Scilab Textbook Companion for Electrical Engineering Materials by R. K. Shukla and A. Singh[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

Crystal structure Bonding and Defects in solids

Scilab code Exa 1.1 `To find lattice constant`

```

//
// chapter 1 example 1

clc;
clear;

// input data
// FCC structured crystal

 p        = 6250;               // Density of crystal in kg/m^3
 N        = 6.023*10^26;        // Avagadros number in atoms/kilomole
 M        = 60.2;               // molecular weight per mole
 n        = 4;                  // No. of atoms per
```

```
    unit cell for FCC

//Calculations

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

//Output

mprintf('Lattice Constant a = %3.2f.   ',a/10^-10);
//
   ==================================================================
```

Scilab code Exa 1.2 `To find interplanar distances`

```

//
   ==================================================================

// chapter 1 example 2
clc;
clear;

//input data
h1       = 1;             // miller indice
k1       = 1;             // miller indice
l1       = 1;             // miller indice
h0       = 0;             // miller indice
k0       = 0;             // miller indice
l0       = 0;             // miller indice
p       = 1980;              // Density of KCl in kg/
   m^3
N       = 6.023*10^26;       // Avagadros number in
   atoms/kilomole
```

```
M        = 74.5;               // molecular weight of KCl
n        = 4;                  // No. of atoms per unit cell for FCC

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

// dhkl     = a/sqrt((h^2)+(k^2)+(l^2)); // interplanar distance
d100     = a/sqrt((h1^2)+(k0^2)+(l0^2)); // interplanar distance
d110     = a/sqrt((h1^2)+(k1^2)+(l0^2)); // interplanar distance
d111     = a/sqrt((h1^2)+(k1^2)+(l1^2)); // interplanar distance

// Output
mprintf('d100 = %3.2f   \n d110 = %3.2f   \n d111 = %3.2f   ',d100*10^10,d110*10^10,d111*10^10);

// ==========================================================================
```

Scilab code Exa 1.3 To find miller indices

```
// ==========================================================================
// chapter 1 example 3


clc;
clear;
```

```
// Variable Declaration
 h           = 4;                   //miller indices
 k           = 1;                   //miller indices
 l           = 2;                   //miller indices

 //result

v= int32([h k l]);
lc=double(lcm(v));
 //calculation
 h1 =1/h;
 k1 =1/k;
 l1 =1/l;
 a = h1*lc;
 b = k1*lc;
 c = l1*lc;
 //result
 mprintf('miller indices = %d %d %d',a,b,c);

 //==================================================================
```

Scilab code Exa 1.4 `To find miller indices`

```
// chapter 1 example 4


clc;
clear;

//intercepts given are 3a,4b,2c
//from the law of rational indices
//3a:4b:2c=a/h:b/k:c/l
```

```
// Variable Declaration
 h1           = 3;                  //miller indices
 k1           = 4;                  //miller indices
 l1           = 2;                  //miller indices

 //calculation
v= int32([h1 k1 l1]);
lc=int32(lcm(v));
h = lc*1/h1;
k = lc*1/k1;
l= lc*1/l1;

 //result
 mprintf('miller indices = %d %d %d',h,k,l);
```

Scilab code Exa 1.5 To find miller indices

```
//
   ========================================================================

//chapter 1 example 5

clc;
clear all;

//intercepts given are a,2b,-3c/2
//from the law of rational indices
//a:2b:-3c/2=a/h:b/k:c/l


//variable declaration
h1 = 1;                 //miller indices
k1 = 1/2;                 //miller indices
l1 = -2/3;                 //miller indices
```

```

//calculation
p = int32([1,2,3]);
l2 = lcm(p);
h=h1*l2;
k=(k1)*double(l2);
l=(l1)*double(l2);

//result
mprintf('miller indices = %d %d %d',h,k,l);

//
    ====================================================================
```

Scilab code Exa 1.6 To find miller indices

```
//
    ====================================================================

//chapter 1 example 6

clc;
clear all;

//intercepts given are 3a,3b,2c
//from the law of rational indices
//3a:3b:2c=a/h:b/k:c/l
//variable declaration

h1 = 1/4;                    //miller indices
k1 = 1/4;                    //miller indices
l1 = 1/2;                    //miller indices
h12 = 1/2;                         //miller indices
k12 = 1;                         //miller indices
```

```
l12 = 1/%inf;                    //miller indices
h13 = 1;
k13 = 2;
l13 = 1;


//calculation
p = int32([4,4,2]);
l2 = lcm(p);
h=h1*double(l2);
k=(k1)*double(l2);
l=(l1)*double(l2);

p1 = int32([2,1,1]);

// 1/%inf = 0  ; (1/2 1/1 0/1) hence lcm is taken
    for [2 1 1]

l22 = lcm(p1);
h3=h12*double(l22);
k3=(k12)*double(l22);
l3=(l12)*double(l22);

p3 = int32([1,1,1]);
l23 = lcm(p3);
h4=h13*double(l23);
k4=(k13)*double(l23);
l4=(l13)*double(l23);



//result
mprintf('miller indices = %d %d %d\n',h,k,l);
mprintf('Note:printing mistake of miller indices in
    textbook \n');
mprintf('\nmiller indices = %d %d %d\n',h3,k3,l3);
mprintf('\nmiller indices = %d %d %d\n',h4,k4,l4);
mprintf('Note:calculation mistake in textbook\n');
```

```


//
```

Scilab code Exa 1.8 To find interplanar distance

```
//
//chapter 1 example 8

clc;
clear all;

//intercepts given are a,2b,−3c/2
//from the law of rational indices
//a:2b:−3c/2=a/h:b/k:c/l


//variable declaration
h12 = 1;                    //miller indices
k12 = 1/2;                    //miller indices
l12 = 1/%inf;                    //miller indices
a = 10*10^-9;
//calculation

p1 = int32([2,1,1]);
// 1/%inf = 0 ; (1/2 1/1 0/1) hence lcm is taken
   for [2 1 1]

l22 = lcm(p1);
h=h12*double(l22);
k=(k12)*double(l22);
```

```
l=(l12)*double(l22);
d=a/double(((h^2)+(k^2)+(l^2))^(1/2));


//result
mprintf('miller indices = %d %d %d',h,k,l);
mprintf('interplanar distance is =%e   ',d);
//
```

Scilab code Exa 1.9 To find interplanar spacing

```
//
// chapter 1 example 9


clc;
clear;

// Variable Declaration

r       = 0.175*10^-9;              //radius in m
h       = 2;                        //miller indices
k       = 3;                        //miller indices
l       = 1;                        //miller indices

//calculation
 a      = (4*r)/sqrt(2);
 dhkl   = a/sqrt((h^2)+(k^2)+(l^2));

 //result
  mprintf('inter planar spacing =%3.2e m\n',dhkl);
```

```
mprintf('Note : calculation mistake in textbook in
    calculating dhkl value ');

//
```

Scilab code Exa 1.10 To find distance between atoms

```
//

// chapter 1 example 10

clc;
clear;

//input data
a       = 4;                //lattice constant in

//calculation
d       = (sqrt(3)*a)/4;

//result
mprintf('distance between two atoms =%3.3f.  \n',d)
   ;

//
```

Scilab code Exa 1.11 To find wavelength

```
//

// chapter 1 example 11
clc;
clear;

//input data

 d      = 1.41;           //lattice constant in
 theta  = 8.8;            // angle in degrees
 n      = 1;

//calculation

 lamda  = (2*d*sin(theta*%pi/180))/n;


//result
mprintf('wavelength=%3.2f   \n',lamda);

//
```

Scilab code Exa 1.12 To find spacing between planes

```
//

// chapter 1 example 12

clc;
clear;

```

```
//input data
 d          = 2.5;                    //spacing in
    angstroms
 theta      = 9;                             //glancing
    angle in degrees
 n1         = 1;
 n2         = 2;


//calculation
 lamda       = (2*sin(theta*(%pi/180))*d);
 theta       = asin((2*lamda)/(2*d));

//result
mprintf('wavelength =%3.4f  \n',lamda);
mprintf('glancing angle =%3.1f  \n',theta*(180/%pi))
   ;

//
   ==================================================================
```

Scilab code Exa 1.13 To find lattice constant

```
//
   ==================================================================

// chapter 1 example 13

clc;
clear;


//input data
 lamda       = 2;                           //wavelength in
```

```
    angstroms
 theta1      = 60;                          //angle in degrees
 n           = 1;

//formula
//2*d*sin(theta)=n*lamda;

//calculation
 d  = (n*lamda)/(2*sin(theta1*%pi/180));

//result

mprintf('lattice constant=%3.4f   \n',d);
mprintf('Note: calculation mistake in textbook')
//==================================================================
```

Scilab code Exa 1.14 To find angle

```
//==================================================================

//chapter 1 example 14

clc;
clear;

//input data
 lamda       = 1.4*10^-10;                  //wavelength in angstroms
 a           = 2*10^-10;                    //lattice parameter in angstroms
 h           = 1;                     //miller indices
```

```
 k           = 1;                    //miller indices
 l           = 1;                    //miller indices
 n          = 1;
//formula
//2*d*sin(theta)=n*lamda

//calculation

dhkl        = a/sqrt((h^2)+(k^2)+(l^2));          //inter planar spacing
theta       = asin((n*lamda)/(2*dhkl));

//result
mprintf('angle=%3.2f.\n',theta*(180/%pi));

//==================================================================
```

Scilab code Exa 1.15 To find wavelength

```
//==================================================================
// Chapter 1 example 15
clc;
clear;

// input data
 d      = 3.84 *10^-10;         //spacing between planes in m
 theta      = 45;               //glancing angle in degrees
 m      = 1.67*10^-27;          //mass ef electron
 h      = 6.62*10^-34;          // planck's constant
```

```
 n      = 1;                    //braggg reflextion
 v      = 5.41*10^-10;

//calculation
//lamda = 2*d*(1/sqrt(2));
lamda = h/(m*v);

//result
 mprintf('wavelength of neutron =%3.2e m\n',lamda);
 mprintf(' Note:calculation mistake in text book in
    calculating wavelength ')
//
    ================================================
```

Scilab code Exa 1.16 To find lattice parameters

```
//
    ================================================

// chapter 1 example 16
clc;
clear;

//input data
 m       = 9.1*10^-31;          // mass of electron in
    kilograms
 e       = 1.6*10^-19;          //charge of  electron in
     coulombs
 n       = 1;                  //bragg's reflection
 h1      = 6.62*10^-34;         //planck's constant J.s
 n      = 1;                    //bragg reflecton
 V       = 200;                 //voltage in V
 theta   = 22;                  //observed reflection

```

```
//calculation

lamda       = h1/sqrt(2*m*e*V);
dhkl        = (n*lamda)/(2*sin(theta*%pi/180));
a          = dhkl*sqrt(3);

//result

mprintf('lattice parameter =%3.0f.  \n',a*10^10);
//
```

Chapter 2

Band Theory of Solids

Scilab code Exa 2.1 `To find three lowest permissible quantum energies`

```
// Chapter 2 example 1

clc;
clear;

// Variable declaration
h    = 6.63*10^-34;          // plancks constant in J.s
m    = 9.1*10^-31;           // mass of electron in kg
a    = 2.5*10^-10;           // width of infinite square well
e    = 1.6*10^-19;           // charge of electron coulombs
n2   = 2;                    //number of permiissable quantum
n3   = 3;                    //number of permiissable quantum

// Calculations
E1   = (h^2)/(8*m*a^2*e);      // first lowest
```

```
permissable quantum energy  in eV
E2  = n2^2 *E1;                    // second lowest permissable quantum energy in eV
E3  = n3^2 *E1;                    // second lowest permissable quantum energy in eV

// Result
mprintf('Lowest three permissable quantum energies are \n E1 = %d eV\n E2 = %d eV\n E3 = %d eV',E1,E2,E3);
```

Scilab code Exa 2.2 To find energy differences between two states

```
// Chapter 2 example 2

clc;
clear;

// Variable declaration
 h   = 6.63*10^-34;            // plancks constant in J.s
 m   = 9.1*10^-31;             // mass of electron in kg
 a   = 10^-10;             // width of infinite square well in m
 e   = 1.6*10^-19;             // charge of electron in coulombs
 n1  = 1;                       //energy level constant
 n2  = 2;                         //energy level constant

// calculations
 E1  = ((n1^2)*(h^2))/(8*m*(a^2)*e);       // ground state energy in eV
```

```
E2  = ((n2^2)*(h^2))/(8*m*(a^2)*e);      // first
    excited state in energy in eV
dE  = E2-E1                              // difference
    between first excited and ground state(E2 - E1)

// Result
mprintf('Energy Difference = %3.2f eV',dE);
```

Scilab code Exa 2.3 comment on first three energy levels of an electron

```
// Chapter 2 example 3
clc;
clear;

// Variable declaration
h   = 6.63*10^-34;           // plancks constant in J
    .s
m   = 9.1*10^-31;            // mass of electron in
    kg
a   = 5*10^-10;              // width of infinite
    potential well in m
e   = 1.6*10^-19;             // charge of electron
    in coulombs
n1  = 1;                       // energy level
    constant
n2  = 2;                       // energy level
    constant
n3  = 3;                       // energy level
    constant

// Calculations
E1  = ((n1^2)*(h^2))/(8*m*(a^2)*e);      // first
    energy level in eV
E2  = ((n2^2)*(h^2))/(8*m*(a^2)*e);     // second
    energy level in eV
```

```
E3  = ((n3^2)*(h^2))/(8*m*(a^2)*e);     // third energy level in eV

// Result
mprintf('First Three Energy levels are \n E1 = %3.2f eV\n E2 = %3.2f eV\n E3 = %3.2f eV',E1,E2,E3);
mprintf('\n Above calculation shows that the energy of the bound electron cannot be continuous')
```

