Scilab Textbook Companion for Engineering Physics (volume - 2) by B. K. Pandey and S. Chaturvedi[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

De Broglie Matter Waves

Scilab code Exa 1.1 Calculation of de Broglie wavelength of Earth

```
 clc
//given that
M = 6e24 // Mass of earth in Kg
v = 3e4 // Orbital velocity of earth in m/s
h = 6.625e-34 // Plank constant

printf("Example 1.1")
lambda = h/(M*v) // calculation of de Broglie
   wavelength

printf("\n de Broglie wavelength of earth is %e m.\n
   \n\n",lambda)
```

Scilab code Exa 1.2 Calculation of de Broglie wavelength of a body

```
clc
//given that
```

```
M = 1 // Mass of object in Kg
v = 10 // velocity of object in m/s
h = 6.625e-34 // Plank constant

printf("Example 1.2")
lambda = h/(M*v) // calculation of de Broglie wavelength

printf("\n de Broglie wavelength of body is %e m.\n\n\n",lambda)
```

Scilab code Exa 1.3 Calculation of de Broglie wavelength of electron

```
clc
// Given that
m = 1e-30 // Mass of any object in Kg
v = 1e5 // velocity of object in m/s
h = 6.625e-34 // Plank constant

printf("Example 1.3")
lambda = h/(m*v) // calculation of de Broglie wavelength

printf("\n de Broglie wavelength of body is %e m.\n\n\n",lambda)
```

Scilab code Exa 1.4 Calculation of velocity momentum and wavelength of electron

```
clc
// Given that
KE = 4.55e-25 // Kinetic energy of an electron in
    Joule
m = 9.1e-31 // Mass of any object in Kg
h = 6.62e-34 // Plank constant
printf("Example 1.4")
v = sqrt(2*KE/m) // Calculation of velocity of
    moving electron
p = m*v //Calculation of momentum of moving electron
lambda = h/p // calculation of de Broglie wavelength
printf("\n velocity of electron is %e m/s.",v)
printf("\n momentum of electron is %e Kgm/s.",p)
printf("\n de Broglie wavelength of electron is %e m
    .\n\n\n",lambda)
```

Scilab code Exa 1.5 Calculation of de Broglie wavelength of proton

```

clc
//Given that
c = 3e8 // speed of light in m/s
v = c/20 // Speed of proton in m/s
m = 1.67e-27 // Mass of proton in Kg
h = 6.625e-34 // Plank constant
printf("Example 1.5")
lambda = h/(m*v) // calculation of de Broglie
    wavelength
printf("\n de Broglie wavelength of proton is %e m.\
    n\n\n",lambda)
// Answer in book is 6.645e-14m which is a
    calculation mistake
```

Scilab code Exa 1.6 Calculation of de Broglie wavelength of neutron

```
clc
//Given that
e = 12.8 // Energy of neutron in MeV
c = 3e8 // speed of light in m/s
m = 1.675e-27 // Mass of neutron in Kg
h = 6.62e-34 // Plank constant
printf("Example 1.6")
rest_e = m*c^2/(1e6*1.6e-19)// rest mass energy of neutron in MeV
if e/rest_e < 0.015 then
    E = e;
    else E = rest_e +e;
end
lambda = h/(sqrt(2*m*e*1e6*1.6e-19)) // calculation of de Broglie wavelength

printf("\n de Broglie wavelength of neutron is %e angstrom.\n\n\n", lambda*1e10)
// Answer in book is 8.04e-5 angstrom which is misprinted
```

Scilab code Exa 1.7 Calculation of de Broglie wavelength of electron

```
clc
//Given that
e = 1.632e-19 // charge on electron in coulomb
```

```
V = 50 // Applied voltage in volts
m = 9.1e-31 // Mass of electron in Kg
h = 6.62e-34 // Plank constant
printf("Example 1.7")

lambda = h/(sqrt(2*e*V*m)) // calculation of de
    Broglie wavelength
printf("\n de Broglie wavelength of neutron is %f
    angstrom.\n\n\n", lambda*1e10)
// Answer in book is 1.735 angstrom which is
    misprinted
```

Scilab code Exa 1.9 Calculation of de Broglie wavelength of electron

```
clc
//Given that
e = 1.6e-19 // charge on electron in coulomb
V = 54 // Applied voltage in volts
m = 9.1e-31 // Mass of electron in Kg
h = 6.63e-34 // Plank constant
printf("Example 1.9")

lambda = h/(sqrt(2*e*V*m)) // calculation of de
    Broglie wavelength
printf("\n de Broglie wavelength of neutron is %f
    angstrom.\n\n\n", lambda*1e10)
```

Scilab code Exa 1.10 Calculation of de Broglie wavelength of electron

```
clc
//Given that
E = 10 // Energy of electron in KeV
m_e = 9.1e-31 // Mass of electron in Kg
h = 6.63e-34 // Plank constant
printf("Example 1.10")
v = sqrt(2*E*1.6e-16/m_e) // Calculation of velocity of moving electron
p = m_e*v //Calculation of momentum of moving electron
lambda = h/p // calculation of de Broglie wavelength
printf("\n velocity of electron is %0.2e m/s.",v)
printf("\n momentum of electron is %.3e Kgm/s.",p)
printf("\n de Broglie wavelength of electron is %.2f angstrom.\n\n\n", lambda*1e10)
 // Answers in book are v = 5.93e6 m/s, p = 5.397e-24 kgm/s, lambda = 1.23 angstrom
// Which is due to wrong calculation
```

Scilab code Exa 1.11 Calculation of velocity and kinetic energy of neutron

```
clc
//Given that
lambda = 1 // de Broglie wavelength of neutron in angstrom
m = 1.67e-27 // Mass of electron in Kg
h = 6.62e-34 // Plank constant
printf("Example 1.11")

v = h/(m*lambda*1e-10) // Calculation of velocity of moving neutron
E = 1/2*m*v^2 // Calculation of kinetic energy of
```

```
   moving neutron
printf("\n velocity of neutron is %e m/s.",v)
printf("\n Kinetic energy of neutron is %f eV.\n\n\n
   ",E/1.6e-19)
```

Scilab code Exa 1.12 Calculation of de Broglie wavelength of electron

```


clc
//Given that
E = 2 // Energy of accelerated electron in KeV
m = 9.1e-31 // Mass of electron in Kg
h = 6.62e-34 // Plank constant
printf("Example 1.12")
lambda = h/sqrt(2*m*E*1e3*1.6e-19) // Calculation of
    velocity of moving electron
printf("\n Wavelength of electron is %e m.\n\n\n",
   lambda)
// Answer in book is 2.74e-12m
```

Scilab code Exa 1.13 Calculation of de Broglie wavelength of proton

```


clc
//Given that
v = 2e8 // speed of moving proton in m/s
c = 3e8 // speed of light in m/s
```

```
m = 1.67e-27 // Mass of proton in Kg
h = 6.62e-34 // Plank constant
printf("Example 1.13")
lambda = h/(m*v/sqrt(1-(v/c)^2)) // Calculation of
    velocity of moving electron
printf("\n Wavelength of electron is %e angstrom.\n\
    n\n", lambda*1e10)
```

Scilab code Exa 1.14 Comparison of momentum total energy and ratio of kinetic energy of electron and proton having same wavelength

```
clc
//given that
lambda = 1// wavelength in m/s
m_e = 9.1e-31 // Mass of electron in Kg
m_p = 1.67e-27 // Mass of proton in kg
c = 3e8 // speed of light in m/s
h = 6.63e-34 // Plank constant
printf("Example 1.14")
p_p = h/(lambda*1e-10) // Momentum of photon
p_e = h/(lambda*1e-10) // Momentum of electron
E_e = p_e^2/(2*m_e) +m_e*c^2 // Total energy of
    electron
E_p = h*c/(lambda*1e-10) // Total energy of photon
K_e = p_e^2/(2*m_e) // Kinetic energy of electron
K_p = h*c/(lambda*1e-10)// Kinetic energy of photon
r_K = K_e/K_p // Ratio of kinetic energies
printf("\n Momentum of photon is %e Kgm/s while
    Momentum of electron is %e Kgm/s \n which are
    equal.",p_p,p_e)
printf("\n Total Energy of photon is %f KeV while
    Total Energy of electron is %f MeV ",E_p/(1.6e
    -19*1e3),E_e/(1.6e-19*1e6))
```

```
printf("\n Ratio of kinetic energies is %e \n\n\n",
    r_K)
```

Scilab code Exa 1.15 Calculation of de Broglie wavelength of neutron

```

clc
//Given that
e = 25 // Energy of neutron in eV
c = 3e8 // speed of light in m/s
m = 1.67e-27 // Mass of neutron in Kg
h = 6.62e-34 // Plank constant
printf("Example 1.15")
rest_e = m*c^2/(1e6*1.6e-19)// rest mass energy of
    neutron in MeV
if e/rest_e < 0.015 then
    E = e;
    else E = rest_e +e;
end
lambda = h/(sqrt(2*m*e*1.6e-19)) // calculation of
    de Broglie wavelength
printf("\n de Broglie wavelength of neutron is %f
    angstrom.\n\n\n", lambda*1e10)
// Answer in book is 8.04e-5 angstrom
```

