Scilab Textbook Companion for Engineering Physics by H. K. Malik, 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

INTERFERENCE

Scilab code Exa 1.1 Calculation of time Coherence

```
clc
// Given that
lambda = 6.6e-7 // wavelength of light in meter
L = 1.32e-5 // coherence length in meter
// Sample Problem 1 on page no. 1.40
printf("\n # PROBLEM 1 # \n")
printf("\n Standard formulae used \n delta_L = c *
    delta_t \n")
coherence_time = L / (3 * 10 ^ 8)//calculation for
    coherence time
printf("\n Coherence time = %e sec",coherence_time)
```

Scilab code Exa 1.2 Calculation No of oscillations of

```
clc
```

```
// Given that
lambda = 5.896e-7 // wavelength of light in meter
L = 2.945e-2 // coherence length in meter
// Sample Problem 2 on page no. 1.40
printf("\n # PROBLEM 2 # \n")
printf("\n Standard formula used \n delta_L = c*
    delta_t. \n")
coherence_time = L / (3 * 10 ^ 8) // calculation for
     coherence time
n = L / lambda // calculation for number of
    oscillations
printf("\n Coherence time = %e sec.",coherence_time)
printf("\n No. of oscillations = %e.",n)
```

Scilab code Exa 1.3 Calculation of Coherence time and Line width and Frequency stability

```
clc
// Given that
lambda = 6.058e-7 // wavelength of light in meter
L = 0.2 // coherence length in meter
// Sample Problem 3 on page no. 1.40
printf("\n # PROBLEM 3 # \n")
printf("\n Standard formula used \n f = c/lambda. \n
    ")
line_width = (lambda ^ 2) / L//calculation for line
    width
f_spread = (3 * 10 ^ 8) / L// calculation for
    frequency spread
f = (3 * 10 ^ 8) / lambda // calculation for
    frequency
f_stability = f_spread / f // calculation for
    frequency stability
```

```
coherence_time = L / (3 * 10 ^ 8) // calculation for
    coherence time
printf("\n Coherence time = %e sec",coherence_time)
printf("\n Line width = %e meter",line_width)
printf("\n Frequency stability = %e", f_stability)
```

Scilab code Exa 1.4 Calculation of Coherence length

```
clc
// Given that
lambda_D = 5.5e-13 // Doppler width of orange light
    in meter
lambda = 6.058e-7 // wavelength of light in meter
// Sample Problem 4 on page no. 1.41
printf("\n # PROBLEM 4 # \n")
printf("\n Standard formula used \n delta_L = lambda
    ^2/delta_lambda. \n")
coherence_length = (lambda ^ 2) / lambda_D//
    calculation for coherence light
printf("\n Coherence length = %f meter",
    coherence_length)
```

Scilab code Exa 1.5 Calculation of The ratio of coherence length of mercury vapour lamp to the coherence length of He Ne laser

```
clc
// Given that
lambda1 = 5.461e-7 // wavelength of light emitted by
    mercury vapour lamp in meter
```

```
band_width1 = 6e8 // band width for mercury vapour lamp in Hz
lambda2 = 6.328e-7 // the operating wavelength of light for He Ne laser
band_width2 = 1e6 // band width for laser in Hz
// Sample Problem 5 on page no. 1.41
printf("\n # PROBLEM 5 # \n")
delta_lambda1 = (lambda1^2 * band_width1) / 3e8 // calculation for difference between two wavelength for mercury vapour
delta_L1 = lambda1^2 / delta_lambda1 // calculation for coherence length for mercury vapour lamp
delta_lambda2 = (lambda2^2 * band_width2) / 3e8 // calculation for difference between two wavelength for He Ne laser
delta_L2 = lambda2^2 / delta_lambda2 // calculation for coherence length for He Ne laser
R = delta_L1/delta_L2 // calculation for ratio of coherence length of mercury vapour lamp to the coherence length of He Ne laser
printf("\n Standard formula used \n delta_lambda = lambda^2*band_width / c, \n coherence length = lambda^2/delta_lambda.\n")
printf("\n The ratio of coherence length of mercury vapour lamp to the coherence length of He Ne laser = 1:%d. ",1/R)
```

Scilab code Exa 1.6 Calculation of Coherence length of laser

```
clc
// Given that
band_width = 3000 // band width of laser in hertz
 // Sample Problem 6 on page no. 1.42
```

```
printf("\n # PROBLEM 6 # \n")
printf("\n Standard formula used \n delta_L = c*delta_t. \n")
coherence_length = (3 * 10 ^ 8) / band_width// calculation for coherence length
printf("\n Coherence length of laser = %e meter.", coherence_length)
```

Scilab code Exa 1.7 Calculation of Coherence length of monochromatic light and band width and line width

```
clc
// Given that
lambda = 6.328e-7 // wavelength of monochromatic light in meter
t = 1e-10 // chopping time in sec
// Sample Problem 7 on page no. 1.42
printf("\n # PROBLEM 7 # \n")
coherence_length = (3 * 10 ^ 8) * t // calculation for coherence length of monochromatic light
band_width = 1 / t // calculation for band width
line_width = ((lambda ^ 2) * band_width) / (3 * 10 ^ 8) // calculation for line width
printf("\n Standard formula used \n coherence_length = (3 * 10 ^ 8) * t. \n line_width = ((lambda ^ 2) * band_width) / (3 * 10 ^ 8). \n")
printf("\n Coherence length of monochromatic light = %e meter. \n band width = %e Hz. \n line width = %f A.",coherence_length, band_width, line_width*1e10)
```

Scilab code Exa 1.8 Calculation of Coherence time of red cadmium line and Spectral line width

```
clc
// Given that
lambda = 6.438e-7 // wavelength of red cadmium line in meter
L = 3.8e-1 // coherence length in meter
// Sample Problem 8 on page no. 1.42
printf("\n # PROBLEM 8 # \n")
printf("\n Standard formula used \n delta_L = c*delta_t. \n")
coherence_time = L / (3 * 10 ^ 8)// calculation for coherence time
spectral_line_width = (lambda ^ 2) / L // calculation for spectral line width
printf("\n Coherence time of red cadmium line = %e sec. \n Spectral line width = %e meter.", coherence_time,spectral_line_width)
```

Scilab code Exa 1.9 Calculation of Ratio of maximum intensity with minimum intensity

```
clc
// Given that
ratio = 16 // ratio of intensities of two waves
// Sample Problem 9 on page no. 1.43
printf("\n # PROBLEM 9 # \n")
```

```
printf("\n Standard formula used \n I = k*a^2. \n")
a1 = sqrt(ratio) // by the formula amplitude = sqrt(intensity)
a2 = 1
R = ((a1 + a2) ^ 2) / ((a1 - a2) ^ 2)// calculation for ratio of maximum intensity with minimum intensity
printf("\n Ratio of maximum intensity with minimum intensity = %f",R)
```

Scilab code Exa 1.10 Calculation of Wavelength of light

```
clc
// Given that
d = 0.0001 // distance between two slits in meter
Beta = 0.005 // width of the fringes formed in meter
D = 1 // distance between slit and screen in meter
// Sample Problem 10 on page no. 1.43
printf("\n # PROBLEM 10 # \n")
lambda = (Beta * d) / D // calculation for wavelength of light = %e meter
printf("\n Standard formula used \n lambda = (Beta * d) / D.\n")
printf("\n Wavelength of light = %f A. ",lambda*1e10)
```

Scilab code Exa 1.11 Calculation of Fringe width

```
clc
```

```
// Given that
alpha = %pi / 180 // angle of bi prism in radian
mu = 1.5 // refractive index of biprism
a = 0.4 // distance of bi prism from slit in meter
b = 0.6 // distance of bi prism from screen in meter
lambda = 5.893e-7 // wavelength of light in meter
// Sample Problem 11 on page no. 1.43
printf("\n # PROBLEM 11 # \n")
D = a + b // calculation for distance between slits
    and screen
fringe_width = (lambda * D) / (2 * a * (mu - 1) *
    alpha) // calculation for fringe width
printf("\n Standard formula used \nD = a + b.\n
    fringe_width = (lambda * D) / (2 * a * (mu - 1) *
     alpha).\n ")
printf("\n Fringe width = %e meter.",fringe_width)
```

Scilab code Exa 1.12 Calculation of Fringe width

```
clc
// Given that
d1 = 4.05e-3 // distance between slits in first
    position in meter
d2 = 2.90e-3 // distance between slits in second
    position in meter
lambda = 5.893e-7 // wavelength of light in meter
D = 1 // distance between slit and screen
// Sample Problem 12 on page no. 1.44
printf("\n # PROBLEM 12 # \n")
d = sqrt(d1 * d2)// calculation for distance between
     fringe
fringe_width = (lambda * D) / d // calculation for
    fringe width
```

```
printf("\n Standard formula used \n d = sqrt(d1*d2),\n beta = lambda*D/d \n")
printf("\n Fringe width = %f mm",fringe_width*1000)
```

Scilab code Exa 1.13 Calculation of Thickness of glass

```
clc
// Given that
fringe_width = 3.42e-4 // fringe width in meter
mu = 1.542 // refractive index of glass
Xn = 2.143e-3 // shift of central fringe in meter
lambda = 5.89e-7 // wavelength of light in meter
// Sample Problem 13 on page no. 1.44
printf("\n # PROBLEM 13 # \n")
n = Xn / fringe_width // calculation for order of the fringe
t = (floor(n) * lambda) / (mu - 1) // calculation for thickness of the glass
printf("\n Standard formula used \n (mu - 1)*t = n*lambda \n")
printf("\n Thickness of glass sheet = %e meter. ",t)
```

Scilab code Exa 1.14 Calculation of Distance between coherent sources

```
clc
// Given that
fringe_width = 9e-4 // fringe width in meter
a = 0.1 // distance of bi prism from slit in meter
b = 0.9 // distance of bi prism from screen in meter
```

```
lambda = 5.896e-7 // wavelength of light in meter
// Sample Problem 14 on page no. 1.45
printf("\n # PROBLEM 14 # \n")
D = a + b // calculation for distance between slits
    and screen
d = (lambda * D) / fringe_width // calculation for
    distance between coherent sources
printf("\n Standard formula used \n D = a + b. \n d
    = (lambda * D) / fringe_width.\n")
printf("\n Distance between coherent sources = %e
    meter. ",d)
```

Scilab code Exa 1.15 Calculation of Wavelength of light

```

clc
// Given that
fringe_width = 1.35e-2 // fringe width in meter
a = 0.5 // distance of bi prism from slits in meter
b = 0.5 // distance of bi prism from screen in meter
mu = 1.5 // refractive index of bi prism
alpha = %pi / 360 // angle of bi prism in radian
// Sample Problem 15 on page no. 1.45
printf("\n # PROBLEM 15 # \n")
D = a + b // calculation for distance between slits
    and screen
lambda = (2 * a * (mu - 1) * alpha * fringe_width) /
     D // calculation for wavelength of light = %e
    meter
printf("\n Standard formula used \n D = a + b. \
    nlambda = (2 * a * (mu - 1) * alpha *
    fringe_width) / D.\n ")
printf("\n Wavelength of light = %f A. ",lambda*1e10
```

```
)
//Answer in the book:5893 A
//Answer in the program:589048.622541 A
```

