux density =")
44
45 disp(B)
46
47 printf("Wb/m^2")
48
```

```
49 H=B/(u0*ur)                                    //magnetic
       field intensity
50
51 printf("    5) Magnetic field intensity =")
52
53 disp(H)
54
55 printf("A/m")
```

Scilab code Exa 3.17.23 calculate Number of AmpereTurns

```
1  //Chapter-3,Example3_17_23,pg 3-44
2
3  phi=10^-3                                      //magnetic
       flux
4
5  ur=1000                                        //relative
       permeability of iron
6
7  u0=4*%pi*10^-7                                 //
       permeability of free space
8
9  A=5*10^-4                                      //cross
       section area of ring
10
11 la=2*10^-3                                     //air gap
12
13 d=20*10^-3                                     //mean
       diameter of ring
14
15 li=%pi*d-la                                    //mean
       circumference of ring
16
17 //using KVL for magnetic circuit
18
```

```
19 //AT(total)=AT(iron)+AT(air gap)
20
21 ATt=(phi/(u0*A))*((li/ur)+la)
22
23 printf("Number of Ampere-Turns required =")
24
25 disp(round(ATt))
```

Scilab code Exa 3.17.24 calculate intensity magnetization and flux density

```
1 //Chapter-3,Example3_17_24,pg 3-44
2
3 X=0.5*10^-5                                    //
    susceptibility of material
4
5 H=10^6                                         //magnetic
    field strength
6
7 I=X*H                                          //intensity
    of magnetization
8
9 u0=4*%pi*10^-7                                 //
    permeability of free space
10
11 B=u0*(H+I)                                    //flux
    density
12
13 printf("            1) intensity magnetization =")
14
15 disp(I)
16
17 printf("Amp/m")
18
19 printf("        2) flux density in the material =")
20
```

```
21 disp(B)
22
23 printf("wb/m^2")
```

Chapter 4

Acoustics and Ultrasonics

Scilab code Exa 4.11.1 calculate length

```
1 //Chapter-4,Example4_11_1,pg 4-17
2
3 d=8900                                    //density
4
5 Y=20.8*10^10                              //Young's
     modulus
6
7 n=40*10^3                                 //frequency
     of wave
8
9 k=1                                       //consider 1
     st harmonic
10
11 l=(k/(2*n))*sqrt(Y/d)                    //arranging
     formula of natural frequency
12
13 printf("length =")
14
15 disp(l)
16
17 printf("meter")
```

Scilab code Exa 4.12.1 calculate thickness

```
1 //Chapter-4,Example4_12_1,pg 4-20
2
3 d=2.65*10^3                                   //density
4
5 Y=8*10^10                                     //Young's
      modulus
6
7 n=1*10^6                                      //frequency
      of wave
8
9 k=1                                           //consider 1
      st harmonic
10
11 t=(k/(2*n))*sqrt(Y/d)                        //arranging
      formula of natural frequency
12
13 printf("thickness =")
14
15 disp(t)
16
17 printf("meter")
```

Scilab code Exa 4.15.1 calculate Reverberation time

```
1 //Chapter-4,Example4_15_1,pg 4-25
2
3 l=20                                          //length of
      room
4
```

```
5 b=15                                          //bredth of
    room
6
7 h=10                                          //height of
    room
8
9 V=l*b*h                                       //volume of
    room
10
11 a=0.106                                      //absorption
     coefficient
12
13 S=2*(l*b+b*h+h*l)                            //surface
    area of hall
14
15 T=(0.161*V)/(a*S)                            //
    Reverberation time,using Sabine's formula
16
17 printf("Reverberation time =")
18
19 disp(T)
20
21 printf("sec")
```

Scilab code Exa 4.15.2 calculate change in intensity level

```
1 //Chapter-4,Example4_15_2,pg 4-26
2
3 m=%i                                          //original
    sound intensity
4
5 n=1000*%i                                     //increased
    intensity value
6
7 l=10*log10(n/m)                               //change in
```