Scilab code Exa 1.16 Calculation of de Broglie wavelength of alpha particle

```
clc
```

```
//Given that
e = 2*1.6e-19 // charge on alpha particle in coulomb
V = 200 // Applied voltage in volts
m = 4*1.67e-27 // Mass of alpha particle in Kg
h = 6.63e-34 // Plank constant
printf("Example 1.16")

lambda = h/(sqrt(2*e*V*m)) // calculation of de Broglie wavelength
printf("\n de Broglie wavelength of neutron is %f angstrom.\n\n\n", lambda*1e10)
// while answer in book is 0.00715 angstrom
```

Scilab code Exa 1.17 Calculation of de Broglie wavelength of a body and electron

```
clc
//Given that
M = 20 // Mass of ball in Kg
V = 5 // velocity of of ball in m/s
m = 9.1e-31 //Mass of electron in Kg
v = 1e6 // velocity of of electron in m/s
h = 6.62e-34 // Plank constant

printf("Example 1.17")
lambda_b = h/(M*V) // calculation of de Broglie wavelength for ball
lambda_e = h/(m*v) // calculation of de Broglie wavelength electron
printf("\n de Broglie wavelength of ball is %e angstrom.",lambda_b*1e10)
printf("\n de Broglie wavelength of electron is %f angstrom.\n\n\n",lambda_e*1e10)
```

```
// answer in book is 6.62e-22 angstrom for ball
```

Scilab code Exa 1.18 Calculation of de Broglie wavelength of neutron

```

clc
//Given that
E = 1 // Energy of neutron in eV
m = 1.67e-27 // Mass of neutron in Kg
h = 6.62e-34 // Plank constant
printf("Example 1.18")
lambda = h/sqrt(2*m*E*1.6e-19) // Calculation of
    velocity of moving electron
printf("\n Wavelength of electron is %f angstrom.\n\
    n\n",lambda*1e10)
// Answer in book is 6.62e-22 angstrom
```

Scilab code Exa 1.19 Calculation of applied voltage

```

clc
//Given that
lambda = 0.5// wavelength of electron in angstrom
m = 9.1e-31 // Mass of electron in Kg
h = 6.62e-34 // Plank constant
q = 1.6e-19 // charge on electron in coulomb
printf("Example 1.19")
V = h^2/(2*m*q*(lambda*1e-10)^2) // Calculation of
    velocity of moving electron
```

```
printf("\n Applied voltage on electron is %f V.\n\n\
   n",V)
// Answer in book is 601.6 Volt
```

Scilab code Exa 1.21 Calculation of de Broglie wavelength of neutron at 37 degree Celsius

```
clc
//Given that
k = 8.6e-5 // Boltzmann constant
t = 37 // Temperature in degree Celsius
h = 6.62e-34 // Plank constant
m = 1.67e-27 // Mass of neutron
printf("Example 1.21")
lambda = h/sqrt(3*m*(k*1.6e-19)*(t+273))//
   Calculation of wavelength
printf("\n Wavelength of neutron at %d degree
   Celsius is %f angstrom.\n\n\n",t,lambda*1e10)
```

Scilab code Exa 1.22 Calculation of de Broglie wavelength of Helium at 27 degree Celsius

```
clc
//Given that
k = 8.6e-5 // Boltzmann constant
t = 27 // Temperature in degree Celsius
h = 6.62e-34 // Plank constant
m = 6.7e-27 // Mass of helium atom
printf("Example 1.22")
```

```
lambda = h/sqrt(3*m*(k*1.6e-19)*(t+273))//
    Calculation of wavelength
printf("\n Wavelength of helium at %d degree Celsius
    is %f angstrom.\n\n\n",t,lambda*1e10)
```

Scilab code Exa 1.23 Calculation of inter atomic spacing for crystal

```
clc
//Given that
E = 200 // energy of electrons in eV
x = 20 // distance of screen in cm
D = 2 // diameter of ring in cm
h = 6.62e-34 // Plank constant
m = 9.1e-31 // Mass of electron in kg
printf("Example 1.23")
lambda = h/sqrt(2*m*E*1.6e-19) // Calculation of
    wavelength
theta = atan(D/(2*x))
d = lambda/(2*sin(theta))// calculation of
    interatomic spacing of crystal
printf("\n Interatomic spacing of crystal is %f
    angstrom.\n\n\n",d*1e10)
```

Scilab code Exa 1.24 Calculation of velocity of electron in Bohr orbit

```

clc
//Given that
r = 0.5 // Bohr radius of hydrogen in angstrom
```

```
m = 9.1e-31 // Mass of neutron in Kg
h = 6.6e-34 // Plank constant
printf("Example 1.24")
v = h/(2*%pi*r*1e-10*m) // velocity of electron in
    ground state
printf("\n Velocity of electron in ground state is
    %e m/s.\n\n\n",v)
// Answer in book is 2.31e6 m/s
```

Scilab code Exa 1.25 Calculation of velocity of electron so that de Broglie wavelength is equal to wavelength of yellow line sodium

```

clc
//Given that
lambda = 5890 // wavelength of yellow radiation in
    angstrom
m = 9.1e-31 // Mass of neutron in Kg
h = 6.63e-34 // Plank constant
printf("Example 1.25")
v = h/(lambda*1e-10*m) // velocity of electron in
    ground state
printf("\n Velocity of electron in ground state is
    %e m/s.\n\n\n",v)
// Answer in book is 1.24e3 m/s
```

Scilab code Exa 1.26 Calculation of velocity and kinetic energy of neutron

```

```

```
clc
//Given that
lambda = 2 // wavelength of neutron in angstrom
m = 1.67e-27 // Mass of neutron in Kg
h = 6.63e-34 // Plank constant
printf("Example 1.26")
v = h/(lambda*1e-10*m) // velocity of neutron
k = 0.5*m*v^2 // Kinetic energy of neutron
printf("\n Velocity of neutron is %e m/s.",v)
printf("\n Kinetic energy of neutron is %f eV.\n\n\n
   ",k/1.6e-19)
// Answer in book is 0.021eV
```

Scilab code Exa 1.29 Calculation of angle for first order diffraction

```
clc
//given that
v1 = 50 // Previous applied voltage
v2 = 65 // final applied voltage
k = 12.28
d = 0.91 // Spacing in a crystal in angstrom
printf("Example 1.29")

lambda = k/sqrt(v1)
theta= asin(lambda/(2*d))// Angel for initial
   applied voltage
lambda1 = k/sqrt(v2)// wavelength for final applied
   voltage
theta1 = asin(lambda1/(2*d))// Angel for final
   applied voltage
printf("\n For first order, sin(theta) is %f \n For
   second order sin(theta) must be %f \n which is
   not possible for any value of angle. \n So no
```

```
    maxima occur for higher orders \n\n\n",sin(theta)
    ,2*sin(theta))
printf("\n Angle of diffraction for first order of
    beam \n is %f degree at %d Volts\n\n\n",theta1
    *180/%pi,v2)
// Answer in book is 57.14 degree
```

Scilab code Exa 1.30 Calculation of group velocity and phase velocity of wave

```
clc
//Given that
lambda = 680 // Wavelength in m
g = 9.8 //Acceleration due to gravity
printf("Example 1.30")
v_g = 1/2*sqrt(g*lambda/(2*%pi)) // Calculation of
    group velocity
printf("\n Group velocity of seawater waves is %f m/
    s.\n\n\n",v_g)
// Answer in book is 16.29 m/s
```

Scilab code Exa 1.32 Calculation of group velocity and phase velocity of wave

```
clc
//Given that
lambda = 2e-13 // de Broglie wavelength of an
    electron in m
c = 3e8 // Speed of light in m/s
```

```
m = 9.1e-31 // Mass of electron in Kg
h = 6.63e-34 // Plank constant
printf("Example 1.32")
E = h*c/(lambda*1.6e-19)
E_rest = m*c^2/(1.6e-19) // Calculation of rest mass
    energy
E_total = sqrt(E^2+E_rest^2) // Total energy in eV
v_g = c*sqrt(1-(E_rest/E_total)^2) // Group velocity
v_p  = c^2/v_g // Phase velocity
printf("\n Group velocity of de Broglie waves is %fc
     and\n phase velocity is %fc .\n\n\n",v_g/c,v_p/
   c)
```

Scilab code Exa 1.33 Calculation of kinetic energy group velocity and phase velocity of wave

```

clc
//Given that
lambda = 2e-12 // de Broglie wavelength of an
   electron in m
c = 3e8 // Speed of light in m/s
m = 9.1e-31 // Mass of electron in Kg
h = 6.63e-34 // Plank constant
printf("Example 1.33")
E = h*c/(lambda*1.6e-19) // Energy due to momentum
E_rest = m*c^2/(1.6e-19) // Calculation of rest mass
    energy
E_total = sqrt(E^2+E_rest^2) // Total energy in eV
KE = E_total - E_rest // Kinetic energy
v_g = c*sqrt(1-(E_rest/E_total)^2) // Group velocity
v_p  = c^2/v_g // Phase velocity

```

```
printf("\n Kinetic energy of electron is %f KeV.",KE
   /1000)
printf("\n Group velocity of de Broglie waves is %fc
    m/s and\n phase velocity is %fc m/s.\n\n\n",v_g/
   c,v_p/c)
// Answer in book is v_g = 0.6035c & v_p = 1.657c
```