Scilab code Exa 1.16 Calculation of Wavelength of light

```
clc
// Given That
a = 0.45 // distance between slit and bi prism in
    meter
b = 0.45 // distance between screen and bi prism in
    meter
alpha = %pi / 180 // angle of bi prism in radian
Mu = 1.5 // refractive index of bi prism
fringe_width = 1.56e-4 // fringe width in meter
// Sample Problem 16 on page no. 1.45
printf("\n # PROBLEM 16 # \n")
D = a + b // calculation for distance between screen
    and slit
lambda = (fringe_width * 2 * a * (Mu - 1) * alpha) /
    D // calculation for wavelength
printf("\n Standard formula used \n lambda = (2a*(mu
    -1)*alpha*beta)/D. \n")
printf("\n Wavelength of light = %f A.", lambda*1e10
    )
```

Scilab code Exa 1.17 Calculation of Wavelength of light

```
clc
```

```
// Given That
D = 1.20 // distance between source and eye piece in
     meter
Xn = 1.9e-2 // distance move by eye piece for 20
    fringe in meter
n = 20 // no. of fringes
d = 6e-4 // distance between slits in meter
// Sample Problem 17 on page no. 1.45
printf("\n # PROBLEM 17 # \n")
lambda = (Xn * d) / (D * n)// calculation for
    wavelength
printf("\n Standard formula used \n beta = lambda*D/
    d.")
printf("\n Wavelength of light = %f A.", lambda*1e10
    )
```

Scilab code Exa 1.18 Calculation of No of fringes observed in field of view in second case

```
clc
// Given That
lambda1 = 5.890e-7 // wavelength of first light in
    meter
lambda2 = 4.358e-7 // wavelength of second light in
    meter
n1 = 40 // no. of fringes observed in the field of
    in first case
// Sample Problem 18 on page no. 1.46
printf("\n # PROBLEM 18 # \n")
n2 = (n1 * lambda1) / lambda2 // by using formula n1
    *lambda1=n2*lambda2
printf("\n Standard formula used \n n1*lambda1=n2*
    lambda2. \n")
```

```
printf("\n No. of fringes observed in field of view
    in second case = %d. ", floor(n2))
```

Scilab code Exa 1.19 Calculation of Least thickness of soap film

```
clc
// Given That
lambda = 5.893e-7 // wavelength of light in meter
Mu = 1.42 // refractive index of soap film
i = 0 // incidence angle in radian
r = 0 // refracted angle in radian
// Sample Problem 19 on page no. 1.46
printf("\n # PROBLEM 19 # \n")
n = 1 // for smallest thickness
t1 = ((2 * n - 1) * lambda) / (4 * Mu * cos(r)) //
    calculation for east thickness of soap film for
    bright fringe
t2 = (n * lambda) / (2 * Mu * cos(r)) // calculation
     for east thickness of soap film for dark fringe
printf("\n Standard formula used \n thickness for
    bright fringe = ((2 * n - 1) * lambda) / (4 * Mu
    * cos(r)). \n thickness for dark fringe = (n *
    lambda) / (2 * Mu * cos(r)).\n ")
printf("\n Least thickness of soap film -\n (a) For
    bright fringe = %e mm. \n (b) For dark fringe =
    %e mm.",t1*1000,t2*1000)
```

Scilab code Exa 1.20 Calculation of Thickness of oil film

```
clc
// Given That
lambda = 5.89e-7 // wavelength of light in meter
Mu_o = 1.4 // refractive index of oil film
Mu_w = 1.33 // refractive index of water
i = %pi / 6 // incidence angle in radian
n = 6 // no. of fringes seen
// Sample Problem 20 on page no. 1.46
printf("\n # PROBLEM 20 # \n")
r = asin(sin(i) / Mu_o) // calculation for angle of refraction
t = (n * lambda) / (2 * Mu_o * cos(r)) // calculation for thickness of film
printf("\n Standard formula used \n mu = sin(i)/sin(r),\n 1*mu*t*cos(r) = n*lambda. \n")
printf("\n Thickness of oil film = %e mm.",t*1000)
```

Scilab code Exa 1.21 Calculation of Least thickness of soap film for bright fringe

```
clc
// Given That
lambda = 6e-7 // wavelength of light in meter
Mu = 1.463 // refractive index of soap film
i = 0 // incidence angle in radian
r = 0 // refracted angle in radian
// Sample Problem 21 on page no. 1.47
printf("\n # PROBLEM 21 # \n")
n = 1 // for smallest thickness
t = ((2 * n - 1) * lambda) / (4 * Mu * cos(r)) // calculation for least thickness of soap film for bright fringe
printf("\n Standard formula used \n t = ((2 * n - 1)
```

```
    * lambda) / (4 * Mu * cos(r)).\n")
printf("\n Least thickness of soap film for bright
    fringe = %e mm. ",t*1000)
```

Scilab code Exa 1.22 Calculation of Thickness of oil film

```
clc
// Given That
lambda = 5.89e-7 // wavelength of light
Mu_o = 1.46 // refractive index of oil film
i = %pi / 6 // incidence angle in radian
n = 8 // no. of fringe is seen
// Sample Problem 22 on page no. 1.47
printf("\n # PROBLEM 22 # \n")
r = asin(sin(i) / Mu_o) // calculation for angle of
    refraction
t = (n * lambda) / (2 * Mu_o * cos(r)) //
    calculation for thickness of oil film
printf("\n Standard formula used \n r = asin(sin(i)
    / Mu_o.\n t = (n * lambda) / (2 * Mu_o * cos(r))
    .\n")
printf("\n  Thickness of oil film = %e mm. ",t*1000)
```

Scilab code Exa 1.23 Calculation of No of dark bands seen between wavelengths

```
clc
// Given That
lambda1 = 4e-7 // max. wavelength of light in meter
```

```
lambda2 = 5e-7 // min. wavelength of light in meter
Mu = 1.4 // refractive index of soap film
i = %pi / 4 // incidence angle in radian
t = 1e-5 // thickness of oil film in meter
// Sample Problem 23 on page no. 1.47
printf("\n # PROBLEM 23 # \n")
r = asin(sin(i) / Mu) // calculation for angle of refraction
n1 = (2 * Mu * t * cos(r)) / lambda1 // calculation for no. of dark bands seen in the case of max. wavelength
n2 = (2 * t * Mu * cos(r)) / lambda2 // calculation for no. of dark seen in the case of min. wavelength
n = floor(n1) - floor(n2) // claculation for no. of dark bands seen between wavelengths
printf("\n Standard formula used \n r = asin(sin(i) / Mu).\n n = (2 * Mu * t * cos(r)) / lambda.\n")
printf("\n No. of dark bands seen between wavelengths. = %d",n)
```

Scilab code Exa 1.24 Calculation of Least thickness of soap film for bright fringe

```
clc
// Given That
lambda = 5.89e-7 // wavelength of light in meter
Mu = 1.5 // refractive index of soap film
r = %pi / 3 // refracted angle in radian
// Sample Problem 24 on page no. 1.48
printf("\n # PROBLEM 24 # \n")
n = 1 // for smallest thickness
t = (n * lambda) / (2 * Mu * cos(r)) // calculation
```

```
for least thickness of soap film for bright fringe
printf("\n Standard formula used \n t = (n * lambda) / (2 * Mu * cos(r)).\n")
printf("\n Least thickness of soap film for bright fringe = %e meter. ",t)
```

Scilab code Exa 1.25 Calculation of Thickness of the film

```
clc
// Given That
lambda1 = 6.1e-7 // max. wavelength of light in meter
lambda2 = 6e-7 // min. wavelength of light in meter
Mu = 1.333 // refractive index of  film
i = %pi / 4 // incidence angle in radian
// Sample Problem 25 on page no. 1.48
printf("\n # PROBLEM 25 # \n")
r = asin(sin(i) / Mu) // calculation for angle of refraction
n = lambda2 / (lambda1 - lambda2) // calculation for no. of bright band
t = (n * lambda1) / (2 * Mu * cos(r)) // calculation for thickness of the film
printf("\n Standard formulae used \n r = asin(sin(i) / Mu).\n n = lambda2 / (lambda1 - lambda2).\n t = (n * lambda1) / (2 * Mu * cos(r)).\n")
printf("\n Thickness of the film = %e meter. ",t)
```

Scilab code Exa 1.26 Calculation of Least thickness of soap film for bright fringe

```
clc
// Given That
lambda = 6e-7 // wavelength of light in meter
Mu = 1.463 // refractive index of soap film
i = 0 // incidence angle in radian
r = 0 // refracted angle in radian
// Sample Problem 26 on page no. 1.49
printf("\n # PROBLEM 26 # \n")
n = 1 // for smallest thickness
t = ((2 * n - 1) * lambda) / (4 * Mu * cos(r)) // calculation for thickness of soap film
printf("\n Standard formula used \n 2*mu*t*cos(r)=(2n-1)*lambda/2. \n")
printf("\n Least thickness of soap film for bright fringe = %e meter. ",t)
```

Scilab code Exa 1.27 Calculation of Thickness of the film

```
clc
// Given That
lambda1 = 6.1e-7 // max. wavelength of light in meter
lambda2 = 6e-7 // min. wavelength of light in meter
Mu = 4 / 3 // refractive index of film
i = asin(4 / 5) // incidence angle in radian
// Sample Problem 27 on page no. 1.49
printf("\n # PROBLEM 27 # \n")
r = asin(sin(i) / Mu) // calculation for angle of refraction
n = lambda2 / (lambda1 - lambda2) // calculation for
```

```
order of fringe
t = (n * lambda1) / (2 * Mu * cos(r)) // calculation for thickness of film
printf("\n Standard formula used \n mu = sin(i)/sin(r),\n 2*mu*t*cos(r) = n*lambda. \n")
printf("\n Thickness of the film = %e mm. ",t*1000)
```

Scilab code Exa 1.28 Calculation of Thickness of wire

```
clc
// Given That
lambda = 5.893e-7 // wavelenth of light in meter
n = 20 // no. of interference fringes are observed
Mu = 1 // refractive index of air
i = 0 // incidence angle in radian
r = 0 // refracted angle in radian
// Sample Problem 28 on page no. 1.50
printf("\n # PROBLEM 28 # \n")
t = (n * lambda) / (2 * Mu) // calculation for thickness of fringe
printf("\n Standard formula used \n w = lambda/(2*mu*theta).\n")
printf("\n  Thickness of wire = %e mm. ",t*1000)
```

Scilab code Exa 1.29 Calculation of Fringe width

```
clc
// Given That
lambda = 6e-7 // wavelength of light in meter
```

```
Mu = 1 // refractive index of air film
l = 6e-5 // diameter of wire in meter
L = 0.15 // distance of wire from edge in meter
i = 0 // incidence angle in radian
r = 0 // refracted angle in radian
// Sample Problem 29 on page no. 1.50
printf("\n # PROBLEM 29 # \n")
theta = l / L //calculation for theta
fringe_width = lambda / (2 * Mu * theta) //
    calculation for fringe width
printf("\n Standard formula used \n w = lambda/(2*mu
    *theta).\n")
printf("\n Fringe width = %f mm.",fringe_width*1000)
```