Scilab code Exa 2.4 To find lowest allowed energy bandwidth

```
// Chapter 2 example 4
clc;
clear;

// Variable declaration
h   = 1.054*10^-34;          //plancks constant in J.s
m   = 9.1*10^-31;           // mass of electron in kg
a   = 5*10^-10;             // width of infinite potential well in m
e   = 1.6*10^-19;            // charge of electron coulombs

// Calculations
//cos(ka) = ((Psin(alpha*a))/(alpha*a)) + cos(alpha*a)
//to find the lowest allowed energy bandwidth,we have to find the difference in  a  values, as ka changes from 0 to
// for ka = 0 in above eq becomes
// 1 = 10*sin( a ))/( a )) + cos( a )
// This gives  a  = 2.628 rad
// ka =    ,  a  =
```

```
// sqrt((2*m*E2)/h^2)*a =
E2   = ((%pi*%pi) *h^2)/(2*m*a^2*e);          //energy
    in eV
E1   = ((2.628^2) *h^2)/(2*m*a^2*e)  // for  a  =
   2.628 rad energy in eV
dE   = E2 - E1;                              //lowest
   energy bandwidth in eV

// Result
mprintf('Lowest energy bandwidth = %3.3f eV',dE);
```

Scilab code Exa 2.5 T find energy of free electron for first Brillouin Zone

```
// Chapter 2 example 5
clc;
clear;

// Variable declaration
a   = 3*10^-10;             // side of 2d square
   lattice in m
h   = 6.63*10^-34;          // plancks constant in J
   .s
e   = 1.6*10^-19           // charge of electron in
   coulombs
m   = 9.1*10^-31;           // mass of electron in
   kg

// calculations
//p   = h*k                    // momentum of the
   electron
k   = %pi/a;                   // first Brillouin
   zone
p   = (h/(2*%pi))*(%pi/a);           //momentum of
   electron
E   = (p^2)/(2*m*e)                   // Energyin eV
```

```

// Result
mprintf('Electron Momentum for first Brillouin zone appearance = %g\n Energy of free electron with this momentum = %4.1feV',p,E);
mprintf(" \n Note: in Textbook Momentum value is wrongly printed as 1.1*10^-10')
```

Chapter 3

Magnetic properties of Materials

Scilab code Exa 3.1 To find magnetic moment and bohr magneton

```
// Chapter 3 example 1
clc;
clear;

// Variable declaration
r   = 0.53*10^-10;          // orbit radius m
n   = 6.6*10^15;            // frequency of
   revolution of electronHz
e   = 1.6*10^-19           // charge of electron in
   coulombs
h   = 6.63*10^-34;          // plancks constant in J
   .s
m   = 9.1*10^-31;           // mass of electron in
   kg

// Calculations
i   = e*n                    // current produced
   due to electron
A   = %pi*r*r                // Area in m^2
```

```
u    = i*A;                    // magnetic moment A*m^2
ub   = (e*h)/(4*%pi*m)         // Bohr magneton in J/T

// Output
mprintf('Magnetic moment = %3.3e Am^2\n Bohr magneton = %3.2e J/T',u,ub);
```

Scilab code Exa 3.2 `To find the magnetic moment of the rod`

```
// Chapter 3 example 2
clc;
clear;

// Variable declaration
ur   = 1150;              // relative permeability
n    = 500;               // turns per m
V    = 10^-3;            // volume of iron rod in m^3
i    = 0.5;              // current in amp

// Calculations
// B = uo(H+M)
// B = uH, u/uo = ur
// M = (ur - 1)H
// if current is flowing through a solenoid having n turns/l then H = ni
 M = (ur - 1)*n*i        // magnetisation
 m = M*V;              // magnetic moment

 // Output
 mprintf('Magnetic moment = %3.2e A-m^2',m);
 mprintf('\n Note: Instead of 2.87*10^2, 2.87*10^-2 is printed in textbook');
```

Scilab code Exa 3.3 To find the magnetic moment of the rod

```
// Chapter 3 example 3
clc;
clear;

// Variable declaration
ur   = 90;              // relative permeability
n    = 300;               // turns per m
i    = 0.5;             // current in amp
d    = 10*10^-3;        // diameter of iron rod
l    = 2;               // length of iron rod

// Calculations
V    = %pi*(d/2)^2 * l        // volume of rod
M    = (ur - 1)*n*i             // magnetisation
m    = M*V                      // magnetic moment

// Output
mprintf('Magnetic Moment of the rod = %3.3g A-m^2\n',m);
mprintf('Note: In textbook length of iron rod given as 2m whereas in calculation it is wrongly taken as 0.2m' )
```

Scilab code Exa 3.4 To find change in magnetic moment

```
// Chapter 3 example 4
clc;
clear;

// Variable declaration
```

```
Bo  = 2;                  // magnetic field in tesla
r   = 5.29*10^-11         // radius in m
m   = 9.1*10^-31;             // mass of electron in
    kg
e   = 1.6*10^-19              // charge of electron

// calculations
du  = (e^2 * Bo * r^2)/(4*m)           // change in
    magnetic moment

// output
mprintf('Change in magnetic moment = %3.1e J/T',du);
```

Scilab code Exa 3.6 To find temperate must the substance cooled

```
// Chapter 3 example 6
clc;
clear;

// Variable declaration
u1  = 3.3;            // magnetic dipole moment
u   = 9.24*10^-24;
B   = 5.2;            // magnetic field in tesla
k   = 1.38*10^-23;    // boltzmann constant

// calculations
T   = (u*u1*B)/(1.5*k);      // Temperature in Kelvin

// Output
mprintf('Temperature to which substance to be cooled
     = %3.1f K\n ',T);
mprintf('Note:Values given in question B = 52, u =
    924*10^-24.Values substituted in calculation B =
    5.2, u = 9.24*10^-24');
```

Scilab code Exa 3.7 To find magnetisation vector and flux density

```
// Chapter 3 example 7
clc;
clear;

// Variable declaration
xm        = -4.2*10^-6;             // magnetic susceptibility in A.m^-1
H         = 1.15*10^5;              // magnetic field in A.m^-1

// Calculations
uo        = 4*%pi*10^-7;            // magnetic permeability  N A^-2
M         = xm*H                    // magnetisation in A.m^-1
B         = uo*(H + M)              // flux density in T
ur        = 1+(M/H)                 // relative permeability

// Output
mprintf('Magnetisation = %3.2f A/m\n flux density = %g Tesla\n relative permeability = %g',M,B,ur);
```

Scilab code Exa 3.8 To find increase in percentage

```
// Chapter 3 example 8
clc;
clear;

// Variable declaration
```

```
xm       = 1.4*10^-5;          // magnetic
   susceptibility
// B      = uoH
// B'     = uruoH
// ur     = 1+xm
// from above equations
//B'      = (1+xm)B
// percentage increase in magnetic induction = ((B'-
   B)/B)*100
//        = (((1+xm)B - B)/B)*100
PI     = xm*100;         // percentage increase

// Output
mprintf('Percentage increase = %3.4f percent',PI);
```

Scilab code Exa 3.9 To find magnetisation vector and flux density

```
// Chapter 3 example 9
clc;
clear;

// Variable declaration
xm       = -0.2*10^-5;         // magnetic
   susceptability in A.m^-1
H        = 10^4;               // magnetic field in A/m


// Calculations
uo       = 4*%pi*10^-7;             // magnetic
   permeability
M        = xm*H                // magnetisation in A/m
B        = uo*(H+M);           // magnetic flux density
    in T

// Output
```

```
mprintf('magnetisation = %3.2f A/m\n Magnetic flux
    density = %3.4f T',M,B);
```

Scilab code Exa 3.10 To find permeability and relative permeability

```
//
    ======================================================================
// chapter 3 example 10


clc;
clear;


//input data
 sighem          = 2.1*10^-5;                //magnetic
    susceptability
 u0              = 4*%pi*10^-7;


//calculation
ur               = 1+(sighem);
u                = u0*ur;

//result
 mprintf('permeability =%3.6f\n',ur);
 mprintf('relative permeability =%3.4e.N/A^2\n',u);

 //
    ======================================================================
```

Scilab code Exa 3.11 To find absolute and relative permeability

```
//
// chapter 3 example 11


clc;
clear;


//input data
 sighem          = 0.084;              //magnetic
    susceptability
 u0              = 4*%pi*10^-7;


//calculation
ur               = 1+(sighem);
u                = u0*ur;

//result
 mprintf('permieability =%3.6f\n',ur);
 mprintf('relative permiability =%3.4e.N/A^2\n',u);

 //
```

Scilab code Exa 3.12 To find relative permeability and magnetic susceptibility

```
//
```

```
// chpter 3 example 12


clc;
clear;


//input data
u               = 0.126;                //permiability
    in N/A^2
u0              = 4*%pi*10^-7;

//calculation
ur                = u/u0
sighe            = ur-1;              //magnetic
    susceptability

//result
mprintf('relative permiability =%3.5e\n',sighe);
mprintf(' Note:Calculation mistake in textbook in
    calculating sighe by taking ur as 10^5 instead
    of 100318.4')

//
    ==================================================
```

Scilab code Exa 3.13 To find diamagnetic susceptability of He

```
//
    ==================================================

// chapter 3 example 13


```

```
clc;
clear;

//input data
//diamagnetic susceptability of He
 R          = 0.6*10^-10;              //mean radius of atom in m
 N          = 28*10^26;               //avagadro number in per m^3
 e          = 1.6*10^-19;               //charge of electron in coulombs
 m          = 9.1*10^-31;                 //mass of electron in kilograms
  Z          = 2;                         //atomic number

 //calculation
 u0         = 4*%pi*10^-7;            //atomic number
 si         = -(u0*Z*(e^2)*N*(R^2))/(6*m);        //susceptability of diamagnetic material

//result
 mprintf('susceptability of diamagnetic material = %3.4e\n',si);

//
```

Scilab code Exa 3.14 To find permiability and susceptibility

```
//
// chpter 3 example 14
```

```
clc;
clear;

//input data
phi          = 2*10^-5;            //magnetic flux in
   Wb/m^2
H           = 2*10^3;              //in A/m
A           = 0.2*10^-4;         //area  in m^2



//calculation
u0          = 4*%pi*10^-7;
B       = phi/A;                 //magnetic flux
   density in Wb/m^2
u       = B/H;                   //permiability in /A
   ^2
sighem = (u/u0)-1;
///result
mprintf('permiability =%3.2e.N/A^2\n',u);
mprintf('susceptability =%4f\n',sighem);
mprintf('Note:answer of permiability is wrong in
   textbook\n');
mprintf(' Note: calcuation mistake in textbook in
   sighem');


//
```

Scilab code Exa 3.15 `To find susceptability`

```
//  ================================================================
// chpter 3 example 15


clc;
clear;

//input data
N          = 6.5*10^25;             //number of atoms in atoms per m^3
e          = 1.6*10^-19;             //charge of electron in coulombs
m          = 9.1*10^-31;             //mass of electron inilograms
h          = 6.6*10^-34;            //planck's constant in J.s
T          = 300;                   //temperature in K
 k          = 1.38*10^-23;            //boltzman constant in J*(K^-1)
 n          = 1;                      //constant


//calculation
u0         = 4*%pi*10^-7;
M               = n*((e*h)/(4*%pi*m));               //magnetic moment in A*m^2
sighe           = (u0*N*(M^2))/(3*k*T);    //susceptability of diamagnetic material

//result
mprintf('susceptability of diamagnetic material = %3.2e\n',sighe);

//  ================================================================
```

Scilab code Exa 3.16 To find number ampere turns

```
//
    ==================================================================

// chpter 3 example 16


clc;
clear;

//input data
L        = 2.0;                      //length in m
A        = 4*10^-4;                  //cross section sq.
    m
u        = 50*10^-4;                //permiability in H*
    m^-1
phi        = 4*10^-4;               //magnetic flux in
    Wb

//calculation
 B       =  phi/A;                  //magnetic flux
     density in Wb/m^2
 NI      = B/u;                     //ampere turn in A/m

 //result
 mprintf('ampere turn =%3.2f.A/m\n',NI);

 //
     ==================================================================
```

Scilab code Exa 3.17 To find current to be sent into solenoid

```
//
===========================================================================

// chapter 3 example 17


clc;
clear;

//input data
 H          = 5*10^3;             //corecivity in A/m
 l          = 10^-1;                //length in m
 n          = 500;                 //number of turns

//calculation
 N      = n/l;                    // number of turns per m
 i      = H/N;                   //current in A

//result
 mprintf('current =%1d A\n',i);

//
===========================================================================
```

Scilab code Exa 3.18 To find number of turns

```
//
===========================================================================

// chapter 3 example 18

```

```
clc;
clear;

//input data
A           = 6*10^-4;                    //area in m^2
l           = 0.5;                        //length in m
u           = 65*10^-4;                   //permiability in H/m
phi         = 4*10^-5;                    // magnetic flux in Wb


//calculation
B           = phi/A;
H           = B/u;
N           = H*l;

//result
mprintf('number of turns =%1f\n',N);
mprintf(' Note: calculation mistake in textbook in calculattig H by taking B value as 0.06 instead of 0.0666');

//==========================================================================
```