Chapter 2

Uncertainty Principle and Schrodinger wave Equation

Scilab code Exa 2.1 Calculation of uncertainty in momentum of electron

```
clc
//given that
del_x = 0.2 // Uncertainty in position in angstrom
h = 6.63e-34 // Plank constant

printf("Example 2.1")
h_bar = h / (2*%pi) // constant
del_p = h_bar/(2*del_x*1e-10) // Calculation of
    uncertainty in momentum
printf("\n Uncertainty in momentum of particle is %e
    kgm/sec \n\n\n",del_p)
```

Scilab code Exa 2.2 Calculation of minimum uncertainty in momentum of electron

```

clc
//given that
del_x = 4e-10 // Uncertainty in position in m
h = 6.63e-34 // Plank constant

printf("Example 2.2")
h_bar = h / (2*%pi) // constant
del_p = h_bar/(2*del_x) // Calculation of
    uncertainty in momentum
printf("\n Uncertainty in momentum of particle is %e
     kgm/sec.\n\n\n",del_p)
// Answer in book is given as 1.32e-23 kgm/sec
```

Scilab code Exa 2.3 Calculation of minimum uncertainty in position of electron

```
clc

//given that
v = 3e7 // Velocity of moving electron in m/s
m = 9.1e-31 // mass of electron in kg
h = 6.63e-34 // Plank constant
c = 3e8 // speed of light in m/s
printf("Example 2.3")
h_bar = h / (2*%pi) // constant
del_p = m*v/(sqrt(1-(v/c)^2)) // calculation of
    uncertainty in momentum
del_x = h_bar/(2*del_p) // Calculation of
    uncertainty in position
printf("\n Uncertainty in position of particle is %f
     angstrom.\n\n\n",del_x*1e10)
//Answer in book is 0.0194 angstrom which is due to
```

```
using approximate values at intermediate steps
```

Scilab code Exa 2.5 Calculation of minimum uncertainty in position of electron

```
clc
//given that
v = 1.05e4 // Velocity of moving electron in m/s
v_error = 0.02 //Percentage error in measurement of velocity

m = 9e-31 // mass of electron in kg
h = 6.63e-34 // Plank constant
printf("Example 2.5")
h_bar = h / (2*%pi) // constant
p = m*v
del_p = v_error*p/100 // calculation of uncertainty in momentum
del_x = h_bar/del_p
printf("\n Uncertainty in position of particle is %e m.\n\n\n",del_x)
// Answer in book is given as 5.58e-3 m
```

Scilab code Exa 2.6 Calculation of minimum uncertainty in position of electron

```
clc
//given that
v = 600 // Velocity of moving electron in m/s
```

```
v_error = 0.005 //Percentage error in measurement of
    velocity
m = 9.1e-31 // mass of electron in kg
h = 6.63e-34 // Plank constant
printf("Example 2.6")
h_bar = h / (2*%pi) // constant
p = m*v
del_p = v_error*p/100 // calculation of uncertainty
   in momentum
del_x = h_bar/(del_p) // Calculation of uncertainty
   in position
printf("\n Uncertainty in position of particle is %e
    m.\n\n\n",del_x)
// Answer in book is 0.39e-2 m
```

Scilab code Exa 2.7 Comparison of uncertainty in velocities of electron and proton for common length

```
clc
//given that
del_x = 1 // let uncertainty in position is unity
m_e = 9.1e-31 // mass of electron in kg
m_p = 1.67e-27 // mass of proton in kg
h = 6.63e-34 // Plank constant
printf("Example 2.7")
h_bar = h / (2*%pi) // constant
del_v_ratio = m_p/m_e // calculation in
   uncertainties in the velocity of electron and
   proton
printf("\n Ratio of uncertainties in the velocity of
    electron to proton is %d.\n\n\n",del_v_ratio)
```

Scilab code Exa 2.8 Calculation of kinetic energy of H atom needed for confinement

```
clc
//given that
r = 0.5 // radius of hydrogen atom in angstrom
m_e = 9.1e-31 // mass of electron in kg
h = 6.63e-34 // Plank constant
printf("Example 2.8")
h_bar = h / (2*%pi) // constant
del_x = 2*r // calculation of uncertainty in
    position
del_p = h_bar/(2*del_x*1e-10) // calculation of
    uncertainty in momentum
p = del_p
E = p^2/(2*m_e*1.6e-19)// Calculation of energy in
    eV
printf("\n Kinetic energy needed by an electron to
    be \n confined in electron is %f eV.\n\n\n",ceil(
    E*100)/100)
```

Scilab code Exa 2.9 Calculation of uncertainty in position of electron

```
clc
//given that
v = 5e3 // Velocity of moving electron in m/s
v_error = 0.003 //Percentage error in measurement of
    velocity
```

```

m = 9.1e-31 // mass of electron in kg
h = 6.63e-34 // Plank constant
printf("Example 2.9")
h_bar = h / (2*%pi) // constant
p = m*v
del_p = v_error*p/100 // calculation of uncertainty in momentum
del_x = h_bar/(2*del_p) // Calculation of uncertainty in position
printf("\n Uncertainty in position of particle is %e m.\n\n\n",del_x)
```

Scilab code Exa 2.10 Calculation of minimum energy with which an electron can exist in atom

```
clc

//given that
r = 0.53 // radius of hydrogen atom in angstrom
m_e = 9.1e-31 // mass of electron in kg
h = 6.63e-34 // Plank constant
printf("Example 2.10")
h_bar = h / (2*%pi) // constant
del_x = 2*r // calculation of uncertainty in position
del_p = h_bar/(2*del_x*1e-10) // calculation of uncertainty in momentum
p = del_p
E = p^2/(2*m_e*1.6e-19)// Calculation of energy in eV
printf("\n Kinetic energy needed by an electron to be \n confined in electron is %f eV.\n\n\n",E)
```

```
// When problem is solved by del_x*del_p = h_bar,
   then minimum value of kinetic energy will become
   13.6eV
```

Scilab code Exa 2.11 Calculation of minimum uncertainty in energy of sate in Hydrogen atom

```
clc

//given that
del_t = 2.5e-14 // lifetime in exited state in micro
    sec
h = 6.63e-34 // Plank constant
printf("Example 2.11")
h_bar = h / (2*%pi) // constant
del_E = h_bar/(1.6e-19*del_t*1e-6) // calculation of
    uncertainty in momentum
printf("\n Minimum error in measurement of energy of
    this state is %e eV.\n\n\n",del_E)
```

Scilab code Exa 2.12 Calculation of percentage uncertainty in momentum of electron

```
clc

//given that
E_eV = 0.5// kinetic energy of electron in KeV
del_x = 0.4 // Uncertainty in position in nm
h = 6.63e-34 // Plank constant
```

```
m = 9.1e-31 // mass of electron in kg
printf("Example 2.12")
h_bar = h / (2*%pi) // constant
E_J = E_eV*1e3*1.6e-19
p = sqrt(2*m*E_J) // Calculation of momentum in kgm/
    s
del_p = h_bar/(2*del_x*1e-9) // Calculation of
    uncertainty in momentum
per_error = del_p*100 / p // calculation of
    percentage error in momentum
printf("\n Percentage error in momentum is %f
    percent.\n\n\n",per_error)
// Answer in book is 1.08 percentage
```

Scilab code Exa 2.13 Calculation of minimum uncertainty in measurement of velocity of electron

```
clc

//given that
del_x = 2e-9 // Uncertainty in position in m
h = 6.63e-34 // Plank constant
m = 9.1e-31 // mass of electron in Kg
printf("Example 2.13")
h_bar = h / (2*%pi) // constant
del_p = h_bar/(2*del_x) // Calculation of
    uncertainty in momentum
del_v = del_p/m
printf("\n Uncertainty in velocity of particle is %e
    m/s.\n\n\n",del_v)
```

Scilab code Exa 2.15 Calculation of uncertainty in momentum of ball and comparison with momentum

```
clc

//given that
del_x = 5000 // Uncertainty in position in angstrom
h = 6.63e-34 // Plank constant
m = 200 // mass of ball in gram
v = 6 // velocity of moving ball in m/s
printf("Example 2.15")
h_bar = h / (2*%pi) // constant
del_p = h_bar/(2*del_x*1e-10) // Calculation of uncertainty in momentum
p = m*v/1000 // Calculation of momentum
per_error = del_p*100/p // Calculation of percentage error in calculation of momentum
printf("\n Uncertainty in momentum of ball is %e kgm/s.",del_p)
printf("\n Percentage error in calculation of momentum is %e.\n\n\n",per_error)
```

Scilab code Exa 2.16 Calculation of uncertainty in position of proton

```
clc

//given that
c = 3e8 // speed of light in m/s
```

```
v = c/10 // Velocity of moving proton in m/s
v_error = 1 // Percentage error in measurement of
    velocity
m = 1.67e-27 // mass of electron in kg
h = 6.63e-34 // Plank constant

printf("Example 2.16")
h_bar = h / (2*%pi) // constant
del_v = v*v_error/100// calculation of uncertainty
    in position
del_x = h_bar/(2*m*del_v) // calculation of
    uncertainty in momentum
printf("\n Uncertainty in position of particle is %e
    m.\n\n\n",del_x)
// Answer in book is 1.04e-13 m
```