```
    intensity level
8
9 printf("change in intensity level =")
10
11 disp(l)
12
13 printf("dB")
```

Scilab code Exa 4.15.3 clculate average sound absorption coefficient and reverbera

```
1 //Chapter-4,Example4_15_3,pg 4-26
2
3 S1=220                                    //wall area
4
5 a1=0.03                                   //absorption
    coefficient for the wall
6
7 S2=120                                    //floor area
8
9 a2=0.8                                    //absorption
    coefficient for the floor
10
11 S3=120                                   //ceiling
    area
12
13 a3=0.06                                  //absorption
    coefficient for the ceiling
14
15 V=600                                    //volume of
    room
16
17 S=S1+S2+S3                               //total
    surface area
18
19 a=(a1*S1+a2*S2+a3*S3)/S                  //average
```

```
    sound absorption coefficient
20
21 printf("1) average sound absorption coefficient =")
22
23 disp(a)
24
25 T=(0.161*V)/(a*S)                          //
    Reverberation time,using Sabine's formula
26
27 printf("2) Reverberation time =")
28
29 disp(T)
30
31 printf("sec")
```

Scilab code Exa 4.15.4 calculate average absorption coefficient

```
1 //Chapter-4,Example4_15_4,pg 4-27
2
3 V=5500                                      //volume
4
5 T=2.3                                       //
    Reverberation time
6
7 S=750                                       //sound
    absorption coefficient
8
9 a=(0.161*V)/(S*T)                           //using
    Sabine's formula
10
11 printf("average absorption coefficient =")
12
13 disp(a)
```

Scilab code Exa 4.15.5 claculate average absorption coefficient and area of floor

```
1 //Chapter-4,Example4_15_5,pg 4-27
2
3 l=20                                          //length of
     room
4
5 b=12                                          //bredth of
     room
6
7 h=12                                          //height of
     room
8
9 V=l*b*h                                       //volume of
     room
10
11 S=2*(l*b+b*h+h*l)                            //surface
     area of hall
12
13 T1=2.5                                       //
     Reverberation time
14
15 a=(0.161*V)/(T1*S)                           //using
     Sabine's formula
16
17 printf("1) average absorption coefficient =")
18
19 disp(a)
20
21 a1=0.5                                       //absorption
     coefficient
22
23 T2=2                                         //
     Reverberation time
```

```
24
25 S1=(0.161*V/(a1-a))*(1/T2-1/T1)
26
27 printf("2) carpet area required =")
28
29 disp(S1)
30
31 printf("m^2")
```

Scilab code Exa 4.15.6 calculate reverberation time for various case

```
1  //Chapter-4,Example4_15_6,pg 4-28
2
3  Ac=10*12                                    //area of
       carpet covering entire floor
4
5  ac=0.06                                     //absorption
       coefficient of carpet
6
7  aS1=Ac*ac                                   //absorption
       due to carpet
8
9  Af=10*12                                    //area of
       false celling
10
11 af=0.03                                     //absorption
       coefficient of celling
12
13 aS2=Af*af                                   //absorption
       due to celling
14
15 As=100*1                                    //area of
       cushioned sets
16
17 as=1                                        //absorption
```

```
    coefficient of cushion sets
18
19 aS3=As*as                                    //absorption
    due to cusion sets
20
21 Aw=346*1                                     //area of
   walls covered with absorbent
22
23 aw=0.2                                       //absorption
    coefficient of walls
24
25 aS4=Aw*aw                                    //absorption
    due to walls
26
27 Ad=346*1                                     //area of
   wooden door
28
29 ad=0.2                                       //absorption
    coefficient of wooden door
30
31 aS5=Ad*ad                                    //absorption
    due to wooden door
32
33 aS=aS1+aS2+aS3+aS4                           //total
   absorption
34
35 ap=0.46                                      //absorption
    coefficient of audience/person
36
37 l=12                                         //assuming
   length of wall
38
39 b=10                                         //assuming
   breadth of wall
40
41 h=8                                          //assuming
   height of wall
42
```