Scilab code Exa 3.19 To find permeability and susceptibility

```
//==========================================================================
// chpter 3 example 19

```

```

clc;
clear;

//input data
 A           = 0.2*10^-4;                  //area in m^2
 H           = 500;                         //magnetising field in A.m^-1
 phi          = 2.4*10^-5;                  // magnetic flux in Wb

 //calculation
 u0          = 4*%pi*10^-7;
 B       = phi/A;                           //magnetic flux density in N*A^-1 *m^-1
 u       = B/H;                             //permiability in N/m
 fm      = (u/u0)-1;                        //susceptability

//result
 mprintf('susceptability =%3.2d\n',fm);


//==========================================================
```

Scilab code Exa 3.20 To find loss of energy per hour

```
//==========================================================
// chapter 3 example 20

```

```

clc;
clear;

//input data
 f      = 50;                    //number of reversals /s in Hz
 W      = 50;                    //weight in kg
 d      = 7500;                  //density in kg/m^3
 A      = 200;                   //area in  joules /m^3

 //calculation

 V      = 1/d;             //volume of 1 kg iron
 E      = A*V;               //loss of energy per kg
 L      = f*E;             //hysteresisloss/s in Joule /second
 Lh     = L*60*60;           //loss per hour

 //calculation
 mprintf('loss of energy per hour =%3.2f\n',Lh);
 mprintf('calculation mistake in textbook in calculating Lh');

//
```

Scilab code Exa 3.21 `To find hysteresis loss per cycle`

```
//
// chpter 3 example 21
```

```


clc;
clear;

//input data
f        = 50;                //frequency in Hz
Bm       = 1.1;              //magnetic flux in Wb/m^2
t        = 0.0005;           //thickness of sheet
p        = 30*10^-8*7800;          //resistivity in ohms m
d        = 7800;                    //density in kg/m^3
Hl       = 380;                     //hysteresis loss per cycle in W-S/m^2

//calculation
 Pl      = ((%pi^2)*(f^2)*(Bm^2)*(t^2))/(6*p);     // eddy current loss
 Hel      = (Hl*f)/d;                              // hysteresis loss
 Tl       = Pl+Hel;                                // total iron loss

 //result
 mprintf('total iron loss =%3.2f watt/kg \n',Tl);
```

Chapter 4

Behaviour of Dielectric Materials in ac and dc fields

Scilab code Exa 4.1 To find dielectric constant of argon at NTP

```
//
==========================================================================

// chapter 4 example 1

clc;
clear;

//input data
 alpha       = 1.8*10^-40;            //polarisability
     of argon in Fm^2
 e0          = 8.85*10^-12;           //dielectric
    constant F/m
 N1          = 6.02*10^23;            //avagadro
    number in mol^-1
 x           = 22.4*10^3;             //volume in m^3

//formula
//er-1=N*p/e0*E=(N/e0)*alpha
```

```
//calculation
 N          = N1/double(x);                  //number of argon atoms in per unit volume in cm^3
 N2         = N*10^6;                        //number of argon atoms in per unit volume in m^3
 er     = 1+((N2/e0))*alpha;                 //dielectric constant F/m


//result
mprintf('dielectric constant of argon=%3.7f\n',er);
//==========================================================================
```

Scilab code Exa 4.2 To estimate the shift of the electron cloud

```
//==========================================================================
// chapter 4 example 2

clc;
clear;


//input dta
 alpha        = 1.8*10^-40;        //polarisability of argon in F*m^2
 E            = 2*10^5;            // in V/m
 z            = 18;
 e            = 1.6*10^-19;


//formula
```

```
//p=18*e*x
//calculation
 p       = alpha*E;
 x       = p/(18*e);      //shift of electron in m


//result
 mprintf('displacement=%3.2e.m\n',x);

//
   ====================================================
```

Scilab code Exa 4.3 To find local field acting on a given molecule

```
//
   ====================================================
// chapter 4 example 3

clc;
clear;


//input data
 E0     = 300*10^2;                   //local field in
      V/m
 P1  = 3.398*10^-7;                   //dipole moment
     Coulomb/m
 P2  = 2.124*10^-5;                   //dipole moment
     Coulomb/m
 e0  = 8.85*10^-12;                   //permittivity
     in F/m


```

```
//formula
//E10Ci=E0-(2*Pi/3*e0)
//calculation
E10C1 = E0-((2*P1)/(3*e0));        //local field of benzene in V/m
E10C2 = E0-((2*P2)/(3*e0));       //local field of water in V/m

//result
mprintf('local field of benzene=%3.2e.V/m\n',E10C1);
mprintf('local field of water=%3.2e.V/m\n',E10C2);

//==========================================================================
```

Scilab code Exa 4.4 `To find polarisabilities of benzene and water`

```
//==========================================================================
// chapter 4 example 4

clc;
clear;

//input data
p1 = 5.12*10^-34;         //p of benzene kg/m^3
p2 = 6.34*10^-34;       //p of water kg/m^3
e10C1 = 4.4*10^3;         //local field of benzene in V/m
e10C2 = 1570*10^3;         //local field of water in V/m

```

```
//formula
//p=alphai*e10Ci
//calculation
 alpha1 = p1/e10C1;        //polarisability of
    benzene in F*m^2
 alpha2 = p2/e10C2;      //polarisability of water in
     F*m^2


 //result
 mprintf('polarisability of benzene=%3.2e.F*m^2\n',
    alpha1);
 mprintf('polarisability of water=%3.2e.F*m^2\n',
    alpha2);
 mprintf('Note: mistake in textbok,alpha1 value is
    printed as 1.16*10^-38 instead of 1.16*10^-37');

//
   ==========================================================
```

Scilab code Exa 4.5 To find polarisation of plates

```
//
   ==========================================================

//chapter 4 example 5

clc;
clear;


//input data
 e0     = 8.85*10^-12;           //abslute
```

```
permitivity in (m^-3)*(kg^-1)*(s^4)*(A^2)
E      = 600*10^2;                //strength in V/cm
er1    = 2.28;           //dielectric constant of benzene in coulomb/m
er2    = 81;             //dielectric constant of water in coulomb/m


//fomula
//p=e0*E*(er-1)
//calculation
pB     = e0*E*(er1-1);      //polarisation of benzene in c/m^2
pW     = e0*E*(er2-1);         //polarisation of water in c/m^2


//result
mprintf('polarisation of benzene=%3.2e.c/m^2\n',pB);
mprintf('polarisation of water=%3.2e.c/m^2\n',pW);

//
```

Scilab code Exa 4.6 To find percentage contribution of ionic polarisability

```
//
// chapter 4 example 6

clc;
clear;
```

```
//input data
er0   = 5.6;        //static dielectric cnstant of
   NaCl
n    = 1.5;           //optical index of refraction


//calculation
er = er0-n^2;
d  = (er/er0*100);

//result
mprintf('percentage contribution from ionic
   polaristion=%3.2f percent\n',d);

//
   ==========================================================================
```

Scilab code Exa 4.7 To find separation between positive and negative charges

```
//
   ==========================================================================

// chaoter 4 example 7
clc;
clear;


//input data
alpha        = 0.18*10^-40;        //polarisability of
    He in F *m^2
E            = 3*10^5;                   // constant in
   V/m
```

```
N             = 2.6*10^25;               //number of atoms in per m^3
e             = 1.6*10^-19;


//formula
//P=N*p
//charge of He=2*electron charge
//p=2(e*d)
//calculation
P       = N*alpha*E;               //in coul/m^2
p       = P/N;                     //polarisation of He in coul.m
d       = p/(2*e);                 //separation between charges in m


//result
mprintf('separation=%3.2e.m\n',d);

//
```

Scilab code Exa 4.8 To find orientational polarisation at room temperature

```
//
// chapter 4 example 8
clc;
clear;

//input data
N       = 10^27;                   //number of HCl
```

```
molecules in molecules/m^3
E      = 10^5;                   //electric field in V/m
P      = 1.04*3.33*10^-30;       //permanent dipole moment in coul.m
T      = 300;                    //temperature in kelvin
K      = 1.38*10^-23;


//calculation
P0     = (N*P^2*E)/(3*K*T);      //oriental polarisation in coul/m^2


//result
mprintf('oriental polarisation=%3.2e.coul/m^2\n',P0);

//====================================================================
```

Scilab code Exa 4.9 To find relative dielectric constant

```
//====================================================================
// chapter 4 example 9

clc;
clear;

//input data
N      = 6.023*10^26;      //avagadro number  (lb-
```

```
mol)^-1
alpha   = 3.28*10^-40;       //polarisability in F*m^2
M       = 32;                //molecular weight in kilograms
p       = 2.08*10^3;         //density of sulphur in g/cm^3
e0      = 8.85*10^12;        //permitivity in F/m

//calculation
er = ((2*N*p*alpha)+(3*M*e0))/((3*M*e0)-(N*p*alpha));

//result

mprintf('relative dielectric constant =%3.1f\n',er);
mprintf(' Note: calculation mistake in text book in calculating relative dielectric constant');
//
```

Scilab code Exa 4.10 `To find ratio between electronic and ionic polarisability`

```
//
// chapter 4 example 10

clc;
clear;


//input data
```

```
er          = 4.94;
n           = 1.64;


//calculatio
//(alphae)/(alphai) =x
x        = ((er-1)/(er+2))*(((n^2)+2)/((n^2)-1));


//result
mprintf('ratio of electronic and ionic
   probabilities =%6f\n',x);

//
   ================================================================
```

Scilab code Exa 4.11 To find dielectric constant and electrical susceptibility

```
//
   ================================================================

// chapter 4 example 11


clc;
clear;


//input data
E       = 1.46*10^-10;              //permitivity in
   c^2*N^-1*m^-2
E0       = 8.885*10^-12;            // permitivity in
    c^2*N^-1*m^-2

```

```

//calculation
 Er          = E/E0;
 sighe       = E0*(Er-1);          //electrical
    suseptbility in c^2*N^-1*M^-2


//result
 mprintf('dielectric constant=%3.2f.\n',Er);
 mprintf('electrical susceptibility=%3.4e.c^2*N^-1*M
    ^-2\n',sighe);

//
    ==========================================================================
```

Scilab code Exa 4.12 To find the polarisation

```
//
    ==========================================================================
// chapter 4 example 12

clc;
clear;

//input data
 r        = 0.1;                    //radius in m
 pw       = 1;                      //density of water
     in g/ml
 Mw       = 18;                     // molecular mass
    of water
 E        = 6.0*10^-30;             //dipole moment of
    water in cm
 N        = 6.0*10^26;            //avagadro constant
```

```
in (lb-mol) 1


//calculation
 n  = N*(4*(%pi)*(r^3)*pw)/(Mw*3)        //number of water molecules in a water drop
 p  = n*E;                                 //polarisation in cm^2


//result
mprintf('polarisation=%3.1e.cm^2\n',p);

//==================================================================
```

Scilab code Exa 4.13 To find dielectric susceptibility

```
//==================================================================
// chapter 4 example 13

clc;
clear;

//input data
 Er      = 1.000074;                    //dielectric constant for a gas at 0 C


//calculation
 sighe      = Er-1;

```

```

//result
 mprintf('dielectric  susceptibility=%3.6f\n',sighe);

//
```

Scilab code Exa 4.14 To find free charge and polarisation and displacement

```
//
// chapter 4 example 14


clc;
clear;


//input data
 E        = 10^6;                    //dielectric in volts/s
 er       = 3;                       //dielectric in mm
 e0       = 8.85*10^-12;


//calculation
 E0      = er*E;                       //electric field in V/m
 sigma   = e0*E0;                     //free charge in Coul/m^2
 P       = e0*(er-1)*E0;              //polarisation in coul/m
 D       = e0*er*E0;                 //displacement in in
```

```
    dielectric


//result
 mprintf('free charge=%3.2e.Coul/m^2\n',sigma);
 mprintf('polarisation=%3.2e.Coul/m\n',P);
 mprintf('displacement=%3.2e\n',D);

//
    ==================================================
```

Scilab code Exa 4.15 To find capacitance and charge stored and displacement vector

```
//
    ==================================================

// chapter 4 example 15

clc;
clear;

//input data
 d      = 1.0*10^-3;              //separation between
    plates in m
 A      = 6.45*10^-4;             // surface area in m
    ^2
 e0      = 8.85*10^-12;           //permitivity of
    electron in (m^-3)*(kg^-1)*(s^4)*(A^2)
 er     = 6.0;                    //relative
    permitivity in (m^-3)*(kg^-1)*(s^4)*(A^2)
 V      = 10;                     //voltage in V
 E      = 10;


```

```
//calculation
 C      = (e0*er*A)/d;              //capacitance in
    Farad
 q      = C*V;                      //charge in
    coulomb
 D      = (e0*er*E)/(10^-3);        //displacement
    vector in c/m^2
 P      = D-(e0*E/(10^-3));                   //
    polarisation vector in c/m^2


//result
 mprintf('capacitance = %3.2e,Farad\n',C);
 mprintf('charge =%3.2e.coulomb\n',q);
 mprintf('displacement =%3.2e.c/m^2\n',D);
 mprintf('polarisation =%3.2e.c/m^2\n',P);
 mprintf('Note:error in calculation of P,E value is
    taken as 5000 instead of 10^4\n');

 //
    ================================================
```