Scilab code Exa 1.30 Calculation of Fringe width

```
clc
// Given That
lambda = 4.56e-7 // wavelength of light in meter
theta = 1.9e-4 // angle of wedge in radian
Mu = 1 // refractive index of air
// Sample Problem 30 on page no. 1.51
printf("\n # PROBLEM 30 # \n")
fringe_width = lambda / (2 * Mu * theta)//
    calculation for fringe width
printf("\n Standard formula used \n w = lambda/(2*mu
    *alpha).\n")
printf("\n Fringe width = %f mm.",fringe_width*1000)
```

Scilab code Exa 1.31 Calculation of Fringe width

```
clc
// Given That
lambda = 6e-7 // wavelength of light in meter
Mu = 1 // refractive index of air film
l = 3e-5 // diameter of wire in meter
L = 0.15 // distance of wire from edge in meter
i = 0 // incidence angle in radian
r = 0 // refracted angle in radian
// Sample Problem 31 on page no. 1.51
printf("\n # PROBLEM 31 # \n")
theta = l / L // calculation for theta
fringe_width = lambda / (2 * Mu * theta) //
    calculation for fringe width
printf("\n Standard formula used \n w = lambda/ (2*
    mu*theta).\n")
printf("\n Fringe width = %f mm.",fringe_width*1000)
```

Scilab code Exa 1.32 Calculation of Distance

```
clc
// Given That
lambda = 5.890e-7 // wavelength of light in meter
theta = 1e-2 // angle of wedge in radian
n = 12 // no. of dark fringe
Mu = 1 // refractive index of air
i = 0 // incidence angle in radian
r = 0 // refracted angle in radian
// Sample Problem 32 on page no. 1.51
printf("\n # PROBLEM 32 # \n")
x = ( n * lambda) / (2 * theta) // calculation for
    distance
```

```
printf("\n Standard formula used \n x = n*lambda/(2*theta).\n")
printf("\n Distance = %f mm. ",x*1000)
```

Scilab code Exa 1.33 Calculation of Angle of wedge

```
clc
// Given That
lambda = 5.5e-7 // wavelength of light in meter
w = 2e-5 // fringe width in meter
Mu = 1.5 // refractive index of film
i = 0 // incidence angle in radian
r = 0 // refracted angle in radian
// Sample Problem 33 on page no. 1.52
printf("\n # PROBLEM 33 # \n")
theta = lambda / (2 * Mu * w)// calculation for the angle of the film
printf("\n Standard formula used \n w = lambda/(2*mu*theta).\n")
printf("\n Angle of wedge = %f degree. ",theta * 180/ %pi)
```

Scilab code Exa 1.34 Calculation of Wavelength of light

```
clc
// Given That
d1 = 5.9e-3 // diameter of 15th ring in meter
d2 = 3.36e-3 // diameter of 5th ring in meter
R = 1 // redius of the plano-convex lens in meter
```

```
// Sample Problem 34 on page no. 1.52
printf("\n # PROBLEM 34 # \n")
p = 15 - 5
lambda = ((d1^2) - (d2^2)) / (4 * p * R) //
    calculation for wavelength of light
printf("\n Standard formula used \n lambda = (d1^2-
    d2^2)/(4*p*R).\n")
printf("\n Wavelength of light = %f A.",lambda*1e10)
```

Scilab code Exa 1.35 Calculation of Wavelength of light

```

clc
// Given That
d1 = 2e-3 // diameter of 10th ring in meter
d2 = 3e-3 // diameter of 20th ring in meter
f = 0.9 // focal length of the plano-convex lens in
    meter
mu = 1.5 // refractive index of lens
// Sample Problem 35 on page no. 1.52
printf("\n # PROBLEM 35 # \n")
p = 20 - 10
R = (f * (mu - 1)) // calculation for radius of
    convex surface of lens
lambda = ((d2^2) - (d1^2)) / (4 * p * R)
printf("\n Standard formula used \n lambda = ((d2^2)
     - (d1^2)) / (4 * p * R).\n")
printf("\n Wavelength of light = %f nm.",lambda*1e9)
//Answer in the book:2777 nm
//Answer in the program:277.77778 nm
```

Scilab code Exa 1.36 Calculation of Diameter of 7th bright ring

```
clc
// Given That
lambda = 5.896e-7 // wavelength of light in meter
f = 1 // focal length of the plano-convex lens in meter
mu = 1.5 // refractive index of lens
n = 7 // no. of bright ring
// Sample Problem 36 on page no. 1.53
printf("\n # PROBLEM 36 # \n")
p = 20 - 10
R = (f * (mu - 1)) * 2 // calculation for radius of lens
D = sqrt(4 * n * lambda * R) // calculation for diameter of 7th ring
printf("\n Standard formula used \n Dn^2 = 4n*lambda*R. \n")
printf("\n Diameter of 7th bright ring = %e meter.", D)
```

Scilab code Exa 1.37 Calculation of Diameter of dark ring

```
clc
// Given That
lambda1 = 6e-7 // wavelength of first light in meter
lambda2 = 4.8e-7 // wavelength of second light in meter
```

```
r = 0.96 // radius of curvature of curved surface of lens in meter
// Sample Problem 37 on page no. 1.53
printf("\n # PROBLEM 37 # \n")
n = lambda2 / (lambda1 - lambda2) // calculation for order of fringe
D = sqrt(4 * (n + 1) * lambda2 * r) // calculation for diameter of ring
printf("\n Standard formula used \n n^2 = 4n*lambda*R. \n")
printf("\n Diameter of (n +1)th dark ring of lambda2. = %e meter.",D)
```

Scilab code Exa 1.38 Calculation of Diameter of nth dark ring

```
clc
// Given That
lambda1 = 6e-7 // wavelength of first light in meter
lambda2 = 5.9e-7 // wavelength of second light in meter
r = 0.9 // radius of curvature of curved surface of lens in meter
// Sample Problem 38 on page no. 1.54
printf("\n # PROBLEM 38 # \n")
n = lambda2 / (lambda1 - lambda2) // calculation for order of ring
D = sqrt(4 * (n + 1) * lambda1 * r) // calculation for diameter of ring
printf("\n Standard formula used \n n^2 = 4n*lambda*R.\n")
printf("\n Diameter of nth dark ring of lambda1 = %f meter.",D)
```

Scilab code Exa 1.39 Calculation of Refractive index of liquid

```
clc
// Given That
lambda = 5.896e-7 // wavelength of light in meter
D = 4e-3 // diameter of 7th brighter fringe in m
R = 1 // radius of curvature in m
// Sample Problem 39 on page no. 1.54
printf("\n # PROBLEM 39 # \n")
n = 7 // for seventh brighter fringe
mu = 2*(2*n-1)*lambda*R / D^2 // calculation for
    refractive index of liquid
printf("\n Standard formula used \n mu = 2*(2*n-1)*
    lambda*R / D^2.\n")
printf("\n Refractive index of liquid = %f.",mu)
```

Scilab code Exa 1.40 Calculation of Refractive index of liquid

```
clc
// Given That
D1 = 3e-3 // diameter of nth dark fringe when liquid
     is absent between the lens and the plate in m
D2 = 2.5e-3 // diameter of nth dark fringe when
    liquid is introduced between the lens and the
    plate in m
c = 3e8 // velocity of light in vacuum in m/sed
// Sample Problem 40 on page no. 1.54
printf("\n # PROBLEM 40 # \n")
```

```
mu = D1^2 / D2^2// calculation for refractive index
v = 3e8 / mu // calculation for velocity of light
printf("\n Standard formula used \n mu = D1^2 / D2^2. \n v = 3e8 / mu. \n")
printf("\n Refractive index of liquid = %f.\n velocity of light in the liquid = %e m/sec.",mu,v)
```

Scilab code Exa 1.41 Calculation of Refractive index of liquid

```
clc
// Given That
lambda = 5.896e-7 // wavelength of light in meter
D = 5.1e-3 // diameter of 16th brighter fringe in m
R = 1 // radius of curvature in m
// Sample Problem 41 on page no. 1.55
printf("\n # PROBLEM 41 # \n")
n = 16 // for sixteenth brighter fringe
mu = 4*n*lambda*R / D^2 // calculation for refractive index of liquid
printf("\n Standard formula used \n mu = 4*n*lambda*R / D^2.\n")
printf("\n Refractive index of liquid = %f.",mu)
```

Scilab code Exa 1.42 Calculation of The radius of smallest dark ring

```
clc
// Given That
lambda = 6.3e-7 // wavelength of light in meter
```

```
mu = 1.63 // refractive index of liquid
R = 0.9 // the radius of curvature of convex lens in
    meter
// Sample Problem 42 on page no. 1.55
printf("\n # PROBLEM 42 # \n")
r = sqrt(lambda*R/mu) // calculation for the radius
    of smallest dark ring
printf("\n Standard formula used \n r = sqrt(n*
    lambda*R/mu). \n")
printf("\n The radius of smallest dark ring = %f mm.
    ",r*1000)
```

Scilab code Exa 1.43 Calculation of the ratio refractive index of media

```
clc
// Given That
r = 10/7 // ratio of nth ring diameter for two media
// Sample Problem 43 on page no. 1.55
printf("\n # PROBLEM 43 # \n")
R = (1/r)^2 // calculation for the ratio of
    refractive index of media
printf("\n Standard formula used \n mu1/mu2 = D2/D1.
    \n")
printf("\n the ratio refractive index of media = %f
    :100.",R*100)
```

Scilab code Exa 1.44 Calculation of Wavelength of light

```
clc
```

```
// Given That
R = 0.9 // radius of curvature of the lower face of
    the lens in meter
D = 4.8e-3 // diameter of the 10th dark ring in
    meter
// Sample Problem 44 on page no. 1.56
printf("\n # PROBLEM 44 # \n")
n = 10 // for 10th dark ring
lambda = D^2 / (4 * n * R) // calculation for
    wavelength of light
printf("\n Standard formula used \n lambda = D^2 /
    (4 * n * R). \n")
printf("\n Wavelength of light = %f A.",lambda * 1
    e10)
```

Scilab code Exa 1.45 Calculation of Refractive index of liquid

```
clc
// Given That
r = 1/2 // ratio of 5th ring diameter when no liquid
     between plane glass plate and convex lens and
    when the liquid between glass plate and convex
    lens
// Sample Problem 45 on page no. 1.56
printf("\n # PROBLEM 45 # \n")
R = (1/r)^2 // calculation for refractive index of
    liquid
printf("\n Standard formula used \n mu1/mu2 = D2/D1.
     \n")
printf("\n Refractive index of liquid = %f. ",R)
```

Scilab code Exa 1.46 Calculation of Distance between 5th and 15th dark ring

```
clc
// Given That
R = 1 // radius of curvature of lens of both side in meter
lambda = 5.4e-7 // wavelength of monochromatic light in meter
// Sample Problem 46 on page no. 1.56
printf("\n # PROBLEM 46 # \n")
n1 = 5 // for 5th dark ring
n2 = 15 // for 10th dark ring
r1 = sqrt((n1*lambda)/(1/R + 1/R)) // calculation for radius of 5th dark ring
r2 = sqrt((n2*lambda)/(1/R + 1/R)) // calculation for radius of 15th dark ring
d = r2 - r1 // calculation for distance between 5th and 15th dark ring
printf("\n Standard formula used \n r = sqrt((n*lambda)/(1/R + 1/R)). \n")
printf("\n Distance between 5th and 15th dark ring = %f cm.",d * 100)
```