```
43 V=l*b*h                                    //volume of
      hall
44
45 //case 1 :(no one inside/emptey  hall)
46
47 T1=(0.161*V)/aS                             //
      reverberation time
48
49 printf("      1)reverberation time of empty hall =")
50
51 disp(T1)
52
53 printf("sec")
54
55 //case 2 :(50 person inside hall)
56
57 T2=(0.161*V)/(aS+50*0.46)                    //
      reverberation time
58
59 printf("  2)reverberation time of hall with 50
      person =")
60
61 disp(T2)
62
63 printf("sec")
64
65 //case 2 :(100 person inside hall/full capacity of
      hall)
66
67 T3=(0.161*V)/(aS+100*0.46)                   //
      reverberation time
68
69 printf("  3)reverberation time of hall with 100
      person =")
70
71 disp(T3)
72
73 printf("sec")
```

Scilab code Exa 4.15.7 calculate average absorption coefficient and total absorpti

```
1 //Chapter-4,Example4_15_7,pg 4-30
2
3 l=20                                          //length of
     room
4
5 b=15                                          //bredth of
     room
6
7 h=5                                           //height of
     room
8
9 V=l*b*h                                       //volume of
     room
10
11 S=2*(l*b+b*h+h*l)                            //surface
     area of hall
12
13 T=3.5                                        //
     Reverberation time
14
15 a=(0.161*V)/(T*S)                            //using
     Sabine's formula
16
17 printf("1) average absorption coefficient =")
18
19 disp(a)
20
21 avg=a*S                                      //average
     total absorption
22
23 printf("2) average total absorption =")
24
```

```
25 disp(avg)
26
27 printf("m^2.S")
```

Scilab code Exa 4.15.8 calculate change in reverberation time

```
1  //Chapter-4,Example4_15_8,pg 4-30
2
3  l=20                                    //length of
       room
4
5  b=15                                    //bredth of
       room
6
7  h=10                                    //height of
       room
8
9  V=l*b*h                                 //volume of
       room
10
11 a=0.1                                   //absorption
       coefficient
12
13 S=2*(l*b+b*h+h*l)                       //surface
       area of hall
14
15 T1=(0.161*V)/(a*S)                      //
       Reverberation time,using Sabine's formula
16
17 printf("1) Reverberation time =")
18
19 disp(T1)
20
21 printf("sec")
22
```

```
23 a2=0.66                                          //absorption
       coefficient of curtain cloth
24
25 S2=100                                           //surface
      area of a curtain cloth
26
27 T2=(0.161*V)/(a*S+a2*S2*2)                       //
      Reverberation time,using Sabine's formula
28
29 T=T1-T2                                          //change in
      Reverberation time
30
31 printf("2) change in Reverberation time =")
32
33 disp(T)
34
35 printf("sec")
```

Scilab code Exa 4.15.9 calculate average absorption coefficient and reverberation

```
1 //Chapter-4,Example4_15_9,pg 4-30
2
3 S1=220                                           //wall area
4
5 a1=0.03                                          //absorption
      coefficient for the wall
6
7 S2=120                                           //floor area
8
9 a2=0.8                                           //absorption
      coefficient for the floor
10
11 S3=120                                          //ceiling
      area
12
```

```
13 a3=0.06                                          //absorption
       coefficient for the ceiling
14
15 V=600                                            //volume of
      room
16
17 S=S1+S2+S3                                       //total
      surface area
18
19 a=(a1*S1+a2*S2+a3*S3)/S                          //average
      sound absorption coefficient
20
21 printf("1) average sound absorption coefficient =")
22
23 disp(a)
24
25 T=(0.161*V)/(a*S)                                //
      Reverberation time,using Sabine's formula
26
27 printf("2) Reverberation time =")
28
29 disp(T)
30
31 printf("sec")
```

Scilab code Exa 4.15.10 calculate depth of seabed and wavelength