Scilab code Exa 4.16 To find phase difference

```

//
    ================================================

// chapter 4 example 16


clc;
clear;

```

```
//input data
 t        = 18*10^-6;              //relaxation time in
     s
 er1      = 1;                     //permitivity in F/m
 er       = 1;                     //permitivity in F/m
 t        = 18*10^-6;              //relaxation time in
     s

 //calculation
 f                  =   1/(2*%pi*t);                //
    frequency in Hz
 theta_c                = atan(er1/er);
 theta_c_deg             = theta_c*(180/%pi);
 phi                  = 90-theta_c_deg;              //
    phase difference in degrees


 //result
 mprintf('frequency = %3.2f KHz\n',(f/10^3));
 mprintf('phase difference =%3.2f  \n',phi);

 //
    ================================================================================
```

Chapter 5

Conductivity of metals and superconductivity

Scilab code Exa 5.1 To find average drift velocity of free electron

```
//
// chapter 5 example 1
clc;
clear;

//input data
 d       = 2*10^-3;                    //diameter in m
 I       = 5*10^-3;                    //current in A
 e       = 1.6*10^-19;                 //charge of electron in coulombs
 a       = 3.61*10^-10;               //side of cube in m
 N       = 4;                         //number of atoms in per unit cell


//formula
```

```
//J=n*v*e

//calculation
r        = d/2;                    //radius in m
n        = N/(a^3);                //number of atoms per unit volume in atoms/m^3
A        = %pi*(r^2);              //area in m^2
J        = I/A;                    //current density in Amp/m^2
v        = J/(n*e);               //average drift velocity in m/s

//result
mprintf('velocity=%3.2e.m/s\n',v);

//
```

Scilab code Exa 5.2 `To find drift velocity`

```
//

// chapter 5 example 2

clc;
clear;


//input data
I        = 6;                        //current in A
d        = 1*10^-3;                 //diameter in m
n        = 4.5*10^28;              //electrons available in electron/m^3
```

```
e       = 1.6*10^-19;            //charge of  electron
     in coulombs


//calculation
r      = d/2;                  //radius in m
A      = %pi*(r^2);          //area in m^2
J      = I/A;                //current density in A/m^3
vd     = J/(n*e);           //density in m/s


//result
 mprintf('velocity=%3.2e.m/s\n',vd);

//
  ================================================================
```

Scilab code Exa 5.3 To find current density and drift velocity of electrons

```
//
  ================================================================

//chapter 5 exmple 3

clc;
clear;

//input data

V        = 63.5;              //atomic weight in kg
d        = 8.92*10^3;         //density of copper in
    kg/m^3
r        = 0.7*10^-3;         //radius in m
I        = 10;                //current in A
```

```
e        = 1.6*10^-19;            //charge of
    electronin coulomb
h        = 6.02*10^28;            //planck's constant
    in (m^2)*kg/s


//calculation
A         = %pi*(r^2);           // area in m^2
N         = h*d;
n         = N/V;
J         = I/A;                //current density in m/
    s
vd        = J/(n*e);            //drift velocity in m/s

//result
mprintf('velocity=%2e.m/s\n',vd);

//
    ==================================================================
```

Scilab code Exa 5.4 To find resistivity of the material

```
//
    ==================================================================

// chapter 5 example 4

clc;
clear;


//input data
R         = 0.182;                //resistance in ohm
l        = 1;                    //length in m
```

```
A        = 0.1*10^-6;            //area in m^2

//formula
//R=(p*l)/A

//calculation
p       = (R*A)/l;                   //resistivity in ohm
    m


//result
mprintf('restivity=%3.2e.ohm m\n',p);

//
  ==========================================================
```

Scilab code Exa 5.5 To find mobility and relaxation time of electrons

```
//
  ==========================================================

// chapter 5 example 5

clc;
clear;

//input data
n         = 5.8*10^28;                     //number of
    silver electrons in electrond/m^3
p         = 1.45*10^-8;                   //resistivity
    in ohm m
E         = 10^2;                       //electric field
     in V/m
e         = 1.6*10^-19;
```

```
//formula
//sigma  = n*e*u
//sigma=//p
//calculation
u       = 1/(n*e*p);
vd      = u*E;                         //drift velocity in m/s

//result
mprintf('velocity=%3.2f.m/s\n',vd);

//==================================================================
```

Scilab code Exa 5.6 To find mobility of conduction electrons

```
//==================================================================
// chapter 5 example 6

clc;
clear;

//input data
W           = 107.9;                   //atomic weight
p           = 10.5*10^3;               //density in kg/m^3
sigma       =6.8*10^7;                 //conductivity in ohm^-1.m^-1
e           =1.6*10^-19;               //charge of electron in coulombs
```

```
N             = 6.02*10^26;          //avagadro number
    in mol^-1


//calculation
n        = (N*p)/W;               //number of atoms
    per unit volume
u       = sigma/(n*e);           //density of
    electron in m^2.V^-1.s^-1


//result
mprintf('density=%3.2e.m^2.V^-1.s^-1\n',u);

//
    ==================================================================
```

Scilab code Exa 5.7 To find relaxation time

```
//
    ==================================================================

// chapter 5 example 7

clc;
clear;

//input data
//for common metal copper
n             = 8.5*10^28;                 //number of
    atoms in m^-3
sigma         = 6*10^7;                    //sigma  in
    ohm^-1m^-1
m             = 9.1*10^-31;                //mass of
```

```
    electron in kilogram
e           = 1.6*10^-19;                //charge of
    electron in coulombs

//calculation
t  = (m*sigma)/(n*(e^2));         //relaxation time
    in s

//result
mprintf('time=%3.2e.s\n',t);

//
    ================================================================
```

Scilab code Exa 5.9 To find thermal conductivity for a metal

```
//
    ================================================================
// chapter 5 example 9

clc;
clear;

//input data
t        = 3.0*10^-14;                //time in s
n        = 2.5*10^22;                //in electrons
    per m^3
m        = 9.1*10^-31;                //mass of
    electron in kilograms
e        = 1.6*10^-19;                //charge of
    electron in coulombs
T        = 3.25;                     //temperature in K

```

```
//formula
//K/(sigma*T)=2.44*10^-8    from wiedemann Franz law
//calculation
sigma    = (n*(e^2)*t)/(m*10^-6);              //conductivity in m^3
K        = (2.44*10^-8)*sigma*T;                //thermalconductivity in W/m-K


//result
mprintf('thermal conductivity=%3.4f.W/m-K\n',K);
mprintf(' Note: calculation mistake in textbook in calculating K as T value is taken 325 instead of 3.25');

//==================================================================================
```

Scilab code Exa 5.10 To find energy difference between two states

```
//==================================================================================
// chapter 5 example 10

clc;
clear;

//input data
a       = 10^-10;                        //one dimension in m
m       = 9.1*10^-31;
h       = 6.62*10^-34;
```

```
//formula
//En    = ((n^2)*(h^2))/(8*m*(a^2))
//calculation
 E1       = (h^2)/(8*m*(a^2));
 E2       = (4*(h^2))/(8*m*(a^2));
 dE        = (3*(h^2))/(8*m*(a^2));


//result
 mprintf('energy diefference=%3.2e.J\n',dE);

//
    ================================================================================
```

Scilab code Exa 5.11 To find fermi energy

```
//
    ================================================================================

// chapter 5 example 11

clc;
clear;

//input data
 N          =6.02*10^23;             //avagadro number
     in atoms /mole
 h         = 6.63*10^-34;            //planck's
    constant in joule-s
 m         = 9.11*10^-31;           //mass in kg
 M         = 23;                   //atomic weight in
    grams /mole
```

```
p        = 0.971;                  //density in gram/cm
    ^3


//formula
//x=N/V=(N*p)/M
//calculation
x        = (N*p)/M;
x1       = x*10^6;
eF       = (((h^2)/(2*m)))*(((3*x1)/(8*%pi))^(2/3));
           //Fermi energy
eF1      = (eF)/(1.6*10^-19);
//result
mprintf('fermi energy=%3.2f.eV\n',eF1);

//
    ================================================================
```

Scilab code Exa 5.12 `To find fermi energy`

```
//
   ================================================================

// chapter 5 example 12

clc;
clear;


//input data
x        = 2.54*10^28;            //number of
    electrons in per m^2
h        = 6.63*10^-34;           // planck's
    constant in joule-s
```

```
m        = 9.11*10^-31;          // mass in kg
p        = 0.971;                //density in grams/
    cm^3
k        = 1.38*10^-23;


//calculation
//x        = (N*p)/M;
eF       = (((h^2)/(2*m)))*(((3*x)/(8*%pi))^(2/3));
           //Fermi energy
eF1      = (eF)/(1.6*10^-19);
vF       = sqrt((2*eF)/m);
TF       = eF/k;


//result
mprintf('fermi energy =%3.2f.eV\n',eF1);
mprintf('fermi velocit =%3.2e.m/s\n',vF);
mprintf('femi temperature =%3.2e.K\n',TF);

//
    ==========================================================
```

Scilab code Exa 5.13 `To find fermi energy`

```
//
   ==========================================================

// chapter 5 example 13

clc;
clear;


```

```
//input data
M       = 65.4;                 //atomic weight
p       = 7.13;                 //density
h       = 6.62*10^-34;         // planck's constant
m       = 7.7*10^-31;          // mass
v       = 6.02*10^23;


//calculation
//x =N/V
V       = M/p;
    //volume of one atom in cm^3
n       = v/V;
    // number of Zn atoms in volume v
x       = 2*n*(10^6);                                   //
    number of free electrons in unit volume iper m^2
eF      = ((h^2)/(2*m))*(((3*x)/(8*%pi))^(2/3));
            // fermi energy in J
eF1     = eF/(1.6*(10^-19));


//result
mprintf('fermi energy =%3.2d.eV\n',eF1);

//
    ==================================================================
```

Scilab code Exa 5.14 `To find number of electrons`

```
//
    ==================================================================
// chapter 5 example 14

```

```
clc;
clear;


//input data
eF      = 4.27;              // fermi energy in eV
m       = 9.11*10^-31;       // mass of electron in kg
h       = 6.63*10^-34;       // planck's constant in J.s


//formula
//x= N/V
//calculation
eF1     = eF*1.6*10^-19;                              // fermi energy in eV
x       = (((2*m*eF1)/(h^2))^(3/2))*((8*%pi)/3);  //number of electrons per unit volume


//result
mprintf('number of electrons per unit volume =%4.0e./m^3\n',x);

//==================================================================
```

Scilab code Exa 5.15 To find electron density

```
//==================================================================
// chapter 5 example 15
```

```
clc;
clear;


//input data
 eF1        = 4.70;               // fermi energy in eV
 eF2        = 2.20;               // fermi energy in eV
 x1         = 4.6*10^28;          // electron density
    of lithium per m^3


//formula
//N/V = (((2*m*eF1)/(h^2))^(3/2))*((8*%pi)/3);
//N/V = k*(eF^3/2)
//N/V = x
//calculation
 x2      = x1*((eF2/eF1)^(3/2));             //
    electron density for metal in per m^3


//result
 mprintf('electron density  for a metal =%4.2e per m
    ^3\n',x2);

 //
   ==================================================
```

Scilab code Exa 5.16 To find average energy and temperature

```
//
  ==================================================
// chapter 5 example 16
```

```
clc;
clear;


//input data
eF      = 5.4;                          //fermi
   energy in eV
k       = 1.38*10^-23;                  // k in
   joule/K


//calculation
e0      = (3*eF)/5;                          //average
    energy in eV
T       = (e0*(1.6*10^-19)*2)/(3*k);              //
   temperature in K


//result
mprintf('average energy =%3.2f.eV\n',e0);
mprintf('temperature =%3.2e.K\n',T);

//
   ============================================
```

Scilab code Exa 5.17 To find average energy and speed of electron

```
//
   ============================================
// chapter 5 example 17

clc;
```

```
clear;


//input data
 EF          = 15;                          //fermi energy
     in eV
 m           = 9.1*10^-31;                 //mass of
    electron in kilogarams


//calculation
 E0          = (3*EF)/5;                             //
    average energy en eV
 v           =sqrt((2*E0*1.6*10^-19)/m);
    //speed of electron in m/s


//result
 mprintf('average energy =%3.2f.eV\n',E0);
 mprintf('speed =%3.2e.m/s\n',v);

//
```

Scilab code Exa 5.18 To find average energy and speed of electron

```
//

// chapter 5 example 18

clc;
clear;

```

```
//input data
EF          = 7.5;                         //fermi energy in eV
m           = 9.1*10^-31;             //mass of electron in kilograms

//calculation

E0          = (3*EF)/5;               //average energy en eV
v=sqrt((2*E0*1.6*10^-19)/m);        //speed in m

//result
mprintf('average energy =%3.2f.eV\n',E0);
mprintf(' speed =%3.2e.m/s\n',v);

//==================================================================
```

Scilab code Exa 5.19 `To find fermi energy and fermi velocity`

```
//==================================================================
// chapter 5 example 19

clc;
clear;

//input data
m     = 9.1*10^-31;        //mass of electron in kg
h     = 6.62*10^-34;       //planck's constant in (m^2)*kg/s

