

Scilab Textbook Companion for
Applied Physics-i
by I. A. Shaikh¹

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

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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
   arranging 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
   arranging 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
    arranging 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 edges.
   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 exhibiting HCP structure the
  arrangement 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 //in angle 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
  arrangig terms we get value of r
18
19 printf("critical radius ratio of 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 plane are 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("miller 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 plane are in proportion 3a:4b:infinity
   (plane parallel to z axis)
4
5 //as a,b and c are basic vectors the proportion 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("miller 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 plane are in proportion 3a:-2b:3/2c
4
5 //as a,b and c are basic vectors the proportion 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("miller 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 //therefore 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
5 ro=6250 //density
6
7 M=60.2 //molecular
  weight
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 1.14.19 calculate wavelength

```

1 //Chapter -1,Example1_14_19 ,pg 1-66
2
3 a=2.82*10^-9 //lattice
  constant
4
5 n=2 //FCC
  crystal
6
7 t=17.167 //glancing
  angle in degree
8
9 q=%pi/180*t //glancing
  angle in radians
10
11 //assuming reflection in (1,0,0) plane
12

```

```

13 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("wavelength 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  $a^3 \cdot \rho / n = \text{mass of unit cell} / (\text{no of atoms}$ 
     $\text{pre unit cell}) = \text{mass of one atom}$ 
16
17  $m = a^3 \cdot \rho / n$ 
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, Example 1.15-1 , pg 1-68
2
3  $d = 4.255 \cdot 10^{-10}$  //
    interplaner spacing
4
5  $\lambda = 1.549 \cdot 10^{-10}$  //wavelength
    of x ray
6
7 //part 1: for smallest glancing angle (n=1)
8
9  $n_1 = 1$ 
10
11 //using Bragg's law  $n \cdot \lambda = 2 \cdot d \cdot \sin(q)$ 
12
13  $q = \text{asind}(n_1 \cdot \lambda / (2 \cdot d))$ 
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  $n \cdot l = 2 \cdot d \cdot \sin(q)$ 
26
27  $n2 = 2 \cdot d / l$  //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, Example 1.15.2 , pg 1-69
2
3  $a = 2.125 \cdot 10^{-10}$  //lattice
    constant
4
5  $d = a / 2$  //
    interplaner spacing
6
7  $n = 2$  //second
    order maximum
8
9  $l = 0.592 \cdot 10^{-10}$  //wavelength
    of rock salt crystal
10
11 //using Bragg's law
12
13  $m = \text{asin}((n \cdot l) / (2 \cdot d))$  //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 inverse 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
15 e=1.6*10^-19 //charge on
    electron
16
17 N=6.023*10^26 //Avogadro's
    number
18
19 //step 1:clculating shortest wavelength
20
21 l=h*c/(e*V)
22
23 printf("    1)shortest wavelength=")
24
25 disp(l)
26
27 printf("m")
28
29 //step:2 calculating distance(d)
30
31 //now a^3*p=n*M/N therefore ,
32
33 a=(n*M/(N*p))^(1/3)
34
35 //since KCl is ionic crystal herefore ,
36
37 d=a/2
38
39 //step 3: calculaing glancing angle
40
41 //using Bragg's law
42
43 //n*l=2*d*sin(t)
44
45 //assume sin(t)=a, wavelength is minimum i.e l and n
    =1
46
47 n=1
48

```

```

49 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 d11=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 d12=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 d13=n*l/(2*sind(q3))
30
31 //for taking ratio divide all dl by d11
32
33 d1=d11/d11
34
35 d2=d12/d11
36
37 d3=d13/d11
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  $n\lambda=2d\sin(\theta)$ 
12
13  $\lambda=2d\sin(\theta)/n$ 
14
15 printf("          1) wavelength=")
16
17 disp( $\lambda$ )
18
19 printf("meter")
20
21 //for part 2
22
23 n1=2
24
25 //using Bragg's law  $n\lambda=2d\sin(\theta)$ 
26
27  $\theta=\text{asind}(n1*\lambda/(2*d))$ 
28
29 printf("    2) glancing angle=")
30
31 disp( $\theta$ )
32
33 printf("degree")
34
35 //for part 3
36
37 //for highest order  $\sin(\theta)$  not exceed one i.e
    maximum value is one
38
39 //using Bragg's law  $n\lambda=2d\sin(\theta)$ 
40
41  $n2=2*d/\lambda$                                      //since  $\sin(\theta)$ 
    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  $n1 \cdot l1 = 2 \cdot d1 \cdot \sin(q1)$ 
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  $n2 \cdot l2 = 2 \cdot d2 \cdot \sin(q2)$ 
22
23 //since for both lines A and B we use same plane of
   same crystal , therefore
24
```

```

25 //d1=d2
26
27 //therefore equation became  $n_2 \cdot l_2 = 2 \cdot n_1 \cdot l_1 / (2 \cdot \sin(q_1) \cdot \sin(q_2))$ 
28
29 //by arranging terms we get
30
31
32  $l_1 = n_2 \cdot l_2 \cdot 2 \cdot \sin(q_1) / (2 \cdot n_1 \cdot \sin(q_2))$ 
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, Example 1.15-11 , 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 creact 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 creact 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