```
1 //Chapter-4,Example4_15_10,pg 4-31
2
3 f=0.07*10^6                                       //frequency
4
5 t=0.65                                            //time
6
7 v=1700                                            //velocity
      of sound
```

```
8
9  d=v*t/2                                          //depth of
       seabed
10
11 printf("1) depth of seabed =")
12
13 disp(d)
14
15 printf("meter")
16
17 l=v/f                                            //wavelength
18
19 printf("2) wavelength =")
20
21 disp(l)
22
23 printf("meter")
```

Scilab code Exa 4.15.11 calculate natural frequency

```
1  //Chapter-4,Example4_15_11,pg 4-31
2
3  t=1*10^-3                                        //thicknesss
       of crystal
4
5  d=2.65*10^3                                      //density
6
7  Y=8*10^10                                        //Young's
       modulus
8
9  k=1                                              //consider 1
       st harmonic
10
11 n=(k/(2*t))*sqrt(Y/d)                            //formula of
       natural frequency
```

```
12
13 printf(" natural frequency =")
14
15 disp(n)
16
17 printf("Hz")
```

Scilab code Exa 4.15.12 calculate thickness

```
1  //Chapter-4,Example4_15_12,pg 4-32
2
3  d=2650                                    //density
4
5  Y=8*10^10                                 //Young's
       modulus
6
7  k=1                                       //consider 1
       st harmonic
8
9  //case 1
10
11 n1=3.8*10^6                               //frequency
       of wave
12
13 t1=(k/(2*n1))*sqrt(Y/d)                   //arranging
       formula of natural frequency
14
15 printf("1) thickness =")
16
17 disp(t1)
18
19 printf("meter")
20
21 //case 2
22
```

```
23 n2=300*10^3                                    //frequency
       of wave
24
25 t2=(k/(2*n2))*sqrt(Y/d)                        //arranging
       formula of natural frequency
26
27 printf("2) thickness =")
28
29 disp(t2)
30
31 printf("meter")
```

Scilab code Exa 4.15.13 calculate thickness

```
1 //Chapter-4,Example4_15_13,pg 4-32
2
3 d=2650                                          //density
4
5 Y=8*10^10                                       //Young's
       modulus
6
7 n=2*10^6                                        //frequency
       of wave
8
9 k=1                                             //consider 1
       st harmonic
10
11 t=(k/(2*n))*sqrt(Y/d)                          //arranging
       formula of natural frequency
12
13 printf("thickness =")
14
15 disp(t)
16
17 printf("meter")
```

Scilab code Exa 4.15.14 calculate distance between two ships

```
1 //Chapter-4,Example4_15_14,pg 4-33
2
3 f=50*10^3                                    //frequency
4
5 v1=348                                       //velocity
    of ultrasound in atmosphere
6
7 v2=1392                                      //velocity
    of ultrasound in sea water
8
9 t=2                                          //time
    difference
10
11 //distance is constant hence v1*t1=v2*t2
12
13 m=v2/v1                                     //assuming
    constant as m
14
15 //(t1-t2=d) and (t1=m*t2) therefore
16
17 t2=t/(m-1)
18
19 d=v2*t2                                     //distance
    between two ship
20
21 printf("distance between two ships =")
22
23 disp(d)
24
25 printf("meter")
```

Scilab code Exa 4.15.15 calculate natural frequency and change in thickness

```
1 //Chapter-4,Example4_15_15,pg 4-34
2
3 //for case1
4 t1=2*10^-3                                    //thicknesss
      of plate
5
6 d=2.65*10^3                                   //density
7
8 Y=8*10^10                                     //Young's
     modulus
9
10 k=1                                          //consider 1
     st harmonic
11
12 n1=(k/(2*t1))*sqrt(Y/d)                      //formula of
      natural frequency
13
14 printf("        1)natural frequency =")
15
16 disp(n1)
17
18 printf("Hz")
19
20 //for case2
21
22 n2=3*10^6                                    //frequency
23
24 t2=(k/(2*n2))*sqrt(Y/d)                      //arranging
     formula of natural frequency
25
26 t=t1-t2                                      //change in
     thickness
```