```

```
//formula
//x=N/V
x      = 2.5*10^28;

//calculation
EF       = ((h^2)/(8*(%pi^2)*m))*((3*(%pi^2)*x)
   ^(2/3));                       //fermi energy in J
EF1      = EF/(1.6*10^-19);
                                        //fermi energy
   in eV
vF       = (h/(2*m*%pi))*((3*(%pi^2)*x)^(1/3));
               //fermi velocity in m/s


//result
mprintf('energy=%3.2e.eV\n',EF1);
mprintf(' speed= =%3.2e.m/s\n',vF);

//
  ================================================================
```

Scilab code Exa 5.20 To find efficiency of transmission and percentage voltage dro

```
//
  ================================================================
// chapter 5 example 20

clc;
clear;

//input data
Ps       = 10^7;
```

```
V       = 33*10^3;
R       = 2;

//calculation
I       = Ps/V;
Pd      = (I^2*R)/1000;
n       = ((Ps-Pd)/Ps)*100;
v       = I*R;
Vd      = (v/V)*100;                //percentage voltage drop

//result
mprintf('efficiency =%0f percent\n',n);
mprintf('voltage drop =%3.2f percent\n',Vd);
```

Scilab code Exa 5.21 `To find value of constants`

```
//=====================================================================

// chapter 5 example 21

clc;
clear;

//input data
a1   = 2.76;                  //a1 in uv/ C
a2  =16.6;                 //a2 in uv/ C
b1  = 0.012;                 //b1 in uv/ C
b2  = -0.03;                 //b2 in uv/ C

//calculation
//aFe,Pb   =a1
//aCu,Pb   = a2
//bCu,Fe   = b1
```

```
//bFe,Pb    = b2

//calculation
 a3     = a1-a2;                    //a3 in uv/ C
 b3     = b1-b2;                    //b3 in uv/( C )^2

//result
 mprintf('aCu,Fe =%3.2f.uV/ C \n',a3);
 mprintf(' bCu,Fe =%3.3f.uV/( C )^2\n',b3);

//
    ==============================================================================
```

Scilab code Exa 5.23 To find neutral temperature and temperature of inversion

```
//
    ==============================================================================

// chapter 5 example 23

clc;
clear;

//input data
 a        = 15;                   //a in uv/ C
 b        = -1/30;                   //b in uv/ C

//E = at+bt^2
//dE/dT =a+2*b*t
//t=tn
//dE/dT =0
//calculation
 tn      = -(a/(2*(b)))                      //neutral
    temperature in  C
```

```
//t1+t2  = 2*t2;
t2    = 2*tn                  //inversion temperature
   in  C

//result
mprintf('neutral temperature =%3.2d  C \n',tn);
mprintf('temperature of inversin =%3.2d  C \n',t2);

//
  ==========================================================
```

Scilab code Exa 5.24 To find resistivity of an alloy

```
//
  ==========================================================

// chapter 5 example 23

clc;
clear;

//input data
p2          =  2.75;          //resistivity of alloy 1
    percent of Ni in uohm-cm
p1              =  1.42;      //resistivity of pure
   copper in uohm-cm
p3             = 1.98;        //resistivity of alloy 3
    percent of silver in uohm-cm

//p(Ni+Cu) =p1
//pCu =p2
//p(Cu+silver)=p3
//calculation
pNi         = p2-p1;
```

```
p4    = (p3-p1)/3;
palloy      = p1+(2*pNi)+(2*p4);          // resistivity of alloy 2 percent of silver and 2 percent of nickel in uohm-cm

//result
mprintf('resistivity of alloy =%3.4f.uohm-cm\n',palloy);
```

Scilab code Exa 5.25 To find transition temperature

```
//================================================================
// chapter 5 example 25

clc;
clear;


//input data
M1        = 202;              //mass number
M2        = 200;             // mass number
Tc1       = 4.153;          // temperature in K
alpha     = 0.5;


//formula
//m^alpha*(Tc)= conatant
// calculation
Tc2     = ((M1^alpha)*Tc1)/(M2^alpha);


//result
mprintf('transition temperature =%3.2f.K\n',Tc2);
```

```

//
```

Scilab code Exa 5.26 `To find critical temperature`

```
//
// chapter 5 example 26

clc;
clear;

//input data
 Tc1      = 2.1;                    //temperature in
    K
 M1       = 26.91;
 M2       =32.13;


//formula
//Tc*(M1^2) = constant
//calculation
 Tc2        = (Tc1*(M1^(1/2)))/(M2^(1/2));


//result
 mprintf('critical temperature =%3.2f.K\n',Tc2);

//
```

Scilab code Exa 5.27 `To find critical temperature`

```
//
// chapter 5 example 27

clc;
clear;

//input data
 Hc1          =  1.41*10^5;         //critical fields in amp/m
 Hc2          = 4.205*10^5;         // critical fields in amp/m
 T1           = 14.1;               //temperature in K
 T2           = 12.9;               // temperature in K
 T3           = 4.2;                //temperature in K


//formula
//Hcn =Hc*((1-((T/Tc)^4)))
//calculation
 Tc          =(((((Hc2*(T1^2))-(Hc1*(T2^2)))/(Hc2-Hc1)))^(1/2));          //temperature in K
 Hc0         = Hc1/(1-((T1/Tc)^2));                          //critical field in A/m
 Hc2         = Hc0*(1-(T3/Tc)^2);                            //critical field in A/m


//result
```

```
mprintf('transition temperature =%3.2f K\n',Tc);
mprintf('critical field  =%3.2e.A/m\n',Hc2);

//
```

Scilab code Exa 5.28 To find critical magnetic field

```
//
// Chapter 5 example 28


clc;
clear;


// input data
 Hc0        = 700000;        //critical field at 0 K
 T          = 4;        //temperature in K
 Tc         = 7.26;       //temperature in K


//calculation
  Hc    = Hc0*(1-(T/Tc)^2);


//result
 mprintf('critical field =%3.4e.A/m\n',Hc);
  mprintf(' Note: calculation mistake in texttbook
     in calculating Hc')

 //
```

Scilab code Exa 5.29 To find critical current density

```
//
// Chapter 5 example 29

clc;
clear;


// input data
 Hc0         = 8*10^4;        //critical field
 T           = 4.5;           //temperature in K
 Tc          = 7.2;           //temperature in K
 D           = 1*10^-3;       //diameter in m


 //calculation
  Hc     = Hc0*(1-(T/Tc)^2);
  r      = D/2;        //radius in m
 Ic      = 2*%pi*r*Hc;


//result
 mprintf('critical current =%3.2f.A\n',Ic);

//
```

Scilab code Exa 5.30 To find transition temperature

```
//
   ============================================================

// Chapter 5 example 30

clc;
clear;


// input data
 Hc0         = 0.0306;        //critical field at 0 K
 T           = 2;         //temperature in K
 Tc          = 3.7;       //temperature in K


 //calculation
  Hc     = Hc0*(1-(T/Tc)^2);


//result
 mprintf('critical field =%3.4f tesla\n',Hc);

 //
   ============================================================
```

Scilab code Exa 5.31 To find transition temperature

```
//
   ============================================================
```

```
// Chapter 5 example 31

clc;
clear;


// input data
 HcT         = 1.5*10^5;       // critical field for
    niobium at 0 K
 Hc0         = 2*10^5;         // critical field for
    nobium at 0 K
 T           = 8;              // temperature in K


//calculation
 Tc      = T/((1-(HcT/Hc0))^0.5);


//result
 mprintf('transition temperature =%3.2f.K\n',Tc);

 //
   ===========================================
```

Scilab code Exa 5.32 `To find transition temperature`

```
//
  ===========================================

// chapter 5 example 32

clc;
clear;
```

```
//input data
 Hc1         =  0.176;        //critical fields
 Hc2         = 0.528;        // critical fields
 T1          = 14;        //temperature in K
 T2          = 13;        // temperature in K
 T3          = 4.2;

//formula
//Hcn =Hc*((1-((T/Tc)^4)))
//calculation
 Tc      =(((((Hc2*(T1^2))-(Hc1*(T2^2)))/(Hc2-Hc1)))
    ^(1/2));
 Hc0     = Hc1/(1-((T1/Tc)^2));
 Hc2     = Hc0*(1-((T3/Tc)^2));


//result
 mprintf('transition temperature =%3.2f K\n',Tc);
 mprintf(' critical field  =%3.2f.T\n',Hc2);

//
    ==========================================================
```

Scilab code Exa 5.33 `To find critical current`

```
//
    ==========================================================
//chapter 5 example 33

clc;
clear;
```

```


//input data
Hc          = 7900;    //magnetic field in A/m
r           = 2.0*10^-3;    //radius of super condutor in m


//calculation
I           = 2*%pi*r*Hc;    //critical current in A

//result
mprintf('critical current =%4f.A\n',I);
mprintf('Note: calculation mistake in textbook in calculation of I');

//==================================================================
```

Scilab code Exa 5.34 To find current

```
//==================================================================
//chapter 5 example 34

clc;
clear;


//input data
d            = 10^-3;            //diameter in m
```

```
Bc            = 0.0548;           // Bc in T


//calculation
u0            = 4*%pi*10^-7;          //permiability m
   ^2
r             = d/2;                    //radius in m
Ic            = (2*%pi*r*Bc)/u0;        //current in
   Amp

//result
mprintf('current =%3.2d Amp\n',Ic);

//
  ==================================================================
```

Scilab code Exa 5.35 To find Londons penetration depth

```
//
  ==================================================================

// chapter 5 example 35

clc;
clear;


//input data
D           =8.5*10^3;               //density in kg/m
   ^3
W           =93;                     //atomic weight
m           =9.1*10^-31;             //mass of
   electron in kilograms
e           =2*1.6*10^-19;            //charge of
```

```
 electron in coulombs
N          =6.023*10^26;           //avagadro number in (lb-mol) 1


//calculation
u0         =4*%pi*10^-7;
ns         =(D*N)/W;                     //in per m^3
lamdaL     =(m/(u0*ns*e^2))^(1/2);     //London's penetration depth in nm

//result
mprintf('penetration depth=%3.2f.nm\n',lamdaL/10^-9);

//==============================================================================
```

Scilab code Exa 5.36 To find penetration depth

```
//==============================================================================

// chapter 5 example 36

clc;
clear;


//input data
Tc      =7.2;   //temperature in K
lamda   =380;   //penetration depth in
T       =5.5;   //temperature in K

```

```

//calculation
 lamdaT=lamda*((1-((T/Tc)^4))^(-1/2));   //
    penetration depth in

//result
 mprintf('penetration depth=%3.1f.  \n',lamdaT);
 mprintf(' Note: calculation mistake in textbook in
    calculating lamdaT');

 //
   ================================================================
```

Scilab code Exa 5.37 To find critical temperature of aluminium

```
//
  ================================================================
// chapter 5 example 37

clc;
clear;


//input data
 lamda1      = 16;       //penetration depth in nm
 lamda2      = 96;       // penetration depth in nm
 T1          = 2.18;      //temperature in K
 T2          = 8.1;       // temperature in K

//formula
//lamdaT =lamda0*((1-((T/Tc)^4))^(-1/4))
//calculation
 Tc          = ((((lamda2*(T2^4))-(lamda1*(T1^4)))/(
```

```
    lamda2-lamda1))^(1/4));


//result
 mprintf('critical temperature =%3.2f K\n',Tc);

 //
```

Scilab code Exa 5.38 To find wavelength

```
//

// chapter 5 example 38

clc;
clear;


//input data
 Eg       =30.5*1.6*10^-23;       //energy gap in eV
 h        =6.6*10^-34;           //planck's constant
    in (m^2)*kg/s
 c        =3.0*10^8;             //velocity of light
    in m


//formula
//Eg=h*v
//calculation
 v        = Eg/h;                //velocity in m
 lamda    = c/v;               //wavelength in m

```

```
//result
 mprintf('wavelength=%2e.m\n',lamda);

//
```

Scilab code Exa 5.39 To find energy gap and wavelength

```
//
//chapter 5 example 39

clc;
clear;


//input data
 k   =1.38*10^-23;
 Tc   =4.2;                  //tempetrature in K
 h   =6.6*10^-34;            //planck's constant in (m
    ^2)*kg/s
 c   =3*10^8;                // velocity of light in m


//calculation
 Eg=(3*k*Tc);         //energy gap in eV
 lamda=h*c/Eg;        //wavelngth in m

//result
 mprintf('region of electromagnetic spectrum=%3.2e.m
    \n',lamda);

 //
```

Chapter 6

Electrical Conducting and Insulating materials

Scilab code Exa 6.1 To find temperature coefficient of resistance

```
//
// chapter 6 example 1

clc;
clear;

//input data

 R75    = 57.2;      //resistance at 75 C in ohm
 R25    = 55;        //resistance at 25 C in ohm
 t1     = 25;        //temperature in C
 t2     = 75         // temperature in C

//formula
//Rt = R0*(1+(alpha*t))
//calculation
 alpha  = (R25-R75)/((25*R75)-(75*R25));         //
```

```
    temperature cofficient


//result
 mprintf('temperature coefficient =%3.5f.K^-1',alpha
    );

//
    ======================================================================
```