```

```

7 u=0.048 //mobility
  of hole
8
9 s=4.4*10^-4 //
  conductivity of Si
10
11 //since millionth Si atom is replaced by an indium
  atom
12
13 n=c*10^-6
14
15 sp=u*e*n //
  conductivity of resultant
16
17 printf("conductivity =")
18
19 disp(sp)
20
21 printf("mho/m")

```

Scilab code Exa 2.21.7 calculate hole concentration and mobility

```

1 //Chapter -2,Example2_21_7 ,pg 2-49
2
3 m=28.1 //atomic
  weight of Si
4
5 e=1.6*10^-19 //charge on
  electron
6
7 N=6.02*10^26 //Avogadro's
  number
8
9 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 intrinsic 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 intrinsic 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
   intrinsic 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

```

```

7 I=200 //current in
    strip
8
9 W=1*10^-3 //thickness
    of strip
10
11 Vh=Rh*(B*I)/W //due to
    Hall effect
12
13 printf("Hall voltage =")
14
15 disp(Vh)
16
17 printf("Volt")

```

Scilab code Exa 2.23.4 calculate Resistivity of P type silicon

```

1 //Chapter -2,Example2_23_4 ,pg 2-53
2
3 Rh=2.25*10^-5 //Hall
    coefficient
4
5 u=0.025 //mobility
    of hole
6
7 r=Rh/u
8
9 printf("Resistivity of P type silicon =")
10
11 disp(r)
12
13 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
   permittivity
10
11 e0=8.85*10^-12 //absolute
   permittivity
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
   permittivity
8
9 e0=8.85*10^-12 //absolute
   permittivity
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
   permittivity
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
   permittivity
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
   permittivity
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 //therefore 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 Permeability

```
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 E1=E*V*n*60*60 //loss of
   energy per hour
14
15 printf("Loss of energy per hour =")
16
17 disp(E1)
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 //therefore 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=1a/(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=1*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=1/(u0*ur*A) //reluctance
18
19 //using ohm's law for magnetic circuit

```

```

20
21 //phi=N*I/S
22
23 I=S*phi/n
24
25 printf("          1) Reluctance =")
26
27 disp(S)
28
29 printf("A-T/Wb")
30
31
32 printf("    2) current =")
33
34 disp(I)
35
36 printf(" Ampere")

```

Scilab code Exa 3.17.22 calculate various parameter of magnetic field

```

1 //Chapter-3,Example3_17_22 , pg 3-43
2
3 ur=1 //relative
   permeability of air
4
5 u0=4*pi*10^-7 //
   permeability of free space
6
7 A=6*10^-4 //cross
   section area of torroid
8
9 n=500 //number of
   turns
10
11 r=15*10^-2 //radius of

```

```

    torroid
12
13 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=1/(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 //breadth 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(1)
12
13 printf("dB")

```

Scilab code Exa 4.15.3 calculate average sound absorption coefficient and reverberation time

```

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 calculate 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 ceiling
10
11 af=0.03 //absorption
    coefficient of ceiling
12
13 aS2=Af*af //absorption
    due to ceiling
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 cushion 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/empty 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 absorption

```
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 time

```

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 //thickness
      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 //thickness
   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
  frequency 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 frequency 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           //thickness
    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 coefficient and total absorption

```
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, Example 4.15.26 , pg 4-39
2
3 //for case1
4 t1=1.8*10^-3 //thickness
   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                         //thickness
    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")

```