Scilab code Exa 2.17 Calculation of uncertainty in velocity of ball

```
clc

//given that
del_x = 1e-9 // Uncertainty in position in m
h = 6.63e-34 // Plank constant
m = 200 // mass of ball in gram
printf("Example 2.17")
h_bar = h / (2*%pi) // constant
del_v = h_bar/(2*del_x*m/1000) // Calculation of
    uncertainty in momentum
printf("\n Uncertainty in velocity of ball is %e m/s
    .\n\n\n",del_v)
// Answer in book is 2.64e-25 m/s
```

Scilab code Exa 2.18 Calculation of uncertainty in energy of gamma ray radiation

```
clc
//given that
del_t = 2e-12 // lifetime of exited state in  sec
h = 6.63e-34 // Plank constant
printf("Example 2.18")
h_bar = h / (2*%pi) // constant
del_E = h_bar/(1.6e-19*2*del_t) // calculation of
    uncertainty in momentum
printf("\n Minimum error in measurement of energy of
     this state is %e eV.\n\n\n",del_E)
// Answer in book is 1.65e-4 eV
```

Scilab code Exa 2.19 Calculation of uncertainty in frequency of photon

```
clc
//given that
del_t = 1e-8 // lifetime of exited state in  sec
h = 6.63e-34 // Plank constant
printf("Example 2.19")
h_bar = h / (2*%pi) // constant
del_nu = h_bar/(2*del_t*h) // calculation of
    uncertainty in frequency
printf("\n Minimum error in measurement of \n
    frequency of photon is %e per second.\n\n\n",
    del_nu)
```

```
// Answer in book is 8e6 per second
```

Scilab code Exa 2.20 Calculation of uncertainty in position of dust particle

```
clc
//given that
del_v = 5.5e-20 // Uncertainty in velocity in m/s
h = 6.63e-34 // Plank constant
m = 1 // mass of dust particle in mg
printf("Example 2.20")
h_bar = h / (2*%pi) // constant
del_x = h_bar/(2*del_v*m*1e-6) // Calculation of
    uncertainty in momentum
printf("\n Uncertainty in position of ball is %f
    angstrom.\n\n\n",del_x*1e10)
// Answer in book is 9.6 angstrom
```

Scilab code Exa 2.21 Calculation of energy of moving electron

```
clc


//given that
l = 1 // width of potential well in angstrom
n = 1 // order corresponding to ground state
h = 6.63e-34 // Plank constant
m = 9.1e-31 // mass of electron in Kg
printf("Example 2.21")
```

```
E = n^2*h^2/(8*m*(l*1e-10)^2) // Calculation of
    energy in Joule
E_eV = E/1.6e-19 // Calculation of energy in eV

printf("\n Energy of electron is %f eV.\n\n\n",E_eV)
// Answer in book is 37.74 eV angstrom
```

Scilab code Exa 2.24 Calculation of lowest permitted energy value of electrons

```
clc

//given that
l = 2.5e-10 // width of potential well in m
h = 6.63e-34 // Plank constant
m = 9.1e-31 // mass of electron in Kg
printf("Example 2.24")
for n = 1:2
    E = n^2*h^2/(8*m*l^2) // Calculation of energy
        in Joule
E_eV = E/1.6e-19 // Calculation of energy in eV

printf("\n Energy of electron for state %d is %f eV.
    ",n,E_eV);
end
```

Scilab code Exa 2.26 Calculate probability of particle

```
clc
```

```
// given that
L = 1// let unit length
l1 = 0.45*L // initial point
l2 = 0.55*L // Final point


printf("Example 2.26 \n")
p = (1/L)*((l2-(L/(2*%pi) *sin(2*l2*%pi/L)))- (l1-(L
   /(2*%pi) *sin(2*l1*%pi/L)))) // Calculation of
   probability of finding particle
p_per = p*100 // probability of finding particle in
   percentage
printf("\n Probability of finding electron between \
   n %fL and %fL is %f percent.",l2,l1,p_per)
```

Scilab code Exa 2.27 Calculation of energy difference between two states

```
clc


//given that
l = 1e-8 // width of potential well in cm
h = 6.63e-34 // Plank constant
m = 9.1e-31 // mass of electron in Kg
printf("\nExample 2.27")
E_1 = (h)^2/(8*m*(l*1e-2)^2) // Calculation of
   energy of ground state in Joule
E_1_eV = E_1/1.6e-19 // Calculation of energy in eV
E_2 = (2)^2*h^2/(8*m*(l*1e-2)^2) // Calculation of
   energy of first state in Joule
E_2_eV = E_2/1.6e-19 // Calculation of energy in eV
del_E = E_2_eV - E_1_eV // calculation of difference
    between first state and ground state
```

```
printf("\n Difference between first state \n and
    ground state energies is %f eV.\n\n\n",del_E);
// Answer in book is 113.04 eV
```

Scilab code Exa 2.28 Calculation of de Broglie wavelength representing first three allowed energy states

```
clc

//given that
l = 1 // width of potential well in angstrom
h = 6.63e-34 // Plank constant
m = 9.1e-31 // mass of electron in Kg
printf("Example 2.28")
for n = 1:3
    lambda = 2*l/n // Calculation of wavelength
    E = n^2*h^2/(8*m*(l*1e-10)^2) // Calculation of
        energy in Joule
E_eV = E/1.6e-19 // Calculation of energy in eV
printf("\n For state:%d  Energy is %f eV &
    wavelength is %f angstrom ",n,E_eV,lambda);
end
```

Scilab code Exa 2.29 Can we observe energy states of a ball

```
clc

//given that
m = 100 //mass of ball in gram
```

```
l = 1 // length of box in m
h = 6.63e-34 // Plank constant
printf("\nExample 2.29")
for n = 1:3
    E = (n^2*h^2)/(8*m*1e-3*l^2*1.6e-19)
     printf("\n  Energy state  E%d of ball is %e eV"
        ,n,E)
end
printf("\n As energy difference is very small so we
   cannot see energy states.\n")
```

Scilab code Exa 2.30 Calculation of probability of finding particle in given length

```
clc

//given that
l = 30 // width of potential well in angstrom
x = l/2
del_x = 2 // interval of length at centre in
   angstrom
h = 6.63e-34 // Plank constant
n = 1 // ground state
printf("\nExample 2.30")
phi_x = ((sqrt(2/l))*sin(n*%pi*x/l))^2
p = phi_x*del_x // Calculation of probability at
   centre
printf("\n Probability of finding particle at centre
    is %d percent.\n\n\n",p*100)
// Answer given in book is 16 percent. It is due to
   wrong calculation
```

Chapter 3

X ray and Compton Effect

Scilab code Exa 3.1 Calculation of longest wavelength which can be analyzed by rock salt

```
clc
//given that
d = 2.82 // crystal spacing in angstrom
n = 2 // order for longest passing wavelength
theta = 90 // angle for longest passing wavelength
printf("Example 3.1")
lambda = 2*d*sin(theta*%pi/180)/n // Calculation of
   longest wavelength

printf("\n Longest wavelength is %f angstrom. \n\n\n
   ",lambda)
```

Scilab code Exa 3.2 Calculation of angles at which second and third order Braggs diffraction maxima occur

```
 clc
//given that
lambda = 0.3 // Wavelength in angstrom
d = 0.5 // crystal spacing in angstrom
n = 2 // order
m = 3 // order
printf("Example 3.2")
theta_n = asin(n*lambda/(2*d))*180/%pi //
    Calculation of angle for order n
theta_m = asin(m*lambda/(2*d))*180/%pi  //
    Calculation of angle for order m

printf("\nAngle for %dnd order maxima is %f degree.
   ",n,theta_n)
printf("\nAngle for %drd order maxima is %f degree.
   \n\n\n",m,theta_m)
// Answers in book are 40.97 degree and 72.29 degree
    which are due to wrong calculation
```

Scilab code Exa 3.3 Calculation of wavelength

```


 clc
//given that
d = 1.87 // crystal spacing in angstrom
n = 2 // order for longest passing wavelength
theta = 30 // angle for longest passing wavelength
printf("Example 3.3")
lambda = 2*d*sin(theta*%pi/180)/n // Calculation of
    longest wavelength

printf("\n Longest wavelength is %f angstrom. \n\n\n
```

```
   ",lambda)
```

Scilab code Exa 3.4 Calculation for inter plane separation of atomic planes

```
 clc
//given that
lambda = 3.6e-9 // Wavelength in cm
theta = 4.8 // glancing angle in degree
n = 1 // order

printf("Example 3.4")
d = n*lambda/(2*sin(theta*%pi/180)) // calculation
   of crystal spacing in angstrom

printf("\n Crystal spacing in angstrom is %e cm. \n\
   n\n",d)
```

Scilab code Exa 3.5 Calculation of wavelength of X ray used

```
 clc
//given that
d = 2.5 // crystal spacing in angstrom
n = 1 // order for longest passing wavelength
theta = 20 // angle for longest passing wavelength
printf("Example 3.5")
lambda = 2*d*sin(theta*%pi/180)/n // Calculation of
   longest wavelength