Scilab code Exa 6.2 To find temperature

```
//
    ======================================================================
// chapter 6 example 2

clc;
clear;

//input data
 R1     = 50;          //resistance in ohm at
    temperature  15 C
 R2     = 60;          // resistance in ohm
    temperature  15 C
 t1     = 15;          //temperature in  C
 alpha  = 0.00425;     //temperature coefficient of
    resistance


//formula
//Rt = R0*(1+(alpha*t))
//Rt1/Rt2 = R0*(1+(alpha*t1))/R0*(1+(alpha*t2))
//calculation
```

```
R           = R2/R1;
X           = 1+(alpha*t1);
t2          = ((R*X)-1)/alpha;



//result
mprintf('temperature coefficient of resistance =%3.2f  C\n',t2);

//
```

Scilab code Exa 6.3 Tofind cold resistance and average temperature coefficient

```
//

// chapter 6 example 3

clc;
clear;

//input data
t1          = 20;                  // temperature in C
alpha       = 5*10^-3;           //average temperature coefficient at 20 C
R1          = 8;                  //resistance in ohm
R2          = 140;              //resistaance in ohm


//calculation
t2      = t1+((R2-R1)/(R1*alpha));        //
```

```
temperature in C

//result
mprintf('Hence temperature under normal condition is %3.2f C\n',t2);

//
```

Scilab code Exa 6.4 To find resistivity

```
//
//chapter 6 example 4
clc;
clear;


//input data
l     = 100;                          //length in cm
d     = 0.008;                        //diameter of wire in cm
R     = 95.5;                         //resistance in ohm
A    = %pi*0.004*0.004;               //cross-sectional area


//formula
//R=p*l/A
//calculation
p   = R*A/l;                          //;resistivity of wire in ohm-cm

```

```
//result
mprintf('resistivity=%3.2e ohm-m\n',p);

//
```

Scilab code Exa 6.5 To find percentage conductivity

```
//
//chapter 6 example 5

clc;
clear;


//input data
R0       =17.5;             //resistance at 0 degree
    c in ohm
alpha    =0.00428;          //temperature
   coefficient of copper in per degree c
t        =16;               //temperature in degree


//formula
Rt      = R0*(1+(alpha*t));            //resistance
   at 16 degree  C
P        = (R0/Rt)*100;                         //
   percentage conductivity at 16 degree C


//result
```

```
mprintf('percentage conductivity=%3.2f.percent\n',P)
    ;

//
```

Scilab code Exa 6.10 To find resistance

```
//

// chapter 6 example 10
clc;
clear;


//input data
 l          = 60;                    //length in m
 r2         = 38/2;                 // radius of outer
     cylinder in m
 r1         = 18/2;                 //radius of inner
     cylinder in m
 p          = 8000;                //specific resistance
     in ohm-m

//calculation
 R   = (p/(2*%pi*l))*log(r2/r1);      //insulation
     resistance of liquid resistor  in ohm

//result
mprintf('insulation resistance=%3.0f ohm\n',R);

//
```

Scilab code Exa 6.11 To find resistivity

```
//
//chapter 6 example 11
clc;
clear;


//input data
 d1  =0.0018;// inner diameter  in m
 d2  =0.005;//outer diameter in m
 R   =1820*10^6;//insulation resistance in ohm
 l   =3000;//length in m


//formula
 r1  =d1/2;//inner radius  in m
 r2  =d2/2;//outer radius in m

//calculation
 p=2*%pi*l*R/log(r2/r1);//resistivity of dielectric
    in ohm-m

//result
 mprintf('resistivity=%3.3e.ohm-m\n',p);

//
```

Scilab code Exa 6.12 To find insulation resistance

```
//
    ====================================================================

// chapter 6 example 12
clc;
clear;


//input data
 d1 = 0.05;       //inner diametr in m
 d2 = 0.07;       //outer diameter in m
 l  = 2000;       //length in m
 p  = 6*10^12;     //specific resistance in ohm-m


//formula
 r1 = d1/2;       //radius in m
 r2 = d2/2;       //radius in m

//calculation
 R = (p/(2*%pi*l))*(log(r2/r1))        //insulation
    resistance

//result
 mprintf('insulation resistance =%1e.ohm\n',R);
 mprintf(' Note: calculation mistake in textbook in
    calculating insulating resistance');

//
    ====================================================================
```

Scilab code Exa 6.13 To find capacitance

```
//
// chapter 6 example 13

clc;
clear;


//input data
 a      = 110*10^-3;                        //area in m^2
 d      = 2;                               //thickness in mm
 er     = 5;                              //relative permitivity
 E      = 12.5*10^3;                      //electric field strength in V/mm
 e0     = 8.854*10^-12;                    //charge of electron in coulombs


//calculations
 A      = a*a;                                //area in m^2
 C      = e0*((er*A)/(d*10^-3))           //capacitance in F
 V      = E*(d);
 Q      = (C)*(V)                         //charge on capacitor in C

// result
 mprintf('capacitance =%3.2e.F\n',C);
```

```
mprintf(' charge=%3.4e C\n',Q);

//
```

Scilab code Exa 6.14 To find charge and electric flux and flux density and electri

```
//
// chapter 6 example 14


clc;
clear;


//input data
 I        = 15*10^-3;                    //current in A
 t        = 5;                            //time in s
 A        = 120*10^-3*120*10^-3;         //area in m^2
 V        = 1000;                        //voltage in volts
 d        = 10^-3;                       //thickness in m

//calculation
 Q       = I*t;                          //charge on capacitor in C
//since charge and electric field are equal
 phi      = Q;                            //electric flux in mc
 D       = Q/A;                          //electric flux density in c/m^2
 E       = V/d;                          //electric field
```

```
strength in dielectric

//result
mprintf('charge=%3.2e.C\n',Q);
mprintf(' electric flux=%4.3f.mc\n',phi);
mprintf(' electric flux density=%3.4f.c/m^2\n',D);
mprintf(' electric field strength=%2.3e.V/m\n',E);

//
```

Scilab code Exa 6.15 `To find capacitance`

```
//

// chapter 6 example 15

clc;
clear;


//input data
 n        = 12;                     //number of plates
 er       = 4;                      //relative permitivty
 d        = 1.0*10^-3;              //distance between plates in m
 A       = 120*150*10^-6;           //area in m^2
 e0      = 8.854*10^-12;            // in F/m

//calculation
 c      = (n-1)*e0*er*A/d;            //capacitance in F
```

```
//result
mprintf('capacitance=%3.4e.F\n',c);

//
```

Scilab code Exa 6.16 To find thickness of insulation

```
//

// chpter 6 example 16

clc;
clear;


//input data
 e0     = 40000;        //dielectric strength  in
    volts/m
 d      = 33000;        //thickness in kV
 t      = d/e0;         //required thickness of
    insulation in mm

//result
mprintf('thickness=%4f.mm\n',t);

//
```

Scilab code Exa 6.17 To find area and breakdown voltage

```
//
  ================================================================

// chapter 6 example 17


clc;
clear;


//input data
 C      = 0.03*10^-6;            //capacitance in F
 d      = 0.001;                //thickness in m
 er     = 2.6;                  //dielectric constant
 e0     = 8.85*10^-12;          //dielectric strength
 E0     = 1.8*10^7

//formula
//C=e0*er*A/d
//e0=v/d
//calculation
 A      = (C*d)/(e0*er);         //area of dielectric
     needed in m^2
 Vb      = E0*d;                 //breakdown voltage
    in m

//result
mprintf('area=%3.2f.m^2\n',A);
mprintf(' breakdown voltage=%3.1e.V\n',Vb);

//
  ================================================================
```

Scilab code Exa 6.18 To find dielectric loss

```
//
    ================================================================
// chapter 6 example 18


clc;
clear;


//input data
 C        = 0.035*10^-6;                         //
    capacitance in F
 tangent     = 5*10^-4;                              //
    power factor
 f        = 25*10^3;                             //
    frequency in Hz
 I        = 250;                                 //
    current in A


//calculation
 V       = I/(2*%pi*f*C)                     //voltage
    across capacitor in volts
 P       = V*I*tangent;                     //dielectric
    loss in watts

//result
mprintf('dielectric loss=%3.2f.watts\n',P);

//
    ================================================================
```

Scilab code Exa 6.19 To find area

```
//
// chapter 6 exmple 19

clc;
clear;

//input data

Q        = 20*10^-6;                    //charge of electron in coulomb
V        = 10*10^3;                     //potential in V
e0       = 8.854*10^-12;                //absolute permitivity
d        = 5*10^-4;                     //separation between plates in m
er       = 10;                          //dielectric constant

//formula
//Q=CV
//C=er*e0*A/d
C       = Q/V;
A       = (C*d)/(er*e0);               //area in m^2

//result
mprintf('area=%1e.m^2\n',A);

//
```

Scilab code Exa 6.20 To find thermal cnductivity

```
// chapter 6 example 2o

clc;
clear;


//input data
 n   = 3.0*10^28;         //number of electrons per m^3
 t    = 3*10^-14;       //time in s
 m    = 9.1*10^-31;      //mass of electron in kg
 L    = 2.44*10^-8;         //lorentz number in ohm W/K
    ^2
 T   = 330;            //temperature in kelvin
 e    = 1.6*10^-19;         //charge of electron


//calculation
 sigma   = n*e^2*t/m;     //electrical conductivity in
     (ohm-m)^-1

//result
 mprintf('electrial conductivity=%3.2e.(ohm-m)^-1\n'
    ,sigma);
```

Chapter 7

Junction Resistor Transistors and Devices

Scilab code Exa 7.2 `To find change in temperature`

```
//
// Chapter 7 example 2

clc;
clear;

//variable declaration
//given Is2/Is1 =150
//Is2/Is1 =2^(T2−T1)/10
//dT=10ln(I)/ln(2)
 I  = 150;



// Calculations
dT  = 10*log(I)/log(2);        // increase in
   temperature in  C
```

```
// Result
mprintf('Increase in temperature necessary to
  increase Is by a factor by 150 is %3.2f  C ',dT);

//
  ================================================================================
```

Scilab code Exa 7.3 `To find current`

```
//
  ================================================================================

// Chapter 7 example 3

clc;
clear;

// Variable declaration
Io  = 0.25*10^-6;       // large reverse biased
  current in A
V   = 0.12;             // applied voltage in V
Vt  = 0.026;            // Volt-equivalent of
  temperature in V

// Calculations
I   = Io*(exp(V/Vt)-1);     // current in A

// Result
mprintf('Current flowing through germanium diode =
  %g uA',I*10^6);

//
  ================================================================================
```

Scilab code Exa 7.4 `To find diffusion coefficients`

```
//
// Chapter 7 example 4

clc;
clear;

// Variable declaration
k    = 1.38*10^-23;          // boltzmann constant (m
    ^2)*(kg)*(s^-2)*(K^-1)
e    = 1.6*10^-19;           // charge of electron in
     coulombs
ue   = 0.19                  // mobility of electron
     in m^2.V^-1.s^-1
uh   = 0.027;                // mobilty of holes in m
    ^2.V^-1.s^-1
T    = 300;                  // temperature in K

// Calculations
Dn   = (k*T/e)*ue;           //diffusion constant of
    electrons in cm^2/s
Dh   = (k*T/e)*uh;           // diffusion constant of
     holes in cm^2/s


// Result
mprintf('Diffusion co-efficients of electrons = %g m
    ^2/s\n Diffusion co-efficients of holes = %g m^2/
    s',Dn,Dh)

```

```
//
```

Scilab code Exa 7.6 To find resistance of diode

```
//
// chapter 7 example 6

clc;
clear;

// Variable declaration
I1  = 20;             // current in ma
V1  = 0.8;            // vtg in volts
V2  = 0.7;            // vtg in volts
I2  = 10;             // current in ma
v3  = -10;
I3  = -1*10^-6;       // current

// Calculations
R   = (V1 - V2)/(I1 - I2);
Vreb  = v3/I3;

// Result
mprintf('a. resistance = %d ohm\n Vreb = %3.1e ohm',
   R*10^3,Vreb);

//
```

Scilab code Exa 7.7 To find diffusion constant

```
//
    ========================================================================
// Chapter 7 example 7

clc;
clear;

// Variable Declaration
T   = 300;           // temp in kelvin
k   = 1.38*10^-23;   // Boltzmann constant (m^2)*(kg)
    *(s^-2)*(K^-1)
e   = 1.602*10^-19;  // charge of electron in
    coulombs
ue  = 3650;          // mobility of electrons
uh  = 1720;          // mobility of holes

// Calculations
De  = (ue*k*T)/e;        // diffusion constant of
    electrons in cm^2/s
Dh  = (uh*k*T)/e;        // diffusion constant of
    holes in cm^2/s

// Result
mprintf('Diffusion constant of electrons = %3.1f cm
    ^2/s\n Diffusion constant of electrons = %3.1f cm
    ^2/s',De,Dh);

//
    ========================================================================
```

Scilab code Exa 7.8 `To find pinch off voltage`

```
//==========================================================================

// chapter 7 example 8

clc;
clear;

// Variable Declaration
p    = 2;          // resistivity in ohm-m
er   = 16;         // relative dielectrivity of Ge cm^2/s
up   = 1800;       // mobility of holes in cm^2/s
e0   = 8.85*10^-12;        //permitivity in (m^-3)*(kg^-1)*(s^4)*(A^2)
a    = 2*10^-4;        //channel height in m

// Calculations
 qNa   = 1/(up*p);
 e     = e0*er;            //permitivity in F/cm
 Vp    = (qNa*(a^2))/(2*e);        // pinch-off voltage in V

// Result
mprintf('Pinch-off voltage = %3.4e V\n',Vp);
mprintf(' Note:calculation mistake in text book ,e value is taken as 14.16*10^-12 instead of 141.6*10^-12');

//==========================================================================
```