Scilab code Exa 1.47 Calculation of Refractive index of mica

```
clc
// Given That
```

```
x = 2.5e-5 // distance moved by movable mirror in
    meter
t = 5e-5 // thickness of mica sheet in meter
// Sample Problem 47 on page no. 1.57
printf("\n # PROBLEM 47 # \n")
mu = x / t + 1 // calculation for refractive index
    of mica
printf("\n Standard formula used \n mu = x / t + 1.
    \n")
printf("\n Refractive index of mica = %f.",mu)
```

Scilab code Exa 1.48 Calculation of Wavelength of light

```
clc
// Given That
x = 6e-5 // distance moved by movable mirror in
    meter
N = 200 // no. of fringes crossed the field of view
// Sample Problem 48 on page no. 1.57
printf("\n # PROBLEM 48 # \n")
lambda = (2 * x) / N // calculation for wavelength
    of light
printf("\n Standard formula used \n lambda = (2 * X)
     / N. \n")
printf("\n Wavelength of light = %f A.",lambda * 1
    e10)
```

Scilab code Exa 1.49 Calculation of Thickness of the plate

```
clc
// Given That
n = 50 // no. of bands crosses the line of observation
lambda = 5.896e-7 // wavelength of light in meter
mu = 1.4 // refractive index
// Sample Problem 49 on page no. 1.57
printf("\n # PROBLEM 49 # \n")
t = n*lambda / (2*(mu-1)) // calculation for thickness of the plate
printf("\n Standard formula used \n t = n*lambda/2*(mu-1)\n")
printf("\n Thickness of the plate = %e m.",t)
```

Scilab code Exa 1.50 Calculation of The path difference

```
clc
// Given That
n = 50 // no. of bands crosses the line of observation
lambda1 = 5.896e-7 // max. wavelength of light in meter
lambda2 = 5.89e-7 // min. wavelength of light in meter
// Sample Problem 50 on page no. 1.57
printf("\n # PROBLEM 50 # \n")
x = lambda1 * lambda2 /(lambda1 - lambda2) // calculation for the path difference
printf("\n Standard formula used \n t = n*lambda/2*(mu-1)\n")
printf("\n The path difference = %f mm.",x*10^3)
```

Scilab code Exa 1.51 Calculation of Wavelength of monochromatic light

```
clc
// Given That
x = 2.948e-5 // distance moved by movable mirror in
    meter
n = 100 // no. of fringes cross the field of view
// Sample Problem 51 on page no. 1.58
printf("\n # PROBLEM 51 # \n")
lambda = 2*x/n // calculation for wavelength of
    monochromatic light
printf("\n Standard formula used \n lambda = 2*x/n.
    \n")
printf("\n Wavelength of monochromatic light = %f A.
    ",lambda * 1e10)
```

Scilab code Exa 1.52 Calculation of The distance through which the movable mirror is move

```
clc
// Given That
lambda1 = 5.896e-7 // max. wavelength of light in
    meter
lambda2 = 5.89e-7 // min. wavelength of light in
    meter
// Sample Problem 52 on page no. 1.58
printf("\n # PROBLEM 52 # \n")
```

```
x = lambda1 * lambda2 /(2*(lambda1 - lambda2)) //
    calculation for the path difference
printf("\n Standard formula used \n x = lambda1 *
    lambda2 /2*(lambda1 - lambda2).\n")
printf("\n The distance through which the movable
    mirror is move = %f mm.",x*10^3)
```

Scilab code Exa 1.53 Calculation of Difference between two wavelengths

```
clc
// Given That
x = 2.945e-4 // distance moved by movable mirror in
    meter
lambda = 5.893e-7 // mean wavelength of light in
    meter
// Sample Problem 53 on page no. 1.58
printf("\n # PROBLEM 53 # \n")
delta_lambda = lambda^2 / (2*x) // calculation for
    difference between two wavelengths
printf("\n Standard formula used \n delta_lambda =
    lambda^2 / (2*x). \n")
printf("\n Difference between two wavelengths = %f A
    .",delta_lambda*1e10)
```

Scilab code Exa 1.54 Calculation of Refractive index of gas

```
clc
// Given That
n = 140 // no. of shift in fringe
```

```
lambda = 5.46e-7 // wavelength of light in meter
t = 0.2 // length of tube in meter
// Sample Problem 54 on page no. 1.58
printf("\n # PROBLEM 54 # \n")
mu = (n*lambda)/(2*t) + 1 // calculation for
    refractive index of gas
printf("\n Standard formula used \n mu = (n*lambda)
    /(2*t) + 1. \n")
printf("\n  Refractive index of gas = %f.",mu)
```

Chapter 2

DIFFRACTION

Scilab code Exa 2.1 Calculation of Radius of half period zone and Area of half period zone

```
clc
// Given that
lambda = 5e-7 // wavelength of light in meter
d = 1 // distance of wavefront received on the
    screen from the opening in meter
n = 80 // no. of half period zone
// Sample Problem 1 on page no. 2.38
printf("\n # PROBLEM 1 # \n")
Rn = sqrt(n * lambda * d)// calculation for radius
    of nth half period zone
A = %pi * d * lambda// calculation for area of half
    period zone
printf("Standard formula used\n Rn = sqrt(n*d*lambda
    ).\n A = pi*d*lambda.\n")
printf("\n Radius of 80th half period zone = %f cm.
    \n Area of half period zone = %f square cm.",Rn
    *100,A*10000)
```

Scilab code Exa 2.2 Calculation of Radius of half period zone

```
clc
// Given that
lambda = 6e-7 // wavelength of light in meter
f = 0.6 // focal length of convex lens in meter
n = 1 // no. of half period zone
// Sample Problem 2 on page no. 2.38
printf("\n # PROBLEM 2 # \n")
Rn = sqrt(n * lambda * f)// calculation for radius
    of half period zone
printf("Standard formula used \n f = Rn^2/(n*lambda)
    \n")
printf("\n Radius of  half period zone = %f mm ",Rn
    *1000)
```

Scilab code Exa 2.3 Calculation of Radius of half period zone

```
clc
// Given that
lambda = 5e-7 // wavelength of light in meter
d = 0.3 // distance of wavefront received on screen
    from the opening in meter
// Sample Problem 3 on page no. 2.38
printf("\n # PROBLEM 3 # \n")
n = 1 // no. of half period zone
Rn = sqrt(n * lambda * d) // because at maxima
    intensity is four time the individual intensity
```

```
of light
printf("Standard formula used \n r = sqrt(d*lambda)\n")
printf("\n Radius of 80th half period zone = %f mm.",Rn*1000)
```

Scilab code Exa 2.4 Calculation of No of half period zone

```
clc
// Given that
lambda = 6e-7 // wavelength of light in meter
d = 0.5 // distance of observation point from circular opening in meter
r1 = 2e-3 // radius of circular opening in first case in meter
r2 = 2e-2 // radius of circular opening in second case in meter
// Sample Problem 4 on page no. 2.39
printf("\n # PROBLEM 4 # \n")
n1 = (r1^2) / (d * lambda) // calculation for no. of half period zone in first case
n2 = (r2^2) / (d * lambda) // calculation for no. of half period zone in second case
printf("\n Standard formula used \n n = (r^2) / (d * lambda) \n")
printf("\n No. of half period zone in first case = %d \n no. of half period zone in second case = %d",n1,n2)
```

Scilab code Exa 2.5 Calculation of Distance of screen from opening

```
clc
// Given that
lambda = 5e-7 // wavelength of light in meter
d = 1e-3 // diameter of the first ring of zone plate in meter
// Sample Problem 5 on page no. 2.39
printf("\n # PROBLEM 5 # \n")
n = 1 // no. of half period zone
D = (d^2) / (4 * lambda * n) // calculation for distance of screen from opening
printf("\n Standard formula used \n D = (d^2) / (4 * lambda * n). \n")
printf("\n Distance of screen from opening = %f meter ",D)
```

Scilab code Exa 2.6 Calculation of Radius of first and second and third half period zone

```
clc
// Given that
lambda = 5.893e-7 // wavelength of light in meter
f = 1 // focal-length of convex lens in meter
n1 = 1 // no. of first half period zone
n2 = 3 // no. of second half period zone
n3 = 5 // no. of third half period zone
// Sample Problem 6 on page no. 2.40
printf("\n # PROBLEM 6 # \n")
R1 = sqrt(n1 * lambda * f) // calculation for Radius of first half period zone
R2 = sqrt(n2 * lambda * f) // calculation for Radius of second half period zone
```

```
R3 = sqrt(n3 * lambda * f) // calculation for Radius
    of third half period zone
printf("Standard formula used \n R = sqrt(f*n*lambda
   )\n")
printf("\n Radius of first ,second and third half
   period zone = %e,%e and %e meter. ",R1,R2,R3)
```

Scilab code Exa 2.7 Calculation of Radius of half period zone

```
clc
// Given that
lambda = 5e-7 // wavelength of light in meter
f = 0.2 // focal length of convex lens in meter
n = 10 // no. of half period zone
// Sample Problem 7 on page no. 2.40
printf("\n # PROBLEM 7 # \n")
Rn = sqrt(n * lambda * f) // calculation for radius
   of 10th half period zone
printf("\n Standard formula used \n Rn = sqrt(n *
   lambda * f).\n")
printf("\n Radius of 10th half period zone = %f mm.
   ",Rn*1000)
```

Scilab code Exa 2.8 Calculation of Focal length and Power and Diameter of first zone

```
clc
// Given that
lambda = 5.89e-7 // wavelength of light in meter
```

```
d1 = 1 // distance of wavefront recieved on the
    screen from the opening in first side in meter
d2 = 2 // distance of wavefront recieved on the
    screen from the opening in other side in meter
// Sample Problem 8 on page no. 2.40
printf("\n # PROBLEM 8 # \n")
f = (d1 * d2) / (d1 + d2)
p = 1 / f // beacause zone plate act as a convex
    lens
n = 1 // for first zone
Rn = sqrt(n * lambda * f) // calculation for radius
    of first zone
Dn = 2 * Rn // calculation for diameter of first
    zone
printf("\n Standard formula used \n ")
printf("\n Focal length = %f meter. \n Power = %f D.
    \n Diameter of first zone = %f mm. ",f,p,Dn
    *1000)
```

Scilab code Exa 2.9 Calculation of Focal length

```
clc
// Given that
lambda1 = 6e-7 // wavelength of first light in meter
lambda2 = 5e-7 // wavelength of second light in
    meter
f1 = 1 // focal length in first case in meter
// Sample Problem 9 on page no. 2.41
printf("\n # PROBLEM 9 # \n")
f2 = (lambda1 * f1) / lambda2 // calculation for
    focal length in second case
printf("\n Standard formula used \n f2 = (lambda1 *
    f1) / lambda2")
```

```
printf("\n Focal length in second case = %f meter",f2)
```