```
27
28 printf("      2)change in thickness =")
29
30 disp(t)
31
32 printf("meter")
```

Scilab code Exa 4.15.16 calculate depth of sea bed

```
1 //Chapter-4,Example4_15_16,pg 4-34
2
3 S=10                                          //salinity
4
5 t=2                                           //time
6
7 T=20                                          //
    temperature
8
9 v=1510+1.14*S+4.21*T-0.037*T^2                //velocity
    of ultrasound in sea
10
11 d=v*t/2                                      //depth of
    sea bed
12
13 printf("depth of sea bed =")
14
15 disp(d)
16
17 printf("meter")
```

Scilab code Exa 4.15.17 calculate depth of sea bed and frequency

```
1 //Chapter-4,Example4_15_17,pg 4-35
```

```
2
3 S=29                                          //salinity
4
5 t=2                                           //time
6
7 l=0.01                                        //wavelength
8
9 T=30                                          //
    temperature
10
11 v=1510+1.14*S+4.21*T-0.037*T^2               //velocity
    of ultrasound in sea
12
13 d=v*t/2                                      //depth of
    sea bed
14
15 printf("1)depth of sea bed =")
16
17 disp(d)
18
19 printf("meter")
20
21 f=v/l                                        //frequency
22
23 printf("2) frequency =")
24
25 disp(f)
26
27 printf("Hz")
```

Scilab code Exa 4.15.18 calculate real thickness

```
1 //Chapter-4,Example4_15_18,pg 4-35
2
3 v1=5.9*10^3                                   //velocity
```

```
    of UW in mild steel
4
5 v2=4.3*10^3                                   //velocity
    of UW in brass
6
7 t2=15*10^-3                                   //thickness
    of brass plate
8
9 t1=v2*t2/v1                                   //since ve;
    ocity is inversly proportional to thickness
10
11 printf("real thickness =")
12
13 disp(t1)
14
15 printf("meter")
```

Scilab code Exa 4.15.19 calculate thickness of crystal

```
1 //Chapter-4,Example4_15_19,pg 4-36
2
3 t1=4*10^-3                                    //thickness
    of 1st crystal
4
5 n1=400*10^3                                   //frequency
    of 1st crystal
6
7 n2=500*10^3                                   //frequency
    of 2nd crystal
8
9 t2=n1*t1/n2                                   //since
    frquency is inversly proportional to thickness
10
11 printf("thickness of 2nd crystal =")
12
```

```
13 disp(t2)
14
15 printf("meter")
```

Scilab code Exa 4.15.20 calculate distance at which defect has occurred

```
1 //Chapter-4,Example4_15_20,pg 4-36
2
3 t2=30*10^-6                                    //pulse
     arrival time of defective steel bar
4
5 t1=80*10^-6                                    //pulse
     arrival time of non defective steel bar
6
7 d=40*10^-2                                     //bar
     thickness
8
9 x=(t2/t1)*d
10
11 printf("distance at which defect has occurred =")
12
13 disp(x)
14
15 printf("meter")
```

Scilab code Exa 4.15.21 calculate echo time

```
1 //Chapter-4,Example4_15_21,pg 4-37
2
3 d=18*10^-3                                     //thickness
4
5 v=5.9*10^3                                     //velocity
6
```

```
7 t=(2*d)/v                                    //echo time
8
9 printf("echo time =")
10
11 disp(t)
12
13 printf("sec")
```

Scilab code Exa 4.15.22 calculate frquency of vibration

```
1 //Chapter-4,Example4_15_22,pg 4-37
2
3 t=1*10^-3                                    //thickness
    of quartz crystal
4
5 //given t=l/2
6
7 l=t*2                                        //wavelength
8
9 Y=7.9*10^10                                  //young's
    module of crystal
10
11 p=2650                                      //density of
     crystal
12
13 v=sqrt(Y/p)                                 //velocity
    of vibration
14
15 n=v/l                                       //frequency
    of vibration
16
17 printf("frquency of vibration =")
18
19 disp(n)
20
```