Scilab code Exa 7.9 `To find pinch off voltage`

```
//
//chapter 7 example 9
clc;
clear;


//input data
 a       = 3.5*10^-6;            //channel width in
     m
 N       = 10^21;                    //number of
     electrons in electrons/m^3
 q       = 1.6*10^-19;           //charge of electron
      in coulombs
 er      = 12;                   //dielectric
     constant F/m
 e0      = 8.85*10^-12;                      //
     dielectric constant F/m


//calculation
 e      = (e0)*(er);                    //permitivityin
     F/m
 Vp      = (q*(a^2)*N)/(2*e);        //pinch off
     voltage in V


//result
 mprintf('pinch off velocity =%2f V\n',Vp);

//
```

Scilab code Exa 7.10 To find transconductance

```
//
//chapter 7 example 10

clc;
clear;


//input data
IDSS        = 10;                //current in mA
IDS         =2.;                 // current in mA
Vp          = -4.0;              //pinch off voltage
   in V

//formula
//IDS    = IDSS*((1-(VGS/Vp))^2)
//calculation
VGS         = Vp*(1-(sqrt(IDS/IDSS)));
gm          = ((-2*IDSS)/Vp)*(1-(VGS/Vp));


//result
mprintf('transconductance =%3.2f.m*A/V\n',gm);

//
```

Scilab code Exa 7.11 To find drain current

```
//====================================================================

//chapter 7 example 11

clc;
clear;


//input data
 VGS        = -3;                  //pinch off voltage in V
 IDSS         =10*10^-3;                    // current in A
 Vp           = -5.0;                //pinch off voltage in V


//calculation
IDS    = IDSS*((1-(VGS/Vp))^2);


//result
 mprintf('current =%3.2f.A\n',IDS/10^-3);

//====================================================================
```

Scilab code Exa 7.12 To find transconductance

```
//
    ==========================================================================

//chapter 7 example 12

clc;
clear;


//input data
 IDS         = 2*10^-3;                  //current in mA
 IDSS        = 8*10^-3;                   // current in
    mA
 Vp          = -4.5;                //pinch off voltage
    in V
 VGS1        = -1.902;              //pinch off voltage
     when IDS =3*10^-3 A

//formula
//IDS    = IDSS*((1-(VGS/Vp))^2)
//calculation
 VGS         = Vp*(1-(sqrt(IDS/IDSS)));
 gm          = ((-2*IDSS)/Vp)*(1-(VGS1/Vp));


//result
 mprintf('transconductance =%3.2f.mS\n',gm/10^-3);

//
    ==========================================================================
```

Scilab code Exa 7.13 To find resistance

```
//
```

```
//chapter 7 example 13


clc;
clear;


//input data
 VGS         = 26;                  //gate source
    voltage in V
 IG          = 1.6*10^-9;          //gate current in A


//calculation
 R           = VGS/IG;             //gate to current
    resistance in ohms


//result
mprintf('resistance =%3.2e.ohms\n',R);

//
```

Scilab code Exa 7.14 `To find transconductance`

```
//
//chapter 7 example 14

clc;
```

```
clear;


//input data
 ID1           = 1;                    //current in A
 ID2           = 2.1;                     // current in A
 VGS1          = 3.0;                  //pinch off voltage in V
 VGS2          = 3.5;                  //pinch off voltage in V


//calculation
 dID          = ID2-ID1;
 dVGS         = VGS2-VGS1;
 gm           = (dID*10^-3)/dVGS;


//result
 mprintf('transconductance =%3.2e mho\n',gm);
 mprintf('Note:wrong answer in textbook');

//==================================================================
```

Scilab code Exa 7.15 `To find drain resistance and transconductance and amplificati`

```
//==================================================================
//chapter 7 example 15

clc;
clear;
```

```
//input data
ID1          = 8;                          // drain current in mA
ID2          = 8.3;                        //drain current in mA
VDS1         = 5;                          //drainn source voltage in V
VDS2         = 14;                         //drain source voltage in V
ID3          = 7.1;                        //drain current when VDS constant VGS change
ID4          = 8.3;                        //drain current when VDS constant VGS change
VGS1          = 0.1;                       //drain source voltage in V
VGS2          = 0.4;                       //drain source voltage in V

//calculation
dID1         = ID2-ID1;
dVDS         = VDS2-VDS1;
rd           = dVDS/dID1;                          //ac drain resistance
dID2         = ID4-ID3;
dVGS         = VGS2-VGS1;
gm           = dID2/dVGS;                          //transconductance
u            = rd*gm;                              //amplification factor


//result
mprintf('ac drain resistnce =%3.2d.k-ohms\n',rd);
mprintf('transconductance =%3.2d.u ohms\n',gm/10^-3);
mprintf('amplification factor=%3.2f.\n',u);
```

```

//
    ==================================================================
```

Scilab code Exa 7.16 `To find transconductance`

```
//
    ==================================================================
// chapter 7 example 16


clc;
clear;

//input data
 u          = 100;              //amplification
    factor
 rd         = 33*10^3;          //drain resistance
    in ohms


//calculation
gm          = u/rd;          //transconductance in
   mhos

//result
 mprintf('transconductance =%3.2f mmhos\n',gm/10^-3)
    ;
 printf('Note:transconductance value is wrongly
    printed in terms of umhos');

//
    ==================================================================
```

Chapter 8

Mechanism of Conduction in Semiconductors

Scilab code Exa 8.1 To find kinetic energy and momenta

```
//
// chapter 8 example 1

clc;
clear;

// Variable declaration
Ephoton = 1.5;          // energy of photon in eV
Eg      = 1.4;          // energy gap in eV
m       = 9.1*10^-31;   // mass of electron in kg
e       = 1.6*10^-19;      //charge ofelectro in
    coulombs
me_GaAs = 0.07;             //times of electro mass
    in kilograms
mh_GaAs = 0.068;              //times of electro mass
     in kilograms

```

```
// Calculations
Eke      = Ephoton - Eg;                    //energy on eV
pe       = sqrt(2*m*me_GaAs*Eke*e)          // momentum of
    electrons  in kg m/s
ph       = sqrt(2*m*mh_GaAs*Eke*e)          // momentum of
    electrons in kg m/s


// Result
mprintf('Kinetic Energy = %3.1f eV\n Momentum of
   electrons = %3.1e kg m/s\n Momentum of holes = %3
   .1e kg m/s',Eke,pe,ph);

//
   ================================================================
```

Scilab code Exa 8.2 To find thermal equilibrium hole concentration

```
//
   ================================================================

// chapter 8 example 2

clc;
clear;

// Variable Declaration
T1   = 300;                  // temperature in kelvin
nv   = 1.04*10^19;          //in cm^-3
T2   = 400;                 //temperature in K
fl   = 0.25;               // fermi level position in eV

// Calculations
Nv   = (1.04*10^19)*(T2/T1)^(3/2);             //Nv at
```

```
400 k in cm^-3
kT  = (0.0259)*(T2/T1);                              //kT in eV
po  = Nv*exp(-(f1)/(kT));                            //hole oncentration in cm^-3


// Result
mprintf('Thermal equilibrium hole concentration = %3.2e cm^-3\n ',po);
mprintf('Note: Calculation mistake in textbook Nv is not multiplied by exponentiation');

//==========================================================================
```

Scilab code Exa 8.3 `To find intrinsic carrier concentration`

```
//==========================================================================
// Chapter 8 example 3

clc;
clear;

// Variable declaration
Nc  = 3.8*10^17;            //constant in cm^-3
Nv  = 6.5*10^18;           //constant in cm^-3
Eg  = 1.42;                // band gap energy in eV
KT1 = 0.03885;            // kt value at 450K
T1  = 300;                //temperature in K
T2  = 450;                //temperature in K

```

```
// calculation
n1i  = sqrt(Nc*Nv*exp(-Eg/0.0259));          // intrinsic carrier concentration in cm^-3
n2i  = sqrt(Nc*Nv*((T2/T1)^3) *exp(-Eg/KT1));      // intrinsic carrier conc at 450K in cm^-3

// Result
mprintf('Intrinsic Carrier Concentration at 300K = %3.2e cm^-3\n Intrinsic Carrier Concentration at 300K = %3.2e cm^-3',n1i,n2i)
mprintf('\n Note : Calculation mistake in textbook in finding carrier conc. at 450K')


// ==================================================================
```

Scilab code Exa 8.4 To find position of intrinsic fermi level

```
// ==================================================================
// Chapter 8 example 4

clc;
clear;

// variable declaration

mh  = 0.56;                 //masses interms of m0
me  = 1.08;                 //masses interms of m0
t   = 27;                   //temperature in  C
k   = 8.62*10^-5;

```

```
// Calculations
T   = t+273;                    //temperature in K
fl  = (3/4)*k*T*log(mh/me);           //position of fermi level in eV

// result
mprintf('The position of Fermi level with respect to middle of the bandgap is %3.1f meV',fl/10^-3)

// ====================================================================================
```

Scilab code Exa 8.5 `To find donor binding energy`

```
// ====================================================================================
// chapter 8 example 5

clc;
clear;

// variable declaration
mo  = 9.11*10^-31;          // mass of electron inkilograms
e   = 1.6*10^-19;           // charge of electron in coulombs
er  = 13.2;                 //relative permitivity in F/m
eo  = 8.85*10^-12;          // permitivity in F/m
h   = 6.63*10^-34;          // plancks constant J.s
me  = 0.067*mo;

```

```
// Calculations

E   = (me*e^4)/(8*(eo*er)^2 * h^2 * e);          //
    energy in eV

// Result
mprintf('Donor binding energy = %3.4f eV',E);

//
```

Scilab code Exa 8.6 To find position of fermi level

```
//

// Chapter 8 example 6

clc;
clear;

// Variable declaration
no      = 10^17      // doping carrier conc
ni      = 1.5*10^10;         // intrinsic
    concentration
kT      = 0.0259

// Calculations
po      = (ni^2)/no
fl      = kT*log10(no/ni)

// Result
mprintf('Equlibrium hole concentration = %3.2e cm
    ^-3\n Position of fermi energy level = %3.3f eV',
```

```
    po,fl)

//
    ================================================================
```

Scilab code Exa 8.7 To find electrical conductivity

```
//
    ================================================================
// Chapter 8 example 7

clc;
clear;

// Variable declaration

k   = 8.62*10^-5;            //in eV/K
Eg  = 1.10;                  //energy in eV
 t1 = 200;                   //temperature in  C
 t2 = 27;                   //temperature in  C
 psi = 2.3*10^3;

// Calculations
// sigma = sigmao*exp(-Eg/(2kT))
// k     = sigma_473/sigma_300;
 t3  = t1+273;               //temperature in K
 t4  = t2+273;                //temperature in K
 k1        = exp((-Eg)/(2*k*t3));          //
    electrical conductivity in cm^-1.m^-1
 k2        = exp((-Eg)/(2*k*t4));          //
    electrical conductivity in cm^-1.m^-1
 k         = k1/k2;
 pm=      k/psi;
```

```
// Result

mprintf('electrical conductivity of pure silicon = %3.2e.ohm^-1.m^-1\n',k);
mprintf('Note:calculation mistake in electrical conductivity,and units of conductivity');

//==============================================================
```

Scilab code Exa 8.8 To find resistivity

```
//==============================================================
// Chapter 8 example 8

clc;
clear;

// Variable declaration
ni   = 2.5*10^19;            // carrier density in per m^3
q    = 1.6*10^-19;           // charge of electron in coulombs
un   = 0.35;                 //mobility of electrons in m^2/V-s
up   = 0.15;                 //mobility of electrons in m^2/V-s

// Calculations
sigma = ni*q*(un + up);          //conductivity in per ohm-m
```

```
p     = 1/sigma;                    //resistivity in ohm-m


// Result
mprintf('Resistivity = %3.1f ohm-m',p);


//
```

Scilab code Exa 8.9 To find intrinsic carrier density

```
//

// chapter 8 example 9

clc;
clear;

// Variable declaration
p   = 3.16*10^3;              // resistivity ohm-m
e   = 1.6*10^-19;             // charge of electron in coulombs
ue  = 0.14;                   //mobility of electrons in m^2/V-s
uh  = 0.05;                    //mobility of holes in m^2/V-s

// Calculations

n   = 1/((p*e)*(ue + uh));            //carrier density  in perm^3
```

```
// Result
mprintf('Intrinsic Carrier Concentration = %3.2e /m
   ^3',n);

//
```

Scilab code Exa 8.10 To find conductivity

```
//

// chapter 8 example 10

clc;
clear;

// Variable declaration
p   = 5.32*10^3;        // density of germanium
Nav = 6.023*10^26;      // Avagadros number
AW  = 72.59;            // atomic wt
ni  = 1.5*10^19         // carrier density
ue  = 0.36
uh  = 0.18
e   = 1.6*10^-19

// calculations
N   = (p*Nav)/AW        // no of germanium atoms per
    unit volume
Nd  = N*10^-6           // no of pentavalent
   impurity atoms/m^3
f   = Nd/ni
nh  = ni^2/Nd           // hole conc
```

```
sigma = e*((Nd*ue)+(nh*uh))

// Result
mprintf('The factor by which the majority conc. is more than the intrinsic carrier conc = %d\n Hole concentration = %3.1e /m^3\n Conductivity = %d / ohm-m',f,nh,sigma)

//
```