Scilab code Exa 2.10 Calculation of No of zone of Fresnel

```
clc
// Given that
lambda = 4e-7 // wavelength of light in meter
u = 0.2 // distance of object from zone plate in meter
v = 0.2 // distance of brightest image from from zone plate in meter
r = 0.01 // radius in meter
// Sample Problem 10 on page no. 2.41
printf("\n # PROBLEM 10 # \n")
f = (u * v) / (u + v) // calculation for focal length
n = (r^2) / (f * lambda) // calculation for no. of zone of Fresnel
printf("\n Standard formula used \n f = (u * v) / (u + v). \n n = (r^2) / (f * lambda).\n ")
printf("\n No. of zone of Fresnel = %f",n)
```

Scilab code Exa 2.11 Calculation of Distance of first image from zone plate

```
clc
// Given that
lambda = 5.893e-7 // wavelength of light in meter
```

```
d = 2.3e-3 // diameter of the central zone of zone plate in meter
u = 6 // distance between point source from zone plate in meter
// Sample Problem 11 on page no. 2.42
printf("\n # PROBLEM 11 # \n")
n = 1 // for central zone
f = (d^2) / (4 * lambda * n) // calculation for focal length
disp(f)
v = (f * u) / (u - f)  // calculation for distance of first image from zone plate
printf("\n Standard formula used \n f = (d^2) / (4 * lambda * n). \n v = (f * u) / (u - f). \n ")
printf("\n Distance of first image from zone plate = %f meter ",v)
```

Scilab code Exa 2.12 Calculation of Principal focal length of zone plate

```
clc
// Given that
R = 2 // radius of curvature in meter
// Sample Problem 12 on page no. 2.42
printf("\n # PROBLEM 12 # \n")
f = R // calculation for principal focal length of zone plate
printf("\n Standard formula used \n f = r^2 / lambda. \n r = sqrt(lambda*R). \n ")
printf("\n Principal focal length of zone plate = %f meter ",f)
```

Scilab code Exa 2.13 Calculation of Angular spread of the central maxima

```
clc
// Given that
lambda = 5.89e-7 // wavelength of light in meter
b = 1e-3 // slit-width in meter
// Sample Problem 13 on page no. 2.42
printf("\n # PROBLEM 13 # \n")
m = 1 // for first minima
theta = asin((m * lambda) / b) // calculation for
    angular spread of the central maxima in radian
theta_ = theta * (180 / %pi) // calculation for
    angular spread of the central maxima in degree
printf("\n Standard formula used \n theta = asin((m
    * lambda) / b).\n")
printf("\n Angular spread of the central maxima = %f
     degree ",2 * theta_)
```

Scilab code Exa 2.14 Calculation of Wavelength of light

```
clc
// Given that
d = 1.2 // distance of screen from slit in meter
x = 3.7e-3 // distance between first maxima to
    central maxima in meter
b = 2e-4 // slit-width in meter
// Sample Problem 14 on page no. 2.43
```

```
printf("\n # PROBLEM 14 # \n")
lambda = (x * b) / d // calculation for wavelength
    of light
printf("\n Standard formula used \n lambda = (x * b)
     / d.\n")
printf("\n Wavelength of light = %e meter. ",lambda)
```

Scilab code Exa 2.15 Calculation of Angular position of second and third minima

```
clc
// Given that
lambda = 5.5e-7 // wavelength of light in meter
b = 2.2e-6 // slit-width in meter
// Sample Problem 15 on page no. 2.43
printf("\n # PROBLEM 15 # \n")
m2 = 2 // for second minima
theta2 = asin((m2 * lambda) / b) * (180 / %pi) //
    calculation for angular position of second minima
m3 = 3 // for third minima
theta3 = asin((m3 * lambda) / b) * (180 / %pi) //
    calculation for angular position of third minima
printf("\n Standard formula used \n theta = asin((m
    * lambda) / b) * (180 / pi). \n")
printf("\n Angular position of second and third
    minima = %f , %f degree respectively ",theta2 ,
    theta3)
```

Scilab code Exa 2.16 Calculation of Half angular width of the central bright maxima

```
clc
// Given that
lambda = 5.89e-7 // wavelength of light in meter
b = 1.2e-6 // slit-width in meter
// Sample Problem 16 on page no. 2.44
printf("\n # PROBLEM 16 # \n")
m = 1 // for first minima
theta = asin((m * lambda) / b) // calculation for
    half angular width of the central bright maxima
    in radian
theta_ = theta * (180 / %pi) // calculation for half
     angular width of the central bright maxima in
    degree
printf("\n Standard formula used \n theta = asin((m
    * lambda) / b).\n")
printf("\n Half angular width of the central bright
    maxima = %f degree ",theta_)
```

Scilab code Exa 2.17 Calculation of Slit width

```
clc
// Given that
lambda = 5e-7 // wavelength of light in meter
theta = %pi / 6 // half angular width of central
    maximum in first case in radian
theta_ = %pi / 2 // half angular width of central
    maximum in second case in radian
// Sample Problem 17 on page no. 2.44
printf("\n # PROBLEM 17 # \n")
m = 1 // for first minima
```

```
b1 = (lambda * m) / sin(theta) // calculation for slit width in first case
b2 = (lambda * m) / sin(theta_) // calculation for slit width in second case
printf("\n Standard formula used \n b = (lambda * m) / sin(theta). \n")
printf("\n Slit width in first case = %e meter. \n Slit width in second case = %e meter",b1,b2)
```

Scilab code Exa 2.18 Calculation of Angular spread and linear width

```
clc
// Given that
lambda = 5.89e-7 // wavelength of light in meter
d = 1 // distance of screen from slit in meter
b = 1e-4 // slit-width in meter
// Sample Problem 18 on page no. 2.44
printf("\n # PROBLEM 18 # \n")
theta = (asin(lambda / b)) * (180 / %pi) // calculation for angular spread
x = (2 * d * lambda) / b// calculation for linear width
printf("\n Standard formula used \n theta = (asin(lambda / b)) * (180 / pi). \n x = (2 * d * lambda) / b. \n")
printf("\n Angular spread = %f degree\n Linear width = %e meter ",theta,x)
```

Scilab code Exa 2.20 Calculation of Angular width of the central maxima

```
clc
// Given that
lambda = 6e-7 // wavelength of light in meter
b = 1.2e-6 // slit-width in meter
// Sample Problem 20 on page no. 2.46
printf("\n # PROBLEM 20 # \n")
m = 1 // for first minima
theta = asin((m * lambda) / b) // calculation for
    angular width of the central maxima in radian
theta_ = theta * (180 / %pi) // calculation for
    angular width of the central maxima in degree
printf("\n Standard formula used \n theta = asin((m
    * lambda) / b). \n")
printf("\n Angular width of the central maxima = %f
    degree ",2 * theta_)
```

Scilab code Exa 2.21 Calculation of Separation of dark band

```
clc
// Given that
lambda = 4.890e-7 // wavelength of light in meter
b = 5e-3 // slit-width in meter
f = 0.4 // focal-length of convex lens in meter
// Sample Problem 21 on page no. 2.46
printf("\n # PROBLEM 21 # \n")
m = 1 // for first dark fringe
x = (f * m * lambda) / b
n = 1 // for first secondary maxima
x_ = ((2 * n + 1) * lambda * f) / (2 * b)
delta_x = x_ - x // calculation for separation of
    dark band
printf("\n Standard formula used \n x = (f * m *
    lambda) / b . \n delta_x = x_ - x. \n")
```

```
printf("\n Separation of dark band = %e meter.",
    delta_x)
```

Scilab code Exa 2.22 Calculation of Separation of dark band on either side of the central maximum

```
clc
// Given that
lambda = 5.893e-7 // wavelength of light in meter
b = 5e-4 // slit-width in meter
f = 1 // focal length of convex lens in meter
// Sample Problem 22 on page no. 2.47
printf("\n # PROBLEM 22 # \n")
x = (2 * lambda * f) / b // calculation for
    Separation of dark band on either side of the
    cenral maximum
printf("Standard formula used \n. \n")
printf("\n Separation of dark band on either side of
     the central maximum = %e meter",x)
```

Scilab code Exa 2.23 Calculation of Missing orders

```
clc
// Given that
d = 4e-4 // separation between slits in meter
b = 8e-5 // slit-width in meter
// Sample Problem 23 on page no. 2.47
printf("\n # PROBLEM 23 # \n")
r = (b + d) / b // calculation for ratio of n with m
```

```
m1 = 1
n1 = r * m1 // calculation for Missing orders
m2 = 2
n2 = r * m2 // calculation for Missing orders
m3 = 3
n3 = r * m3 // calculation for Missing orders
printf("\n Standard formula used \n r = (b + d) / b.
    \n n = r * m. \n")
printf("\n Missing orders = %d,%d,%d,......",n1,n2,
   n3)
```

Scilab code Exa 2.24 Calculation of Wavelength of light and Missing order

```
clc
// Given that
d = 4e-4 // separation between slits in meter
b = 2e-4 // slit-width in meter
fringe_width = 2.5e-3 // fringe width in meter
D = 1.6 // distance between screen and slits
// Sample Problem 24 on page no. 2.47
printf("\n # PROBLEM 24 # \n")
lambda = (fringe_width * d) / D // calculation for
   wavelength of light
r = (b + d) / b // calculation for ratio of n with m
m1 = 1
n1 = r * m1 // calculation for missing order
m2 = 2
n2 = r * m2 // calculation for missing order
m3 = 3
n3 = r * m3 // calculation for missing order
printf("\n Standard formula used \n lambda = (
   fringe_width * d) / D. \n r = (b + d) / b. \n n =
```

```
r * m. \n")
printf("\n Wavelength of light = %e meter. \n Missing order = %d,%d,%d....",lambda,n1,n2,n3)
```

Scilab code Exa 2.25 Calculation of Wavelength of light

```
clc
// Given that
N = 425000 // no. of lines in plane transmission grating per meter
theta = %pi / 6 // angle at which second order spectral line is observed in radian
n = 2 // order of spectral line
// Sample Problem 25 on page no. 2.48
printf("\n # PROBLEM 25 # \n")
lambda = sin(theta) / (2 * N) // calculation for wavelength of light
printf("\n Standard formula used \n lambda = sin(theta) / (2 * N). \n")
printf("\n Wavelength of light = %e meter. ",lambda)
```

Scilab code Exa 2.26 Calculation of Wavelength of light

```
clc
// Given that
N = 500000 // no. of lines in plane transmission grating per meter
theta = %pi / 6 // angle at which second order spectral line is observed in radian
```

```
n = 2 // order of spectral line
// Sample Problem 26 on page no. 2.48
printf("\n # PROBLEM 26 # \n")
lambda = sin(theta) / (2 * N) // calculation for wavelength of light
printf("\n Standard formula used \n lambda = sin(theta) / (2 * N). \n ")
printf("\n wavelength of light = %e meter. ",lambda)
```

Scilab code Exa 2.27 Calculation of Wavelength of light

```

clc
// Given that
lambda2 = 5.461e-7 // wavelength of  light in second case in meter
n1 = 4 // no. of order in first case
n2 = 3 // no. of order in second case
// Sample Problem 27 on page no. 2.48
printf("\n # PROBLEM 27 # \n")
lambda1 = (n2 * lambda2) / n1 // calculation for Wavelength of light in first case
printf("Standard formula used \n lambda1 = (n2 * lambda2) / n1. \n")
printf("\n Wavelength of light in first case = %d A",ceil(lambda1*1e10))
```