```
21 printf("Hz")
```

Scilab code Exa 4.15.23 calculate length

```
1 //Chapter-4,Example4_15_23,pg 4-38
2
3 d=7.23*10^3                                   //density
4
5 Y=11.6*10^10                                  //Young's
    modulus
6
7 n=20*10^3                                     //frequency
    of wave
8
9 k=1                                           //consider 1
    st harmonic
10
11 l=(k/(2*n))*sqrt(Y/d)                        //arranging
    formula of natural frequency
12
13 printf("length =")
14
15 disp(l)
16
17 printf("meter")
```

Scilab code Exa 4.15.24 calculate natural frequency and change in thickness

```
1 //Chapter-4,Example4_15_24,pg 4-38
2
3 //for case1
4 t1=2*10^-3                                    //thicknesss
     of plate
```

```
5
6  d=2.65*10^3                                    //density
7
8  Y=8*10^10                                      //Young's
       modulus
9
10 k=1                                            //consider 1
       st harmonic
11
12 n1=(k/(2*t1))*sqrt(Y/d)                        //formula of
        natural frequency
13
14 printf("        1)natural frequency =")
15
16 disp(n1)
17
18 printf("Hz")
19
20 //for case2
21
22 n2=3*10^6                                      //frequency
23
24 t2=(k/(2*n2))*sqrt(Y/d)                        //arranging
       formula of natural frequency
25
26 t=t1-t2                                        //change in
       thickness
27
28 printf("      2)change in thickness =")
29
30 disp(t)
31
32 printf("meter")
```

Scilab code Exa 4.15.25 calculate average absorption coefficien and total absorpti

```
1  //Chapter-4,Example4_15_25,pg 4-39
2
3  l=20                                          //length of
       room
4
5  b=15                                          //bredth of
       room
6
7  h=10                                          //height of
       room
8
9  V=l*b*h                                       //volume of
       room
10
11 S=2*(l*b+b*h+h*l)                             //surface
       area of hall
12
13 T=3                                           //
       Reverberation time
14
15 a=(0.161*V)/(T*S)                             //using
       Sabine's formula
16
17 printf("1) average absorption coefficient =")
18
19 disp(a)
20
21 m=a*S                                         //total
       absorption
22
23 printf("2) total absorption of surface =")
24
25 disp(m)
26
27 printf("m^2/sec")
```

Scilab code Exa 4.15.26 calculate natural frequency and change in thickness

```
1 //Chapter-4,Example4_15_26,pg 4-39
2
3 //for case1
4 t1=1.8*10^-3                          //thicknesss
      of plate
5
6 d=2.65*10^3                           //density
7
8 Y=8*10^10                             //Young's
     modulus
9
10 k=1                                  //consider 1
     st harmonic
11
12 n1=(k/(2*t1))*sqrt(Y/d)              //formula of
      natural frequency
13
14 printf("        1)natural frequency =")
15
16 disp(n1)
17
18 printf("Hz")
19
20 //for case2
21
22 n2=2*10^6                             //frequency
23
24 t2=(k/(2*n2))*sqrt(Y/d)               //arranging
     formula of natural frequency
25
26 t=t1-t2                               //change in
     thickness
```

```
27
28 printf("      2)change in thickness =")
29
30 disp(t)
31
32 printf("meter")
```

Scilab code Exa 4.15.27 calculate Youngs modulus

```
1 //Chapter-4,Example4_15_27,pg 4-39
2
3 n=0.4999*10^6                          //frequency
4
5 t=5.5*10^-3                            //thicknesss
      of plate
6
7 d=2.65*10^3                            //density
8
9 k=1                                    //consider 1
     st harmonic
10
11 Y=4*(t^2)*(n^2)*d/k                   //arranging
     formula of natural frequency
12
13 printf("Youngs modulus =")
14
15 disp(Y)
16
17 printf("N/m^2")
```