```

```
printf("\nLongest wavelength is %f angstrom. \n\n\n"
   ,lambda)
```

Scilab code Exa 3.6 Calculation of longest wavelength which can be analyzed by rock salt

```
 clc
//given that
d = 2.5 // crystal spacing in angstrom
n = 1 // order for longest passing wavelength
theta = 90 // angle for longest passing wavelength
printf("Example 3.6")
lambda = 2*d*sin(theta*%pi/180)/n // Calculation of
   longest wavelength

printf("\nLongest wavelength is  of %d angstrom. \n\
   n\n",lambda)
```

Scilab code Exa 3.7 Show that given crystal is simple cubic crystal

```
clc
// given that
theta1_deg = 5 // Absolut degree part of angle for
   first angle
theta1_min = 23//remainder minute part of angle for
   first angle
theta2_deg = 7 // Absolut degree part of angle for
   second angle
```

```
theta2_min = 37//remainder minute part of angle for
   second angle
theta3_deg = 9 // Absolut degree part of angle for
   third angle
theta3_min = 25//remainder minute part of angle for
   third angle

printf("Example 3.7 \n")
val1 = sin((theta1_deg+ theta1_min/60)*%pi/180)//
   Sin value for first angle
val2 = sin((theta2_deg+ theta2_min/60)*%pi/180) //
   Sin value for second angle
val3 = sin((theta3_deg+ theta3_min/60)*%pi/180)//Sin
    value for third angle
ratio_21 = val2/val1
ratio_31 = val3/val1
printf("\n Interatomic layer separation ratios in
   crystal are as\n 1 : %f : %f",ratio_21,ratio_31)
printf("\n Above relation shows that crystal is
   simple cubic crystal structure.")
```

Scilab code Exa 3.8 Calculation of possible spacing

```
 clc
//given that
lambda = 1.2 // wavelength in angstrom
theta_deg = 9 // angle fraction in degree
theta_min = 30 // Angle fraction in minute
printf("Example 3.8\n")
theta = theta_deg+theta_min/60 // Total angel
for n = 1:4
    d = lambda/(n*2*sin(theta*%pi/180)) // Inter
       layer spacing
```

```
    printf(" If order is %d then spacing is %f
        angstrom.\n",n,d)
end
```

Scilab code Exa 3.9 Determining the spacing of crystal

```
 clc
//given that
h = 6.62e-34 // Planks constant
m_e = 9.1e-31 // mass of electron in kg
e = 1.6e-19 // charge on electron in coulomb
v = 340 // Applied voltage in volt
n = 1 // order for longest passing wavelength
theta = 60 // angle for longest passing wavelength
printf("Example 3.9")
lambda= h/sqrt(2*m_e*e*v) // calculation of
    wavelength
d = n*lambda/(2*sin(theta*%pi/180))// calculation of
     spacing of crystal

printf("\nSpacing of crystal is %f angstrom. \n\n\n"
    ,d*1e10)
```

Scilab code Exa 3.10 Calculate the energy of recoiled electron

```
 clc
//given that
E = 100 // Energy of X ray beam in KeV
theta = 30 // Scattering angle in degree
```

```
m = 9.1e-31 // mass of electron in kg
c = 3e8 // Speed of light in m/s
printf("Example 3.10")
E_rest = m*c^2/(1.6e-19*1e3) // Rest mass energy in
   KeV
k = 1/E + (1-cos(theta*%pi/180))/(E_rest)
del_e = E - 1/k // Energy of recoiled electron
    printf("\n  Energy of recoiled electron is %f
       KeV\n\n\n",del_e)
```

Scilab code Exa 3.11 Calculation of Compton shift

```
 clc
//given that
lambda = 1 //wavelength in angstrom
h = 6.62e-34 // Planks constant
m_e = 9.1e-31 // mass of electron in kg
c = 3e8 // speed of light in m/sec
theta = 90 // angle for longest passing wavelength
printf("Example 3.11")
d_lambda= h*(1-cos(theta*%pi/180))/(m_e*c) //
   calculation of wavelength shift

printf("\nWavelength shift is %f angstrom. \n\n\n",
   d_lambda*1e10)
```

Scilab code Exa 3.12 Calculation of wavelength of scattered radiation

```
 clc
```

```
//given that
lambda = 0.015 //wavelength in angstrom
h = 6.63e-34 // Planks constant
m_e = 9.1e-31 // mass of electron in kg
c = 3e8 // speed of light in m/sec
theta = 60 // angle for longest passing wavelength
printf("Example 3.12")
d_lambda= h*(1-cos(theta*%pi/180))*1e10/(m_e*c) // calculation of wavelength shift in angstrom
lambda_n = lambda+d_lambda

printf("\n Wavelength shift is %f angstrom. \n\n\n", lambda_n)
```

Scilab code Exa 3.13 Calculation of Compton shift kinetic energy imported to the recoiled electron

```
 clc
//given that
lambda = 1 //wavelength in angstrom
h = 6.63e-34 // Planks constant
m_e = 9.1e-31 // mass of electron in kg
c = 3e8 // speed of light in m/sec
theta = 90 // angle for longest passing wavelength
printf("Example 3.13")
d_lambda= h*(1-cos(theta*%pi/180))*1e10/(m_e*c) // calculation of wavelength shift in angstrom
lambda_n = lambda+d_lambda // Calculation of recoiled electron wavelength
d_E = h*c*(lambda_n-lambda)*1e10/(1.6e-19*lambda_n*lambda)// Calculation of recoiled electron energy in eV
printf("\nWavelength shift is %f angstrom.",lambda_n
```

```
)
printf("\nEnergy of recoiled electron is %deV. \n\n\n",ceil (d_E))
```

Scilab code Exa 3.14 Calculation of wavelength and energy of incident photon

```
clc
//given that
lambda = 1 //let wavelength in angstrom
lambda_n = 2*lambda // recoiled electron wavelength
h = 6.63e-34 // Planks constant
m_e = 9.1e-31 // mass of electron in kg
c = 3e8 // speed of light in m/sec
theta = 90 // angle for longest passing wavelength
printf("Example 3.14")
lambda = h*1e10/(m_e*c) // calculation of wavelength in angstrom
E = h*c*1e10/(lambda*1.6e-19) // calculation of energy of electron

printf("\nWavelength shift is %f angstrom. ",lambda)
printf("\nEnergy of recoiled electron is %f KeV. \n\n\n",E/1e3)
```

Scilab code Exa 3.15 Calculation fraction of energy lost by photon in collision

```
clc
```

```
//given that
lambda = 2 //wavelength in angstrom
h = 6.63e-34 // Planks constant
m_e = 9.1e-31 // mass of electron in kg
c = 3e8 // speed of light in m/sec
theta = 45 // scattering angle
printf("Example 3.15")
d_lambda= h*(1-cos(theta*%pi/180))*1e10/(m_e*c) // calculation of wavelength shift in angstrom
lambda_n = lambda+d_lambda // Calculation of recoiled electron wavelength
f = d_lambda/lambda // Calculation of fraction of energy lost by photon
printf("\nFraction of energy lost by photon is %f\n\n\n",f)
```

Scilab code Exa 3.16 Calculation of wavelength of scattered radiation at 90 degree

```
 clc
//given that
E_eV = 510 // Energy of gamma ray in keV
lambda = 2 //wavelength in angstrom
h = 6.63e-34 // Planks constant
m_e = 9.1e-31 // mass of electron in kg
c = 3e8 // speed of light in m/sec
theta = 90 // scattering angle in degree
printf("Example 3.16")
E_j = E_eV*1e3*1.6e-19 // Energy of gamma ray in Joule
```

```
lambda = h*c*1e10/E_j // Calculation of wavelength
    in angstrom

d_lambda= h*(1-cos(theta*%pi/180))*1e10/(m_e*c) //
    calculation of wavelength shift in angstrom
lambda_n = lambda+d_lambda // Calculation of
    recoiled electron wavelength
printf("\nWavelength of scattered radiation is %f
    Angstrom \n\n\n",lambda_n)
```

Scilab code Exa 3.17 Calculation of wavelength of radiation being scattered at ninty degree Kinetic energy imparted to the recoiled electron

```

 clc
//given that
lambda = 2 //wavelength in angstrom
h = 6.63e-34 // Planks constant
m_e = 9.1e-31 // mass of electron in kg
c = 3e8 // speed of light in m/sec
theta = 90 // angle for longest passing wavelength
printf("Example 3.17")
d_lambda= h*(1-cos(theta*%pi/180))*1e10/(m_e*c) //
    calculation of wavelength shift in angstrom
lambda_n = lambda+d_lambda // Calculation of
    recoiled electron wavelength
d_E = h*c*(lambda_n-lambda)*1e10/(1.6e-19*lambda_n*
    lambda)// Calculation of recoiled electron energy
     in eV
printf("\n Scattered wavelength is %f angstrom.",
    lambda_n)
printf("\n Energy of recoiled electron is %feV. \n\n
    \n",d_E)
```