Scilab code Exa 8.11 To find carrier density

```
//

// chapter 8 example 11

clc;
clear;

// variable declaration
p   = 5*10^-3;          // resistivity in ohm-m
ue  = 0.3;              // electron mobility m^2/volt-s
uh  = 0.1;              // hole mobility m^2/volt-s
e   = 1.6*10^-19        // charge of electron in coulombs

// calculations
sigma   = 1/p;                    // conductivity in per ohm -m
n       = sigma/(e*(ue + uh));  // carrier density per m^3
```

```
// Result
mprintf('Carrier Density = %3.1e /m^3',n);

//
```

Scilab code Exa 8.12 `To find drift velocity`

```
//
// chapter 8 example 12

clc;
clear;

// Variable declaration
Jd  = 500;       // current density A/m^2
p   = 0.05       // resistivity in ohm-m
l   = 100*10^-6      // travel length m
ue  = 0.4;           // electron mobility m^2/Vs
e   = 1.6*10^-19;    // charge of electron in coulombs


// Calculations
ne  = 1/(p*e*ue);        //iin per m^3
vd  = Jd/(ne*e);              //drift velocity in m/s
t   = l/vd;                   //time teken in s

// result
mprintf('Drift velocity = %d m/s\n time = %e s',vd,t);
```

```
//
```

Scilab code Exa 8.13 To know about changes in temperature

```
//

// Chapter 8 example 13

clc;
clear;

T        = 300;                    // room temperature
    in K
psi1       =100;                  //
psi2     = 130;



// T+dT = 1/((1/T)-(2k/Eg)log1.3)
// T+dT = 305.9
dT  = 305.9 - 300;


mprintf('Therefore %3.1f K rise in temperature will
   lead to a rise of 30 percent in conductivity',dT)

//
```

Scilab code Exa 8.14 To find conductivity

```
//
// Chapter 8 example 14

clc;
clear;

// variable declaration
v   = 5;              // voltage in volts
r   = 10;             // resistance in k-ohm
J   = 60;             // current density in A/cm^2
E   = 100;            // electric field in V.m^-1
Nd  = 5*10^15;        //in cm^-3
up  = 410;            // approx hole mobility cm^2/V-s
Na  = 1.25*10^16;     // approx in cm^-3
e   = 1.6*10^-19;     // charge of electron in
    coulombs

// Calculations
I   = v/r;                 // total current A
A   = I/J                  // cross sectional area cm^2
L   = v/E                  // length of resistor cm
sigma = L/(r*A);           //conductivity in (ohm-cm)
    ^-1
sigma_comp = e*up*(Na - Nd);        //conductivity
    in (ohm-cm)^-1

// Result
mprintf('Conductivity of the compensated p-type
    semiconductor is %3.3f',sigma_comp);
```

```
//
```

Scilab code Exa 8.15 To find diffusion current density

```
//

// chapter 8 example 15

clc;
clear;

// Variable declaration
e    = 1.6*10^-19;          // charge of electron in
    coulombs
Dn   = 250;                 // electron diffusion co-
    efficient cm^2/s
n1   = 10^18                // electron conc. in cm^-3
n2   = 7*10^17              // electron conc. in cm^-3
dx   = 0.10                 // distance in cm

// Calculations
Jdiff    = e*Dn*((n1-n2)/dx);     // diffusion current
     density A/cm^2

// Result
mprintf('Diffusion Current Density = %d A/cm^2',
    Jdiff);

//
```

Scilab code Exa 8.16 To find wavelength

```
//
// Chapter 8 example 16

clc;
clear;

// Variable declaration
e    = 1.6*10^-19        // charge of electron in
   coulombs
Eg   = 0.75;              // bandgap energy eV
c    = 3*10^8;            // velocity of light in m
h    = 6.62*10^-34        // plancks constant in J.s

// Calculations
lamda   = (h*c)/(Eg*e)      // wavelength in

// Result
mprintf('Wavelength at which Ge starts to absorb
   light = %d   ',lamda*10^10);

//
```

Scilab code Exa 8.17 To find cut off wavelength

```
//
```

```
// chapter 8 example 17

clc;
clear;

// Variable Declaration

  Eg          = 1.35*1.6*10^-19;            //energy in
      eV
  h           = 6.63*10^-34;               //plancks
      constant in J.s
  c           = 3*10^8;                   //velocity in m

  //calculation
  lamda       = (h*c)/Eg;                 //wavelength in
      m

  //result
  mprintf('cutoff wavelength =%3.2e m\n',lamda);

  //
      ==================================================================
```

Scilab code Exa 8.18 `To find energy`

```
//
    ======================================================================
// Chapter 8 example 18

clc;
clear;

```

```
// Variable declaration
h    = 6.62*10^-34          // plancks constant J.s
c    = 3*10^8;              // velocity of light in m
lamda = 1771*10^-9;         // wavelengthg in m
e    = 1.6*10^-19           // charge of electron in coulombs

// Calculations
Eg   = (h*c)/(lamda*e);          // bandgap energy eV

// Result
mprintf('bandgap energy = %3.3f eV',Eg);

// ====================================================================
```

Scilab code Exa 8.19 `To find hall voltage`

```
// ====================================================================
// Chapter 8 example 19

clc;
clear;

// Variable declaration
Nd   = 10^21;          // donar density per in  m^3
H    = 0.6;            // magnetic field in T
J    = 500;            // current density A/m^2
d    = 3*10^-3;        // width in m
e    = 1.6*10^-19           // charge of electron coulombs

```

```
// Calculations
Ey  = (J*H)/(Nd*e)        // field in V/m
vh  = Ey*d;               // hall voltage V

// Result
mprintf('Hall Voltage = %3.1f mV',vh*10^3);

//
```

Scilab code Exa 8.20 To find current density

```
//

// Chapter 8 example 20

clc;
clear;

// Variable declaration
e   = 1.6*10^-19          // charge of electron
Rh  = -0.0125;            // hall co-efficient
ue  = 0.36;               // electron mobility
E   = 80;                 // electric field

// Calculations
n   = -1/(Rh*e)
J   = n*e*ue*E            // current density

// Result
mprintf('Current density = %d Ampere/m^2',J);

//
```

Scilab code Exa 8.21 To find hall coefficient

```
//
// Chapter 8 example 21

clc;
clear;

// Variable declaration
p    = 0.00893;       // resistivity  in ohm-m
Hz   = 0.5;           // field  in  weber/m^2
Rh   = 3.66*10^-4;    // hall co-efficient  hall
   coefficient  in m^3

// Calculations

u    = Rh/p;                    //mobility  of  charge
   cerrier  in m^2*(V^-1)*s^-1
theta_h = (atan(u*Hz))*(180/%pi);      // hall  angle
    in  degrees

// Result
mprintf('Hall  angle = %3.4f  degrees',theta_h);

//
```

Chapter 9

Mechanical Properties of Materials

Scilab code Exa 9.1 To find elongation

```
//

// chapter 9 example 1
clc
clear

// Variable declaration
F   = 8482;      // Tensile force in newtons
lo  = 0.30;      // length of steel wire in cm
Y   = 207*10^9;  // Youngs modulus of steel Gpa
r   = 3*10^-3;   // radius of steel wire  in m
v   = 0.30;      // poisson ratio

// Calculations

dl  = (F*lo)/(Y*%pi*r^2);        // elongation in mm
e1  = dl/lo                      // longitudanl
   strain
```

```
e2  = v*e1                          // lateral strain
dr  = e2*r;                         // lateral contraction in m

// Result
mprintf('Elongation = %3.3f mm\n Lateral contraction = %3.1f um',dl/10^-3,dr/10^-6);

//
```

Scilab code Exa 9.3 To find stress

```
//
// chapter 9 example 3

clc
clear

// Variable declaration

P   = 400;          // tensile force in newtons
d   = 6*10^-3;      // diameter of steel rod m

// Calculations
r   =d/2;
E_stress = P/((%pi/4)*r*r);         //e_stress in N/m^2

// Result

mprintf('Engineering stress = %3.2f MPa',E_stress
```

```
/10^6);

//
```

Scilab code Exa 9.4 To find strain

```
//

// chapter 9 example 4
clc
clear

// Variable declaration
Lf  = 42.3;         // guage length after strain mm
Lo  = 40;           // guage length in mm

// Calculations
e   = ((Lf - Lo)/Lo)*100        // Engineering Strain
    in percent

// Result
mprintf('Percentage of elongation = %3.2f percent',e
    );

//
```

Scilab code Exa 9.5 To find ductility

```
//

// chapter 9 example 5

clc;
clear;

// Variable declaration

dr  = 12.8       // original diameter of steel wire
   in mm
df  = 10.7;      // diameter at fracture in mm

// Calculations

percent_red = (((%pi*dr*dr) - (%pi*df*df))/(%pi*dr*
   dr))*100;


// Result

mprintf('Percent reduction in area = %3.2f percent',
   percent_red);

//
```

Chapter 10

Mechanical Properties of Materials

Scilab code Exa 10.1 `To find wavelength`

```
//
// chapter 10 example 1

clc;
clear;

// Variable declaration
E2      = 5.56*10^-19;          // Higher Energy level in J
E1      = 2.36*10^-19;          // Lower Energy level in J
h       = 6.626*10^-34;         // plancks constant in J.s
c       = 3*10^8;               // velocity of light in m

// Calculations
```

```
dE    = E2 - E1;                    // Energy difference
    in J
lamda = (h*c)/dE;                   // wavelength in m


// Result

mprintf('Wavelength of the photon = %d   \n',lamda
   /10^-10);
mprintf(' The colour of the photon is red')

//
   ================================================
```

Scilab code Exa 10.2 `To find maximum wavelength of opaque`

```
//
   ================================================

// chapter 10 example 2
clc
clear

// Variable declaration

h    = 6.63*10^-34;          // plancks constant in J
    .s
c    = 3*10^8;                // velocity of light in
    m
E    = 5.6;                   // bandgap in eV
e    = 1.6*10^-19;            // charge of electron
    coulombs

// Calculations
```

```

lamda     = (h*c)/(E*e)          // wavelength in m

// output

mprintf('Maximum Wavelength for which diamond is
   opaque is Imax = %d    ',lamda/10^-10);
mprintf('\n Note: Imax is wrongly printed as 220
    in textbook');

//
   ==========================================================================
```

Scilab code Exa 10.3 `To find composition`

```
//
   ==========================================================================

// chapter 10 example 3

clc;
clear;

// Variable declaration

h    = 6.63*10^-34;              // plancks constant
c    = 3*10^8;                   // velocity of light
lamda = 0.6*10^-6;               // wavelength in m
e    = 1.6*10^-19;               // charge of electron
EGap = 2.25                      // energy in eV
EGas = 1.42                      // energy in eV

// Calculations

```

```
E   = (h*c)/(lamda*e)              // Energy in eV
p_change = (EGap - EGas)/100;      // rate of energy gap
x   = (E-EGas)/p_change            // mol % og GaP to be added to get an energy gap of E

// Result

mprintf('Energy of radiation = %3.4f eV\n Rate of energy gap varies with addition of GaP is %3.5f\n mol percent to be added to get an energy gap of %3.4f eV is %3.1f mol percent',E,p_change,E,x);

// ==================================================================
```

Scilab code Exa 10.4 To find energy of metastable state

```
// ==================================================================

// chapter 10 example 4
clc;
clear;

// Variable declaration

h   = 6.63*10^-34;          // plancks constant in J.s
c   = 3*10^8;               // velocity of light in m
lamda = 1.1*10^-6;          // wavelength in m
e   = 1.6*10^-19;           // charge of electron
```

```
in coulombs
E2  = 0.4*10^-19;             // energy level in
    joules


// Calculations
E3  = E2 + (h*c)/(lamda);          //energy in J

// Result
mprintf('Energy of the metastable state E3 = %3.1e
    J',E3);

//
    ================================================================
```

Scilab code Exa 10.5 To find number of optical modes

```
//
    ================================================================
// chapter 10 example 5
clc
clear

// Variable declaration
c   = 3*10^8;                 // velocity of light in
    m
L   = 1.5;                    //length in m
n   = 1.0204;                 // refractive index
BW  = 1.5*10^9;               // Bandwidth in Hz

// Calculations
dV  = c/(2*L*n);               //frequency in Hz
N   = BW/dV;                  // Number of optical
```

```
    nodes

// Result

mprintf('Number of Optical modes = % d',N);

//
```

Scilab code Exa 10.6 To find numerical aperture

```
//
// chapter 10 example 6

clc
clear

// Variable declaration
n1  = 1.55;          // refractive index of core
n2  = 1.53;          // refractive index of cladding


// Calculations

NA  = sqrt(n1^2 - n2^2);


// Result
mprintf('Numerical aperture = %3.3f',NA);

//
```

Scilab code Exa 10.7 To find critical angle

```
//
    ==================================================================

// chapter 10 example 7
clc
clear

// Variable declaration
 n1      = 1.33;          //refractive index of water
 n2      = 1;             // refractive index of air

// Calculations
 theta_c = asin((n2/n1))
 theta_c_deg = theta_c*(180/%pi);        // radian
     to degree conversion

// Result
mprintf('For angles above %3.2f degrees , there will
     be total internal reflection in water',
    theta_c_deg );

//
    ==================================================================
```