Scilab code Exa 2.28 Calculation of No of lines in per cm

```
clc
// Given that
lambda = 5e-7 // wavelength of light in meter
theta = %pi / 6 // angle at which second order
    spectral line is observed in radian
n = 2 // order of spectral line
// Sample Problem 28 on page no. 2.49
printf("\n # PROBLEM 28 # \n")
k = (n * lambda) / sin(theta) // calculation for (b+
    d)
N = 1 / k // calculation for no. of lines in per cm
printf("\n Standard formula used \n b+d = (n *
    lambda) / sin(theta). \n N = 1 / k. \n ")
printf("\n No. of lines per cm = %f ",N / 100)
```

Scilab code Exa 2.29 Calculation of Angle of separation

```
clc
// Given that
lambda1 = 5.048e-7 // wavelength of light in first
    case in meter
lambda2 = 5.016e-7 // wavelength of light in second
    case in meter
n = 2 // no. of order in first case
N = 15000 // no. of lines in grating per inch
// Sample Problem 29 on page no. 2.49
printf("\n # PROBLEM 29 # \n")
k = 2.54 / 1500000 // in meter
theta1 = asin(n * lambda1 / k) * (180 / %pi) //
    calculation for angle in first case
theta2 = asin(n * lambda2 / k) * (180 / %pi) //
    calculation for angle in second case
delta_theta = theta1 - theta2 // calculation for
```

```
angle of separation
printf("\n Standard formula used \n theta = asin(n * lambda / k) * (180 / pi). \n")
printf("\n Angle of separation = %f degree", delta_theta)
```

Scilab code Exa 2.30 Calculation of Angle of separation

```
clc
// Given that
lambda1 = 5.89e-7 // wavelength of  light in first case in meter
lambda2 = 5.896e-7 // wavelength of  light in second case in meter
n = 2 // no. of order in first case
N = 600000 // no. of lines in grating per meter
// Sample Problem 30 on page no. 2.50
printf("\n # PROBLEM 30 # \n")
k = 1 / N // in meter
theta1 = asin(n * lambda1 / k) * (180 / %pi) // calculation for angle in first case
theta2 = asin(n * lambda2 / k) * (180 / %pi) // calculation for angle in second case
delta_theta = theta2 - theta1 // calculation for angle of separation
printf("\n Standard formula used \n theta1 = asin(n * lambda1 / k) * (180 / pi). \n ")
printf("\n Angle of separation = %f degree", delta_theta)
```

Scilab code Exa 2.31 Calculation of No of lines per cm

```
clc
// Given that
lambda1 = 5.4e-7 // wavelength of light for nth order in meter
lambda2 = 4.05e-7 // wavelength of light for (n+1)th order in meter
theta = %pi / 6 // angle of diffraction in radian
// Sample Problem 31 on page no. 2.50
printf("\n # PROBLEM 31 # \n")
k = (lambda1 * lambda2) / ((lambda1 - lambda2) * sin(theta)) // calculation for b+d
N = (1 / k) * (0.01) // calculation for no. of lines per cm
printf("\n Standard formula used \n b+d = (lambda1 * lambda2) / ((lambda1 - lambda2) * sin(theta)). \n N = (1 / k) * (0.01). \n")
printf("\n No. of lines per cm = %d ",N)
```

Scilab code Exa 2.32 Calculation of Difference in two wavelength

```
clc
// Given that
d_theta = 0.01 // angular separation between two wavelengths in radian
theta = %pi / 6 // angle of diffraction in radian
lambda = 5e-7 // wavelength of light in meter
```

```
// Sample Problem 32 on page no. 2.51
printf("\n # PROBLEM 32 # \n")
d_lambda = (lambda * cos(theta) * d_theta) / sin(theta) // calculation for difference in two waveligth
printf("Standard formula used \n d_lambda = (lambda * cos(theta) * d_theta) / sin(theta). \n\n")
printf("\n Difference in two wavelength = %e meter ",d_lambda)
```

Scilab code Exa 2.33 Calculation of Order of spectrum

```
clc
// Given that
N = 2620 // no. of lines in plane transmission grating per inch
lambda = 5e-7 // wavelength of incident radiation in meter
// Sample Problem 33 on page no. 2.51
printf("\n # PROBLEM 33 # \n")
k = 2.54 / N * 1 / 100 // calculation for b+d in meter
n = k / lambda // calculation for order of spectrum
printf("\n Standard formula used \n n = k / lambda ")
printf("\n Order of spectrum = %d",n)
```

Scilab code Exa 2.34 Calculation of Order of spectrum

```
clc
// Given that
N = 500000 // no. of lines in plane transmission
    grating per meter
lambda = 5e-7 // wavelength of incident radiation in
     meter
// Sample Problem 34 on page no. 2.51
printf("\n # PROBLEM 34 # \n")
k = 1 / N // calculation for b+d in meter
n = k / lambda // calculation for order of spectrum
printf("\n Standard formula used \n k = 1 / N. \n n
    = k / lambda. \n")
printf("\n Order of spectrum = %d",n)
```

Scilab code Exa 2.35 Calculation of Observed order

```
clc
// Given that
N = 400000 // no. of lines in plane transmission
    grating per meter
lambda1 = 4e-7 // wavelength of light in first case
    in meter
lambda2 = 7e-7 // wavelength of light in second case
     in meter
// Sample Problem 35 on page no. 2.52
printf("\n # PROBLEM 35 # \n")
n1 = 1 / (N * lambda1) // calculation for Observed
    order in first case
n2 = 1 / (N * lambda2) // calculation for Observed
    order in second case
printf("Standard formula used \n n = 1 / (N * lambda
    ). \n")
printf("\n Observed order = %d,%d",n1,n2)
```

Scilab code Exa 2.36 Calculation of Dispersive power

```
clc
// Given that
N = 400000 // no. of lines in grating per meter
lambda = 5e-7 // wavelength of incident radiation in
    meter
n = 3 // no. of order
// Sample Problem 36 on page no. 2.52
printf("\n # PROBLEM 36 # \n")
p = (n * N) / (sqrt(1 - (N * n * lambda)))//
    dispersive power (p) = d(theta)/d(lambda)
printf("\n Standard formula used \n p = (n * N) / (
    sqrt(1 - (N * n * lambda))). \n")
printf("\n Dispersive power = %e rad/m",p)
```

Scilab code Exa 2.37 Calculation of Minimum no of lines in grating

```
clc
// Given that
n = 2 // no. of order
lambda1 = 5.89e-7 // wavelength of light in first
    case in meter
lambda2 = 5.896e-7 // wavelength of light in second
    case in meter
// Sample Problem 37 on page no. 2.52
printf("\n # PROBLEM 37 # \n")
```

```
N = lambda1 / (n * (lambda2 - lambda1)) // calculation for minimum no. of lines in grating
printf("\n Standard formula used \n N = lambda1 / (n * (lambda2 - lambda1)). \n")
printf("\n Minimum no. of lines in grating = %f,",N)
```

Scilab code Exa 2.38 Calculation of Minimum no of lines in grating

```
clc
// Given that
n = 1 // no. of order
lambda1 = 5.89e-7 // wavelength of light in first case in meter
lambda2 = 5.896e-7 // wavelength of light in second case in meter
// Sample Problem 38 on page no. 2.53
printf("\n # PROBLEM 38 # \n")
N = lambda1 / (n * (lambda2 - lambda1)) // calculation for minimum no. of lines in grating
printf("Standard formula used \n lambda/d(lambda)=n*N. \n")
printf("\n Minimum no. of lines in grating = %f,",N)
```

Scilab code Exa 2.39 Calculation of Grating space and Total width of ruled surface

```
clc
// Given that
n = 3 // no. of order
```

```
theta = %pi / 6 // view angle of third order in radian
lambda1 = 5.89e-7 // min. wavelength of light in meter
lambda2 = 5.896e-7 // max.wavelength of light in meter
// Sample Problem 39 on page no. 2.53
printf("\n # PROBLEM 39 # \n")
mean_lambda = (lambda1 + lambda2) / 2 // calculation for mean wavelength
s = (n * mean_lambda) / sin(theta) // calculation for grating space b+d
N = lambda1 / (n * (lambda2 - lambda1)) // calculation for minimum no. of lines in grating
printf("\n Standard formula used \n mean_lambda = (lambda1 + lambda2) / 2. \n s = (n * mean_lambda) / sin(theta). \n N = lambda1 / (n * (lambda2 - lambda1)). \n")
printf("\n Grating space = %e meter. \n Total width of ruled surface = %e meter. ",s,s * N)
```

Scilab code Exa 2.40 Calculation of The separation of two points on moon

```
clc
// Given that
lambda = 5.5e-7 // wavelength of light in meter
a = 5 // diameter of objective lens of telescope in meter
R = 3.8e8 // distance of moon in meter
// Sample Problem 40 on page no. 2.53
printf("\n # PROBLEM 40 # \n")
theta = (1.22 * lambda) / a // calculation for angle
x = (R * theta) // calculation for the separation of
```

```
    two points on moon
printf("\n Standard formula used \n theta = (1.22 *
   lambda) / a. \n x = (R * theta). \n")
printf("\n The separation of two points on moon = %f
    meter",x)
```

Scilab code Exa 2.41 Calculation of Diameter of telescope objective

```
clc
// Given that
lambda = 5e-7 // wavelength of light in meter
theta = (1e-3) * (%pi / 180) // separation angle of
   stars in radian
// Sample Problem 41 on page no. 2.54
printf("\n # PROBLEM 41 # \n")
a = (1.22 * lambda) / theta // calculation for
   diameter of telescope objective
printf("\n Standard formula used \n a = (1.22 *
   lambda) / theta. \n")
printf("\n Diameter of telescope objective = %f
   meter",a)
```

Scilab code Exa 2.42 Calculation of Diameter of telescope objective

```
clc
// Given that
lambda = 6e-7 // wavelength of light in meter
theta = 2.44e-6 // separation angle of stars in
   radian
```

```
// Sample Problem 42 on page no. 2.54
printf("\n # PROBLEM 42 # \n")
a = (1.22 * lambda) / theta // calculation for
    diameter of telescope objective
printf("\n Standard formula used \n a = (1.22 *
    lambda) / theta. \n")
printf("\n Diameter of telescope objective = %f
    meter",a)
```

Scilab code Exa 2.43 Calculation of Max distance of pin holes from microscope

```
clc
// Given that
lambda = 5.5e-7 // wavelength of light in meter
a = 0.004 // diameter of objective lens of telescope
     in meter
x = 1.5e-3 // distance between two pin holes in
    meter
// Sample Problem 43 on page no. 2.54
printf("\n # PROBLEM 43 # \n")
theta = (1.22 * lambda) / a // calculation for angle
R = x / theta // calculation for max. distance of
    pin holes from microscope
printf("\n Standard formula used \n theta = (1.22 *
    lambda) / a. \n R = x / theta. \n ")
printf("\n Max. distance of pin holes from
    microscope = %f meter",R)
```