Scilab code Exa 3.18 Calculation of wavelength of scattered radiation at ninety degree energy imparted to the recoiled electron and Direction of corresponding electron

```

 clc
//given that
E_eV = 510 // Energy of gamma ray in keV
h = 6.63e-34 // Planks constant
m_e = 9.1e-31 // mass of electron in kg
c = 3e8 // speed of light in m/sec
theta = 90 // scattering angle in degree
printf("Example 3.18")
E_j = E_eV*1e3*1.6e-19 // Energy of gamma ray in Joule
lambda = h*c/E_j // Calculation of wavelength in meter

d_lambda= h*(1-cos(theta*%pi/180))*1e10/(m_e*c) // calculation of wavelength shift in angstrom
lambda_n = lambda+d_lambda/1e10 // Calculation of recoiled electron wavelength
d_E = h*c*(d_lambda/1e10)/(1.6e-19*lambda_n*lambda) // Calculation of recoiled electron energy in eV
psi= atan(1/(tan((theta*%pi/180)/2)/(1+(h/(lambda*m_e*c)))))
phi_deg = 90 - psi*180/%pi // Calculation of degree part of angle of recoiled electron
phi_min = 60*(phi_deg - floor(phi_deg))// Calculation of minute part of angle of recoiled electron
printf("\nWavelength of scattered radiation is %e m
```

```
    ",lambda_n)
printf("\nEnergy of recoiled electron is %f MeV.",
    d_E/1e6)
printf("\nRecoiled electron angle is %d degree%d
    minute \n\n\n",phi_deg,phi_min)
```

Scilab code Exa 3.19 Calculation of after collision frequency

```
 clc
//given that
nu = 2e19 // initial frequency of X ray photon
h = 6.63e-34 // Planks constant
m_e = 9.1e-31 // mass of electron in kg
c = 3e8 // speed of light in m/sec
theta = 90 // scattering angle in degree
printf("Example 3.19")
d_lambda = h/(m_e*c) // calculation of wavelength
    shift
k = 1/nu + d_lambda/c
nu_1 = 1/k // Frequency after collision
nu_1 = floor(nu_1/1e18)*1e18 // rounding off
printf("\nFrequency after collision is %e Hz \n\n\n"
    ,nu_1)
```

Chapter 4

Dielectrics

Scilab code Exa 4.4 Calculation of induced dipole moment

```
clc
//Given that
epsilon_r = 1.000074 // Dielectric constant of He at
    0C and 1atm
epsilon_0 = 8.854e-12 // Permittivity of free space
E = 100 // Electric field in V/m
n = 2.68e27 // Electron density in no,/m^
N_a = 6e23 // Avogadro number
V = 22.4 // Volume at STP in litter
printf("Example 4.4")
P = epsilon_0*(epsilon_r-1)*E // Calculation of
    polarization

N = N_a/(V*1e-3)// Calculation of total number of
    atoms
p = P/N // dipole moment per atom
printf("\n Dipole moment per atom is %e Coulomb-
    meter \n\n\n",p)
// Answer in book is in different form and as 24.45e
    -40 coulomb-meter
```

Scilab code Exa 4.6 Calculation of electronic polarizability and relative permeability

```
clc
//Given that
r = 0.055 // Radius of hydrogen atom in nm
n = 9.8e26 // Number of atoms/cc

epsilon_0 = 8.854e-12 // Permittivity of free space

printf("Example 4.6")
alpha_e = 4*%pi*epsilon_0*(r*1e-9)^3 // Calculation
    of electronic polarisability
epsilon_r = 1+n*alpha_e/epsilon_0 // Calculation of
    relative permeability

printf("\n Electronic polarisability is %eFm^2 \n
    Relative permeability is %f \n\n\n",alpha_e,
    epsilon_r)
```

Scilab code Exa 4.8 Calculation of relative permeability

```
clc
//Given that
epsilon_0 = 8.854e-12 // Permittivity of free space
```

```
E = 2000 // Electric field in V/m
P = 6.4e-8 // Polarization in C/m^2
printf("Example 4.8")
epsilon_r = 1+ P/(epsilon_0*E) // Calculation of relative permittivity

printf("\n Relative permittivity is %f\n\n\n", epsilon_r)
```

Scilab code Exa 4.9 Calculation of dielectric constant of material

```

clc
//Given that
alpha_e = 2e-40 // Electronic polarisability in Fm^2
N = 4e28 // density in atoms/m^3
epsilon_0 = 8.85e-12 // Permittivity of free space

printf("Example 4.9")
epsilon_r = 1+ N*alpha_e/(epsilon_0) // Calculation of relative permittivity
printf("\n Relative permittivity is %f\n\n\n", epsilon_r)
```

Scilab code Exa 4.10 Calculation of dielectric constant and electrical susceptibility

```
clc
//Given that
```

```
epsilon = 2.4e-10 // permitivity of a  dielectric
    material in C^2/N?m^2
epsilon_0 = 8.854e-12 // Permittivity of free space

printf("Example 4.10")
K = epsilon/epsilon_0  // Calculation of dielectric
    constant
zai_e = epsilon_0*(K-1) // Calculation of electrical
     susceptibility

printf("\n Relative permittivity is %f",K)
printf("\n Electrical susceptibility is %e C^2/Nm^2\
    n\n\n",zai_e)
```

Scilab code Exa 4.11 Calculation of value of vectors E D and P

```

clc
//Given that
V = 100 // Applied potential in Volt
d = 1 // Separation between plates in cm
k1 = 8 // Dielectric constant
k2 = 9 //dielectric constant
epsilon_0 = 8.854e-12 // Permittivity of free space

printf("Example 4.11")
E_0 = V/(d*1e-2) // Calculation of electric field
E = E_0/k1*k2 // Calculation of electric field
D = k1*epsilon_0*E // Calculation of electrical
    displacement vector
P = (k1-1)*epsilon_0*E  // Calculation of electrical
     polarization

```

```
printf("\n Magnitude of Electrical vector is %e Volt/meter",E) // Answer in book is 1.125e3 Volt/meter

printf("\n Magnitude of Electrical Displacement vector is %e C/m^2",D)// Answer in book is 8.85e-8C/m^2

printf("\n Magnitude of Electric polarization vector is %e C/m^2\n\n\n",P)// Answer in book is 7.774e-8C/m^2
```

Scilab code Exa 4.12 Calculation of deformational polarizability and orientational polarizability

```

clc
//Given that
alpha_300 = 2.5e-39 // total polarisability in C^2m/N at 300 K
alpha_600 = 1.75e-39 // total polarisability in C^2m/N at 600 K
T1 = 300 // Initial temperature in Kelvin
T2 = 600 // Final Temperature in Kelvin
printf("Example 4.12\n")
b = (alpha_300-alpha_600)*T2
al_def_300 = alpha_300 - b/300
al_oriant_300 = b/300
al_oriant_600 = b/600
printf("\n Deformational Polarizability is %e C^2mN^-1",al_def_300)
printf("\n Orientational Polarizability at %d degree Celcius is %e C^2mN^-1",T1,al_oriant_300)
```

```
printf("\n Orientational Polarizability at %d degree Celcius is %e C^2mN^-1",T2,al_oriant_600)
```

Scilab code Exa 4.13 Calculation of dielectric constant of material

```

clc
//Given that
alpha_e = 1.5e-40 // Electronic polarizability in Fm^2
N = 4e28 // density in atoms/m^3
epsilon_0 = 8.85e-12 // Permittivity of free space

printf("Example 4.13")
k = N*alpha_e/(3*epsilon_0)
epsilon_r = (1+ k*2)/(1-k)// Calculation of relative permittivity
printf("\n Relative permittivity is %f\n\n\n", epsilon_r)
```

Scilab code Exa 4.14 Calculation of relative dielectric constant of material

```

clc
//Given that
m = 32 // Atomic weight of sulphur
d = 2.08 // Density in g/cm^3
```

```
alpha_e = 3.5e-40 // Electronic polarizability in Fm^2
N_a = 6.022e23 // Avogadro Number
epsilon_0 = 8.85e-12 // Permittivity of free space

printf("Example 4.14")
N = N_a*d*1e6/m // Calculation of Atoms per unit
k = N*alpha_e/(3*epsilon_0)

epsilon_r = (1+ k*2)/(1-k)// Calculation of relative permittivity
printf("\n Relative permittivity is %f\n\n\n", epsilon_r)
// Answer in book is 4.17
```

Scilab code Exa 4.15 Calculation of percentage of ionic polarizability

```

clc
//Given that
n = 1.5 // Refractive index
epsilon = 5.6 // Static dielectric constant
printf("Example 4.15")
per = (1-((n^2-1)/(n^2+2))*(epsilon+2)/(epsilon-1))*100 // Pecentage ionic polarisability
printf("\n Percentage ionic polarizability is %f pecent\n\n\n",per)
// Answer in book is 5.14 %
```

Scilab code Exa 4.16 Calculation of electronic polarizability of sulphur

```
clc
//Given that
m = 32 // Atomic weight of sulphur
d = 2050 // Density in Kg/m^3
N_a = 6.022e23 // Avogadro Number
epsilon_0 = 8.85e-12 // Permittivity of free space
epsilon_r = 3.75 // Dielectric constant of sulphur

printf("Example 4.16")
N = N_a*d*1e3/m // Calculation of Atoms per unit
alpha_e = 3*epsilon_0*((epsilon_r-1)/(epsilon_r+2))/ N


printf("\n Electronic polarizability  is %e Fm^2\n\n\n",alpha_e)
```