Scilab code Exa 2.44 Calculation of The resolving limit of microscope

```
clc
// Given that
lambda = 5.5e-7 // wavelength of light in meter
theta = %pi / 6 // semi-angle of cone in radian
// Sample Problem 44 on page no. 2.55
printf("\n # PROBLEM 44 # \n")
d = (1.22 * lambda) / (2 * sin(theta)) //
    calculation for the resolving limit of microscope
printf("Standard formula used \n d*sin(theta)= 1.22*
    lamda. \n")
printf("\n The resolving limit of microscope = %e
    meter",d)
```

Scilab code Exa 2.45 Calculation of Numerical aperture of objective

```
clc
// Given that
lambda = 5.461e-7 // wavelength of light in meter
d = 4e-7 // separation between objects in meter
// Sample Problem 45 on page no. 2.55
printf("\n # PROBLEM 45 # \n")
NA = (1.22 * lambda) / (2 * d) // calculation for
    numerical aperture of objective
printf("\n Standard formula used \n NA = (1.22 *
    lambda) / (2 * d). \n")
printf("\n Numerical aperture of objective = %f",NA)
```

Chapter 3

POLARISATION

Scilab code Exa 3.1 Calculation of Brewster angle and Angle of refraction

```
clc
// Given that
mu = 1.5 // refractive index of glass
// Sample Problem 1 on page no. 3.23
printf("\n # PROBLEM 1 # \n")
Ip = atan(mu) * (180 / %pi) // by brewster's law
r = 90 - Ip // calculation for angle of refraction
printf("Standard formula used \n mu=tan(Ip)\n")
printf("\n Brewster angle = %f degree\n Angle of
   refraction = %f degree",Ip,r)
```

Scilab code Exa 3.2 Calculation of Angle of Brewster

```
clc
// Given that
```

```
mu = 1.33 // refractive index of glass
// Sample Problem 2 on page no. 3.24
printf("\n # PROBLEM 2 # \n")
Ip = atan(mu) * (180 / %pi) // by Brewster's law
printf("Standard formula used \n mu=tan(Ip)\n")
printf("\n Angle of brewster = %f degree",Ip)
```

Scilab code Exa 3.3 Calculation of difference between polarization angle

```
clc
// Given that
mu_w = 1.33 // refractive index of water
mu_g = 1.54 // refractive index of glass
// Sample Problem 3 on page no. 3.24
printf("\n # PROBLEM 3 # \n")
Ip_1 = atan(mu_g / mu_w) * (180 / %pi)//calculation
    for polarizing angle for water
Ip_2 = atan(mu_w / mu_g) * (180 / %pi) //
    calculation for polarizing angle for glass
printf("Standard formula used \n mu=tan(Ip)\n")
printf("\n Polarizing angle for water to glass = %f
    degree,\n Polarizing angle for glass to water =
    %f degree",Ip_1,Ip_2)
printf("\n So polarizing angle is greater for a beam
     incident from water to glass")
```

Scilab code Exa 3.4 Calculation of Angle of minimum deviation

```
clc
```

```
// Given that
Ip = %pi / 3 // polarizing angle of piece of glass for green light in radian
a = %pi / 3 // angle of prism in radian
// Sample Problem 4 on page no. 3.24
printf("\n # PROBLEM 4 # \n")
mu = tan(Ip) // calculation for refractive index
delta_m = 2 * (asin(mu * sin(a / 2)) - (a / 2)) * (180 / %pi) // calculation for angle of minimum deviation
printf("\n Standard formula used \n mu = tan(Ip). \n delta_m = 2 * (asin(mu * sin(a / 2)) - (a / 2)) * (180 / pi). \n")
printf("\n Angle of minimum deviation = %f degree",delta_m)
```

Scilab code Exa 3.5 Calculation of Brewster angle

```
clc
// Given that
mu_w = 1.33 // refractive index of water
mu_g = 1.5 // refractive index of glass
// Sample Problem 5 on page no. 3.25
printf("\n # PROBLEM 5 # \n")
Ip = atan(mu_g / mu_w) * (180 / %pi) // calculation for Brewster angle
printf("\n Standard formula used \n Ip = atan(mu_g / mu_w) * (180 / pi). \n")
printf("\n Brewster angle = %f degree",Ip)
```

Scilab code Exa 3.6 Calculation of Angle of incidence and angle of refraction

```
clc
// Given that
mu = 1.732 // refractive index of glass
// Sample Problem 6 on page no. 3.25
printf("\n # PROBLEM 6 # \n")
Ip = atan(mu) * (180 / %pi) // by Brewster's law
r = 90 - Ip// calculation for angle of refraction
printf("Standard formula used \n mu=tan(Ip)\n")
printf("\n Angle of incidence = %f degree\n Angle of
    refraction = %f degree",Ip,r)
```

Scilab code Exa 3.7 Calculation of Ratio between transmitted intensity to incident intensity

```
clc
// Given that
alpha = %pi / 3 // angle between polarizer and
   analyzer
// Sample Problem 7 on page no. 3.25
printf("\n # PROBLEM 7 # \n")
r = (cos(alpha))^2 // where r = transmitted
   intensity / incident intensity
printf("\n Standard formula used \n r = (cos(alpha))
   ^2. \n")
```

```
printf("\n Ratio between transmitted intensity to incident intensity = %f ",r)
```

Scilab code Exa 3.8 Calculation of The angle between characteristics directions of the sheet

```
clc
// Given that
r1 = 1/3 // ratio of intensity of transmitted light to the intensity of transmitted beam in first case
r2 = 1/3 // ratio of intensity of transmitted light to the intensity of incident beam in second case
p = 50 // percentage reduction in intensity of unpolarized light by the sheet
// Sample Problem 8 on page no. 3.25
printf("\n # PROBLEM 8 # \n")
theta1 = acosd(sqrt(r1)) // calculation for the angle between characteristics directions of the sheet in first case
theta2 = acosd(sqrt(2*r2)) // calculation for the angle between characteristics directions of the sheet in second case
printf("\n Standard formula used \n theta = acosd(sqrt(r)). \n")
printf("\n The angle between characteristics directions of the sheet in first case = %f degree. \n the angle between characteristics directions of the sheet in second case = %f degree.",theta1,theta2)
```

Scilab code Exa 3.9 Calculation of Angle between the nicol prisms

```
clc
// Given that
r = 3 / 4 // ratio of intensity of transmitted light
    to the intensity of incident light
// Sample Problem 9 on page no. 3.26
printf("\n # PROBLEM 9 # \n")
theta = acos(sqrt(r)) * (180 / %pi) // calculation
   for angle between the nicol prisms
printf("\n Standard formula used \n theta = acos(
   sqrt(r)) * (180 / pi). \n")
printf("\n Angle between the nicol prisms = %f
   degree",theta)
```

Scilab code Exa 3.10 Calculation of Percentage reduction in intensity of light

```
clc
// Given that
theta1 = %pi / 6 // angle between Nicole prisms in
   first case in radian
theta2 = %pi / 4 // angle between Nicole prisms in
   second case in radian
theta3 = %pi / 3 // angle between Nicole prisms in
   third case in radian
theta4 = %pi / 2 // angle between Nicole prisms in
   fourth case in radian
```

```
// Sample Problem 10 on page no. 3.26
printf("\n # PROBLEM 10 # \n")
I1 = (1 - (cos(theta1))^2) * 100
I2 = (1 - (cos(theta2))^2) * 100
I3 = (1 - (cos(theta3))^2) * 100
I4 = (1 - (cos(theta4))^2) * 100
 // calculation for percentage reduction in
    intensity of ligth
 printf("\n Standard formula used \n I = (1 - (cos(
    theta))^2) * 100. \n")
printf("\n Percentage reduction in intensity of
   ligth -\n(i)%f per\n(ii)%f per\n(iii)%f per\n(iv)
   %f per",I1,I2,I3,I4)
```

Scilab code Exa 3.11 Calculation of Angle between the Nicols

```
clc
// Given that
i1 = 1 / 2 // reduced intensity ratio in first case
i2 = 1 / 4 // reduced intensity ratio in second case
// Sample Problem 11 on page no. 3.27
printf("\n # PROBLEM 11 # \n")
theta1 = acos(sqrt(i1)) * (180 / %pi)// calculation
   for angle between nicols in first case
theta2 = acos(sqrt(i2)) * (180 / %pi)// calculation
   for angle between nicols in second case
printf("Standard formula used \n I=I_cos(theta)^2\n"
   )
printf("\n Angle between the Nicols in first case =
   %f degree\n And in second case = %f degree",
   theta1,theta2)
```

Scilab code Exa 3.12 Calculation of Thickness of half wave plate of quartz

```
clc
// Given that
lambda = 5e-7 // wavelength of light in meter
mu_e = 1.553 // refractive index for extraordinary
   light
mu_o = 1.544 // refractive index for ordinary light
// Sample Problem 12 on page no. 3.27
printf("\n # PROBLEM 12 # \n")
t = lambda / (2 * (mu_e - mu_o)) // calculation for
   thickness of half-wave plate of quartz
printf("\n Standard formula used \n t = lambda / (2
   * (mu_e - mu_o)). \n")
printf("\n Thickness of half-wave plate of quartz =
   %e meter",t)
```

Scilab code Exa 3.13 Calculation of Thickness of quartz plate

```
clc
// Given that
lambda = 5.893e-7 // wavelength of light in meter
mu_e = 1.533 // refractive index for extraordinary
   light
mu_o = 1.554 // refractive index for ordinary light
// Sample Problem 13 on page no. 3.27
printf("\n # PROBLEM 13 # \n")
```

```
t = lambda / (4 * (mu_o - mu_e)) // calculation for thickness of quartz plate
printf("\n Standard formula used \n t = lambda / (4 * (mu_o - mu_e)). \n ")
printf("\n Thickness of quartz plate  = %e meter",t)
```

Scilab code Exa 3.14 Calculation of Thickness quartz plate

```
clc
// Given that
lambda = 5.89e-7 // wavelength of light in meter
mu_e1 = 1.5 // refractive index for extraordinary light in first case
mu_o1 = 1.55 // refractive index for ordinary light in first case
mu_e2 = 1.57 // refractive index for extraordinary light in second case
mu_o2 = 1.55 // refractive index for ordinary light in second case
// Sample Problem 14 on page no. 3.28
printf("\n # PROBLEM 14 # \n")
t1 = lambda / (4 * (mu_o1 - mu_e1))
t2 = lambda / (4 * (mu_e2 - mu_o2))
 // calculation for thickness of plate of quartz
 printf("\n Standard formula used \n t = lambda / (4 * (mu_o - mu_e)) ")
printf("\n Thickness of plate of quartz in first case = %e meter,\n And thickness of plate of quartz in second case = %e meter",t1,t2)
```

Scilab code Exa 3.15 Calculation of Thickness of calcite plate

```
clc
// Given that
lambda = 5.89e-7 // wavelength of light in meter
mu_e = 1.486 // refractive index for extraordinary
   light
mu_o = 1.658 // refractive index for ordinary light
// Sample Problem 15 on page no. 3.28
printf("\n # PROBLEM 15 # \n")
t = lambda / (4 * (mu_o - mu_e)) // calculation for
   thickness of calcite plate
printf("\n Standard formula used \n t = lambda / (4
   * (mu_o - mu_e)). \n")
printf("\n Thickness of calcite plate  = %e meter",t
   )
```