Scilab code Exa 4.17 Calculation of electronic polarizability and ionic polarizability

```
clc
//Given that
n = 1.5 // Refractive index
epsilon = 4 // Static dielectric constant
epsilon_0 = 8.85e-12 // permittivity of free space
printf("Example 4.17")
k1 = (epsilon-1)/(epsilon+2)
k2 = (n^2-1)/(n^2+2)
```

```
ratio = 1/((k1/k2)-1)
printf("\n Ratio of electronic to ionic polarizability is %f .\n\n\n",ratio)
// Answer in book is 1.43
```

Scilab code Exa 4.18 Calculation of frequency and phase difference

```

clc
//Given that
t = 1.8e-5 // Relaxation time in second
epsilon_r = 1 // let
printf("Example 4.18")
f = 1/(2*%pi*t) // Calculation of frequency
delta = atan(epsilon_r/epsilon_r)
phi = 90 - delta*180/%pi // Calculation of phase difference
printf("\n Frequency is %f KHz\n",f/1e3)
printf(" Phase difference between current and voltage is %d degree.",phi)
```

Chapter 6

Ultrasonic Waves

Scilab code Exa 6.1 Calculation of fundamental frequency of quartz

```

clc
//Given that
E = 7.9e10 // Young s modulus in N/m^2
rho = 2650 // Density in Kg/m^3
t = 0.003 // Thickness of quartz crystal in m
printf("Example 6.1\n")
v = sqrt(E/rho)// Calculation of velocity
lambda = 2*t // Calculation of fundamental wavelength
nu = v/lambda // Calculation of fundamental frequency
printf("Fundamental frequency is %e Hz.\n\n\n",nu)
```

Scilab code Exa 6.2 Calculation of fundamental frequency of crystal

```
clc
//Given that
v = 5760 // Velocity in m/s
T = 1.6 // Thickness of quartz crystal in mm
printf("Example 6.2\n")
nu = v/(2*T*1e-3)// Calculation of fundamental
    frequency
printf("Fundamental frequency of crystal is %f MHz.\
    n\n\n",nu/1e6)
```

Scilab code Exa 6.3 Calculation of depth of defect

```
clc
//Given that
T =40 // Thickness of steel bar in cm
t1 = 40 // Time in ms
t2 = 80 // Time in ms
printf("Example 6.3\n")
X = T*t1/t2 // Calculation of depth of defect
printf("Depth of defect is %d cm.\n\n\n",X)
```

Scilab code Exa 6.4 Calculation of fundamental frequency of quartz

```
clc
//Given that
E = 7.9e10 // Young s modulus in N/m^2
rho = 2650 // Density in Kg/m^3
```

```
t = 0.006 // Thickness of quartz crystal in m
printf("Example 6.4\n")
v = sqrt(E/rho)// Calculation of velocity
lambda = 2*t // Calculation of fundamental
    wavelength
nu = v/lambda // Calculation of fundamental
    frequency
printf("Fundamental frequency is %e Hz.\n\n\n",nu)
```

Scilab code Exa 6.5 Calculation of capacitance

```

clc
//Given that
L = 1 // Inductance in Hanery
nu = 2e6 // Frequency in Hz
printf("Example 6.5\n")
C= 1/(4*((%pi)^2)*nu^2*L) // Calculation of
    capacitance
printf("Capacitance is %e microfarad.\n\n\n",C*1e6)
// Answer in book is 0.00634 micro Farad
```

Chapter 7

Maxwells Equations and Electromagnetic Waves

Scilab code Exa 7.1 Calculation of average values of electrical and magnetic field vector

```

clc
//Given that
p = 1000 // power in watt
d = 2 // Distance from lamp in m
epsilon_0 = 8.854e-12 // Permittivity of free space
mu_0 = 4*%pi*1e-7 // Permeability of free space
printf("Example 7.1")
s = p/(4*%pi*d^2)// Calculation of pointing vector
E_H_ratio = sqrt(mu_0/epsilon_0) // Calculation of ratio of Electric field and magnetic field
E= sqrt(E_H_ratio*s) // Calculation of  Electric field
printf("\n Average value of electric field at distance %d m is %f Volt/m \n\n\n",d,E)
// Answer in book is 48.87 volt/m which is due to wrong calculation at intermediate steps
```

Scilab code Exa 7.2 Calculation of amplitudes of electrical and magnetic field vector

```

clc
//Given that
p = 2 // power in cal/min/cm^2

epsilon_0 = 8.854e-12 // Permittivity of free space
mu_0 = 4*%pi*1e-7 // permeability of free space
printf("Example 7.2")
s = p*4.2e4/60 // Calculation of pointing vector
E_H_ratio = sqrt(mu_0/epsilon_0) // Calculation of
    ratio of Electric field and magnetic field
E= sqrt(E_H_ratio*s) // Calculation of Electric
    field
H = s/E // Calculation of Electric field

printf("\n Average value of electric field  is %f
    Volt/m ",E*sqrt(2))
printf(" \nAverage value of magnetic field is %f Amp
     turn/m \n\n\n",H*sqrt(2))
```

Scilab code Exa 7.3 Calculation of skin depth for a given frequency

```

clc
//Given that
```

```
mu_0 = 4*%pi*1e-7 // permeability of free space
mu = mu_0 //permeability of silver
sigma = 3e7 // conductivity in mhos/m
f = 1e8 // frequency in Hz
printf("Example 7.3")
omega = 2*%pi/f // Calculation of time period
delta = sqrt(2/(omega*sigma*mu)) // Calculation of
    skin depth penetration
Delta = floor (delta/100)*100 // Rounding off
printf("\n Skin depth penetration is %e cm. \n\n\n",
    Delta*1e-6)
```

Scilab code Exa 7.5 Calculation of frequency for a given skin depth and show that sea water can be considered as good conductor for particular frequencies

```

clc
//Given that
k = 80 // relative Dielectric constant of sea water
epsilon_0 = 1/9e9 // Permittivity of free space
epsilon = 80*epsilon_0 // Permittivity of free space
sigma = 4.3 // conductivity in mho/m
delta = 10 // penetration depth in cm
mu_0 = 4*%pi*1e-7 // permeability f free space
F = 1e8 // Given frequency in Hz
printf("Example 7.5")
f = (1/(%pi*mu_0*sigma))/(delta*1e-2)^2 //
    Calculation of frequency
f1= ceil(f/1e8)*1e8 // Rounding off
printf("\nFrequency required for penetration of
    depth %d cm is %e Hz",delta,f1)
omega = 2*%pi*F
```

```
x = 2*sigma/(epsilon*omega)
if x>1 then
    printf("\n Sea water is good conductor at
        frequency lesser than 1e8 Hz\n\n ")
end
```

Scilab code Exa 7.7 Show that silicon water can be considered as good conductor for particular frequencies

```

clc
//Given that
k = 12 // relative Dielectric constant of sea water
epsilon_0 = 1/9e9 // Permittitivity of free space
sigma = 2 // conductivity in mho/cm
mu_0 = 4*%pi*1e-7 // permeability f free space
f= 1e9 // Given frequency in Hz
F = 1e6 // Given frequency in Hz
printf("\nExample 7.7")
delta = sqrt(2/(2*%pi*F*mu_0*sigma*100)) //
    Calculation of frequency
printf("\n For %eHz frequency, Penetration depth is
    %f cm",F,delta*100)
omega = 2*%pi*f
x = 2*sigma*100/(k*epsilon_0*omega)
if x>1 then
    printf("\n Silicon is good conductor at
        frequency lesser than 1e9 Hz \n\n\n")
end
// Answer in book is 3.6 cm
```

Scilab code Exa 7.8 Calculation of frequency for a given skin depth and predict name of radiation

```
clc
//Given that
mu_0 = 4*%pi*1e-7 // permeability of free space
mu = mu_0 //permeability of silver
sigma = 5.8e7 // conductivity in simens /m
delta = 0.1 // Skin depth penetration in mm

printf("Example 7.8")
f = 2/((delta*1e-3)^2*sigma*mu*2*%pi) // Calculation
    of skin depth penetration
printf("\n Required frequency is %.2e Hz",f)
printf("\n The incident electromagnetic wave is the
   radio part of spectrum.")
// Answer in book is 3.36e5 Hz. Difference is due to
    approximation at intermediate stages
```

Scilab code Exa 7.9 Calculation of skin depth for a given frequency

```


clc
//Given that
mu_0 = 4*%pi*1e-7 // Permeability of free space
mu = mu_0 //Permeability of silver
sigma = 3e7 // conductivity in mhos/m
```

```
f = 1e10 // frequency in Hz
printf("Example 7.9")
delta = sqrt(1/(%pi*sigma*f*mu)) // Calculation of skin depth penetration
printf("\n Skin depth penetration is %f micrometre.\n\n\n",delta*1e6)
// Answer in book is 0.93 micrometer
```

Scilab code Exa 7.10 Calculation of intensities of electrical and magnetic field

```

clc
//Given that
p = 500 // power in watt
d = 1 // Distance from lamp in m
epsilon_0 = 8.854e-12 // Permittivity of free space
mu_0 = 4*%pi*1e-7 // Permeability of free space
printf("Example 7.10")
s = p/(4*%pi*d^2)// Calculation of pointing vector
E_H_ratio = sqrt(mu_0/epsilon_0) // Calculation of ratio of Electric field and magnetic field
H = s/E_H_ratio // Calculation of Electric field
h = ceil(H*100)/100 // rounding off for 2 decimal places
E= p/(4*%pi*h) // Calculation of Electric field
printf("\n Average value of electric field at distance %d m is %f Volt/m ",d,E)
printf("\n Average value of magnetic field at distance %d m is %f Amp-turn/m \n\n\n",d,h)
```

Scilab code Exa 7.11 Calculation of frequency for a given skin depth and and predict name of radiation

```

clc
//Given that
mu_0 = 4*%pi*1e-7 // Permeability of free space
mu = mu_0 //Permeability of silver
sigma = 3.5e7 // conductivity in simens /m
delta = 0.03 // Skin depth penetration in mm

printf("Example 7.11")

f = 2/((delta*1e-3)^2*sigma*mu*2*%pi) // Calculation
    of skin depth penetration
printf("\n Required frequency is %d MHz.",f/1e6)
printf("\n The incident electromagnetic wave is the
    radio part of spectrum")
```

Scilab code Exa 7.12 Calculation of solar energy received by moon during solar eclipse

```

clc
//Given that
p = 3.8e26 // power radiated by moon in watt
d_sun = 1.44e11 // Distance between sun and earth in
    meter
```

```
d_moon = 3e8 //Distance between moon and earth in meter
epsilon_0 = 8.854e-12 // Permittivity of free space
mu_0 = 4*%pi*1e-7 // Permeability of free space
printf("Example 7.12")
s = p/(4*%pi*d_sun^2)// Calculation of solar energy received during solar eclipse in watt /m^2
S = s*60/(4.2*1e4) // Unit conversion

printf("\n Solar energy received during solar eclipse is %f Cal per min per m^2 \n\n\n",S)
// Answewr in book is 2.1 cal per min per m^2
```

Scilab code Exa 7.13 Calculation of skin depth

```


clc
//Given that
mu_0 = 4*%pi*1e-7 // Permeability of free space
mu = mu_0 //Permeability of silver
sigma = 3.5e7 // conductivity in simens /m
lambda = 6328 // Wavelength in angstrom
c = 3e8// Speed of light in m/sec

printf("Example 7.13")
f = c/(lambda*1e-10)
omega = 2*%pi/f // Calculation of time period
f = c/(lambda*1e-10) // Calculation of frequency in Hz
delta = sqrt(1/(%pi*f*sigma*mu)) // Calculation of skin depth penetration
printf("\n Skin depth penetration is %f nm. \n\n\n",
```

```
    delta*1e9)
// Answer in book is 3.9 mm, unit used in book is
    wrong
```

Chapter 8

Superconductivity

Scilab code Exa 8.1 Calculation of critical field at 2K

```
 clc
// Given that
H_c_0=  0.0306// Critical Field in tesla
T_c = 3.7 // Critical temperature in kelvin
T = 2 // Temperature in kelvin
printf("Example 8.1\n")
printf("Standard formula used \tH_c = H_c_0*(1-(T/
   T_c)^2)  \n")
H_c = H_c_0*(1-(T/T_c)^2) // Calculation of critical
    field

printf("Magnetic Field at %d K is %f tesla.\n\n\n",T
   ,H_c)
```

Scilab code Exa 8.2 Calculation of magnitude of magnetic field

```
 clc
// Given that
H_c=  3.3e4 // // Magnetic field in A/m
T_c = 7.2 // Critical temperature in kelvin
T = 5 // Temperature in kelvin
printf("Example 8.2\n")
printf("Standard formula used \tH_c = H_c_0*(1-(T/
   T_c)^2)  \n")
H_c_0 = H_c*(1-(T/T_c)^2)^(-1) // Calculation of
   critical field
printf("Magnetic Field at %d K is %e A/m\n\n\n",T,
   H_c_0)
```

Scilab code Exa 8.3 Calculation of temperature

```
 clc
// Given that
H_c_0= 1 // Let
H_c= 0.1 * H_c_0 // Magnetic field in A/m
T_c = 7.2 // Critical temperature in kelvin

printf("Example 8.3\n")
printf("Standard formula used \tH_c = H_c_0*(1-(T/
   T_c)^2)  \n")
T = T_c*sqrt(1- (H_c/H_c_0)) // Calculation of
   Temperature

printf("Required temperature is %f K.\n\n\n",T)
```

Scilab code Exa 8.4 Calculation of critical field

```
  clc
// Given that
H_c_0=  0.0803// Critical Field in tesla
T_c = 7.2 // Critical temperature in kelvin
T = 4.2 // Temperature in kelvin
printf("Example 8.4\n")
printf("Standard formula used \tH_c = H_c_0*(1-(T/
   T_c)^2)  \n")
H_c = H_c_0*(1-(T/T_c)^2) // Calculation of critical
    field

printf("Magnetic Field at %d K is %f tesla.\n\n\n",T
   ,H_c)
// Answer in book is 0.0548 tesla
```

Scilab code Exa 8.5 Calculation of temperature

```
  clc
// Given that
H_c_0= 1.5e5// Critical field in A/m
H_c= 1.05e5 // Magnetic field in A/m
T_c = 9.2 // Critical temperature in kelvin
```

```
printf ("Example 8.5\n")
printf("Standard formula used \tH_c = H_c_0*(1-(T/
    T_c)^2)  \n")
T = T_c*sqrt(1- (H_c/H_c_0)) // Calculation of
    Temperature

printf("Required temperature is %f K.\n\n\n",T)
```

Scilab code Exa 8.6 Calculation of transition temperature

```


  clc
// Given that
H_c_0= 2e5// Critical field in A/m
H_c= 1e5 // Magnetic field in A/m
T_c = 8 // Critical temperature  in kelvin

printf("Example 8.6\n")
printf("Standard formula used \tH_c = H_c_0*(1-(T/
    T_c)^2)  \n")
T = T_c/sqrt(1- (H_c/H_c_0)) // Calculation of
    Temperature

printf("Required temperature is %f K.\n\n\n",T)
```

Scilab code Exa 8.7 Making observation for given data

```
clc
// Given that
H_c_0= 8e5// Critical field in A/m
H_c= 4e4 // Magnetic field in A/m
T_c = 7.26 // Critical temperature in kelvin

printf("Example 8.7\n")
printf("Standard formula used \tH_c = H_c_0*(1-(T/
    T_c)^2)  \n")
T = T_c*sqrt(1- (H_c/H_c_0)) // Calculation of
    Temperature

printf("Required temperature is %f K.\n\n\n",T)
```

Scilab code Exa 8.8 Calculation of transition temperature and critical field

```
clc
// Given that
T1 = 14 // Temp in K
T2 = 13 // Temp in K
T = 4.2 // Temp in K
Hc_T1 = 0.176 // Critical field at Temp T1
Hc_T2 = 0.528 // Critical field at Temp T2

printf("Example 8.8\n")
printf("Standard formula used \tH_c = H_c_0*(1-(T/
    T_c)^2)  \n")
T_c = sqrt((T1^2*(Hc_T2/Hc_T1)- T2^2) /(Hc_T2/Hc_T1
    - 1)) // Calculation of transition temperature
t_c = ceil(T_c*10)/10 // Rounding off two two
    decimal places
```

```
Hc_0 = Hc_T1/(1-(T1/t_c)^2) // Calculation of critical field
Hc_T = Hc_0*(1-(T/t_c)^2) // Calculation of critical field

printf("\n Transition temperature is %f K.\n",t_c)
printf("Critical field at %f K is %fT.\n",T,Hc_0)
printf("Critical field at 0 K is %fT.\n\n\n",Hc_T)
// Answer in book is 2.588 T for 0 K and 2.37 for 4.2 K
```

Scilab code Exa 8.9 Calculation of depth of penetration

```

  clc
// Given that
m_0 = 9.1e-31 // Mass of electron in kg
mu_0 = 1.256e-6// SI
e = 1.6e-19 // Charge on electron in coulomb
eta_s = 1e28 // superelectron density in  no. per cube
T_1 = 0 // First temp in kelvin
T_2 = 1 // Second temp in kelvin
T_c = 3 // Critical temp in kelvin

printf("Example 8.9\n")
printf("Standard formula used \tlambda_0 = sqrt(m_0/(mu_0*eta_s*e^2))\n")
lambda_0 = sqrt(m_0/(mu_0*eta_s*e^2))// Calculation of penetration depth at 0K
lambda_t = lambda_0/sqrt(1-(T_2/T_c)^4) // Calculation of penetration depth at 2K

```

```
printf("Penetration depth at %d K is %d angestrom.",
    T_1,lambda_0*1e10)
printf("\nPenetration depth at %d K is %f angestrom
    .\n\n\n",T_2,lambda_t*1e10)
```

Scilab code Exa 8.10 Calculation of penetration depth

```

  clc
// Given that
T_1 = 3.5 // Temperature in kelvin
T_c = 4.153 // Critical temp in kelvin
lambda_t = 750 // Penetration depth at T_1 in
    angstrom
printf("Example 8.10\n")
printf("Standard formula used \nlambda_0 = lambda_t*
    sqrt(1-(T_1/T_c)^4) \n")

lambda_0 = lambda_t*sqrt(1-(T_1/T_c)^4) //
    Calculation of penetration depth at 3.5K
printf("\n Penetration depth at 0 K is %f angstrom.\
    n\n\n",lambda_0)
```