Scilab code Exa 3.16 Calculation of Thickness of quartz plate

```
clc
// Given that
lambda = 5e-7 // wavelength of light in meter
mu_e = 1.5533 // refractive index for extraordinary
   light
mu_o = 1.5442 // refractive index for ordinary light
// Sample Problem 16 on page no. 3.28
printf("\n # PROBLEM 16 # \n")
```

```
t = lambda / (4 * (mu_e - mu_o)) // calculation for thickness of quartz plate
printf("\n Standard formula used \n t = lambda / (4 * (mu_e - mu_o)). \n")
printf("\n Thickness of quartz plate  = %e meter",t)
```

Scilab code Exa 3.17 Calculation of Thickness of quartz plate

```
clc
// Given that
lambda = 5.89e-7 // wavelength of light in meter
mu_e = 1.54 // refractive index for extraordinary light
mu_o = 1.55 // refractive index for ordinary light
// Sample Problem 17 on page no. 3.28
printf("\n # PROBLEM 17 # \n")
t = lambda / (4 * (mu_o - mu_e)) // calculation for thickness of quartz plate
printf("\n Standard formula used \n t = lambda / (4 * (mu_o - mu_e))")
printf("\n Thickness of quartz plate  = %e meter",t)
```

Scilab code Exa 3.18 Calculation of Thickness of quartz plate

```
clc
// Given that
lambda = 5.89e-7 // wavelength of light in meter
mu_e = 1.553 // refractive index for extraordinary light
```

```
mu_o = 1.544 // refractive index for ordinary light
// Sample Problem 18 on page no. 3.28
printf("\n # PROBLEM 18 # \n")
t = lambda / (4 * (mu_e - mu_o)) // calculation for
    thickness of quartz plate
printf("\n Standard formula used \n t = lambda / (4
    * (mu_e - mu_o)).\n")
printf("\n Thickness of quartz plate  = %e meter",t)
```

Scilab code Exa 3.19 Calculation of Thickness of quartz plate

```
clc
// Given that
mu_e = 1.5442 // refractive index for extraordinary
    light
mu_o = 1.5533 // refractive index for ordinary light
lambda = 5e-7 // wavelength of plane polarized light
     in meter
// Sample Problem 19 on page no. 3.29
printf("\n # PROBLEM 19 # \n")
t = lambda / (2 * (mu_o - mu_e))// calculation for
    thickness of quartz plate
printf("Standard formula used \n t=lambda/4(mu_o-
    mu_e)\n")
printf("\n Thickness of quartz plate  = %e meter",t)
```

Scilab code Exa 3.20 Calculation of Concentration of sugar solution

```
clc
```

```
// Given that
theta = 10 // rotation of plane of polarization in degree
s = 60 // specific rotation of sugar solution in degree per decimeter per unit concentration
l = 2.5 // length of Polari meter in decimeter
// Sample Problem 20 on page no. 3.29
printf("\n # PROBLEM 20 # \n")
c = theta / (s * l) // calculation for concentration of sugar solution
printf("\n Standard formula used \n c = theta / (s * l). \n")
printf("\n Concentration of sugar solution = %f gm/cc",c)
```

Scilab code Exa 3.21 Calculation of Specific rotation of sugar solution

```
clc
// Given that
theta = 26.4 // rotation of plane of polarization in degree
c = 0.2 // concentration of sugar solution in gm/cc
l = 2 // length of polarizing tube in decimeter
// Sample Problem 21 on page no. 3.29
printf("\n # PROBLEM 21 # \n")
s = theta / (l * c)// calculation for specific rotation of sugar solution
printf("Standard formula used \n s = (10*theta)/(l*c)\n")
printf("\n Specific rotation of sugar solution = %f degree/(dm-cc)",s)
```

Scilab code Exa 3.22 Calculation of Specific rotation of sugar solution

```
clc
// Given that
theta = 6.5 // rotation of plane of polarization in
    degree
c = 0.05 // concentration of sugar solution in gm/cc
l = 2 // length of polarizing tube in decimeter
// Sample Problem 22 on page no. 3.29
printf("\n # PROBLEM 22 # \n")
s = theta / (l * c) // calculation for specific
    rotation of sugar solution
printf("\n Standard formula used \n s = theta / (l *
    c). \n ")
printf("\n Specific rotation of sugar solution = %f
    degree/(dm-cc)",s)
```

Scilab code Exa 3.23 Calculation of Concentration of sugar solution

```
clc
// Given that
w = 80 // weight of impure sugar in gm
theta = 9.9 // rotation of plane of polarization in
    degree
s = 66 // specific rotation of sugar solution in
    degree per decimeter per unit concentration
l = 2 // length of Polari meter in decimeter
// Sample Problem 23 on page no. 3.30
```

```
printf("\n # PROBLEM 23 # \n")
c = theta / (s * l) * (1000) // in gm/l
per_c = (c * 100) / w // calculation for concentration of sugar solution
printf("\n Standard formula used \n c = theta / (s * l) * (1000). \n per_c = (c * 100) / w. \n")
printf("\n Concentration of sugar solution = %f percent",per_c)
```

Scilab code Exa 3.24 Calculation of Concentration of sugar solution

```
clc
// Given that
theta = 11 // rotation of plane of polarization in degree
s = 66 // specific rotation of sugar solution in degree per decimeter per unit concentration
l = 2 // length of Polari meter in decimeter
// Sample Problem 24 on page no. 3.29
printf("\n # PROBLEM 24 # \n")
c = theta / (s * l) // calculation for concentration of sugar solution
printf("\n Standard formula used \n c = theta / (s * l). \n ")
printf("\n Concentration of sugar solution = %f gm/cc",c)
```

Scilab code Exa 3.25 Calculation of Specific rotation of sugar solution

```
clc
// Given that
theta = 26.4 // rotation of plane of polarization in degree
c = 0.2 // concentration of sugar solution in gm/cc
l = 2 // length of polarizing tube in decimeter
// Sample Problem 25 on page no. 3.30
printf("\n # PROBLEM 25 # \n")
s = theta / (l * c) // calculation for specific rotation of sugar solution
printf("\n Standard formula used \n s = theta / (l * c). \n")
printf("\n Specific rotation of sugar solution = %f degree/(dm-cc)",s)
```

Scilab code Exa 3.26 Calculation of Optical rotation of diluted solution

```
clc
// Given that
theta = 13 // rotation of plane of polarization in degree
r = (1 / 3) // ratio of the final concentration to the initial solution
l = 2 // length of Polari meter in decimeter
l_ = 3 // length of second polarizing tube in decimeter
// Sample Problem 26 on page no. 3.30
printf("\n # PROBLEM 26 # \n")
theta_ = (l_ * r * theta) / l// calculation for optical rotation of diluted solution
printf("Standard formula used \n s=theta/(l*c)\n")
printf("\nOptical rotation of diluted solution = %f degree",theta_)
```

Chapter 4

LASERS AND HOLOGRAPHY

Scilab code Exa 4.1 Calculation of Ratio of population of upper level to the lower energy level and Temperature

```

clc
// Given that
lambda = 5.5e-7 // wavelength of light in meter
c = 3e+8 // speed of light in m/sec
h = 6.63e-34 // Planck constant in j/sec
e = 1.6e-19 // charge on electron in coulomb
k = 8.62e-5 // Boltzmann constant in eV/K
T = 300 // temperature in kelvin
// Sample Problem 1 on page no. 4.24
printf("\n # PROBLEM 1 # \n")
delta_E = (h * c) / (lambda * e) // calculation for
    energy difference
r = exp(-delta_E / (k * T)) // calculation for ratio
     of population of upper level to the lower energy
     level
```

```
T_ = (delta_E / (k * 0.693)) // calculation for temperature for the second condition
printf("\n Standard formula used \n delta_E = (h * c) / (lambda * e). \n r = exp(-delta_E / (k * T)). \n T_ = (delta_E / (k * 0.693)). \n")
printf("\n Ratio of population of upper level to the lower energy level = %e. \n Temperature for the second condition = %f K. ",r,T_)
//Answer in the book: 1.3 X 10^-38 and 37800 K
//Answer in the program:1.100524 X 10^-38 and 37836.557301 K"
```

Scilab code Exa 4.2 Calculation of Beam divergence angle

```
clc
// Given that
lambda1 = 6.328e-7 // wavelength of light in first case in meter
lambda2 =2e-7 // wavelength of light in second case in meter
r1 = 2.3e-4 // the radius of internal beam of laser in first case in meter
r2 = 2.4e-3 // the radius of internal beam of laser in second case in meter
// Sample Problem 2 on page no. 4.24
printf("\n # PROBLEM 2 # \n")
theta1 = lambda1 / (%pi * r1) // calculation for beam divergence angle in first case
theta2 = lambda2 / (%pi * r2) // calculation for beam divergence angle in second case
printf("\n Standard formula used \n theta = lambda / (pi * r). \n")
printf("\n Beam divergence angle in first case = %e
```

```
radian. \n Beam divergence angle in second case =
 %e radian. ",theta1,theta2)
```

Scilab code Exa 4.3 Calculation of Total energy

```
clc
// Given that
l = 6e-2 // length of laser in meter
D = 1e-2 // diameter of laser in meter
lambda = 6.944e-7 // wavelength of light in meter
d = 3700 // density of aluminium oxide in kg/meter
   cube
Na = 6e+23 // Avogadro number
M = 0.102 // molar mass of aluminium oxide in kg/
   meter cube
h = 4.1e-15 // Planck constant in eV-sec
c = 3e+8 // speed of light in meter/sec
// Sample Problem 3 on page no. 4.25
printf("\n # PROBLEM 3 # \n")
v = (%pi * (D^2) * l) / 4 // calculation for volume
N = (2 * Na * d * v) / M // calculation for no. of
   aluminium ions
N_ = N / 3500 // calculation for the no. of chromium
    ions
E = (h * c) / lambda // calculation for the energy
   of stimulated emission photon
Et = N_ * E * (1.6e-19) // calculation for total
   energy
printf("\n Standard formula used \n v = (pi * (D^2)
   * l) / 4. \n N = (2 * Na * d * v) / M. \n N_ = N
   / 3500. \n E = (h * c) / lambda. \n Et = N_ * E *
    (1.6e-19). \n")
printf("\n Total energy = %f J",ceil(Et))
```

Scilab code Exa 4.4 Calculation of Power per unit area delivered by the laser

```
clc
// Given that
p = 4e-3 // energy of laser pulse in meter
r = 1.5e-5 // radius of spot in meter
t = 1e-9 // pulse length in time in sec
// Sample Problem 4 on page no. 4.26
printf("\n # PROBLEM 4 # \n")
p_ = p / t// calculation for  power in watt
I = p_ / (%pi * r^2)// calculation for power per unit area delivered by the laser
printf("Standard formula used \n I=P/a\n")
printf("\nPower per unit area delivered by the laser = %e watt/square meter",I)
```

Scilab code Exa 4.5 Calculation of Power per unit area delivered by the laser

```
clc
// Given that
D = 5e-3 // diameter of laser in meter
lambda = 7.2e-7 // wavelength of light in meter
d = 4e8 // distance at moon from earth in meter
// Sample Problem 5 on page no. 4.26
printf("\n # PROBLEM 5 # \n")
```

```
r = (D / 2) // calculation for radius
theta = (0.637 * lambda) / r // calculation for
    angular spread
areal_spread = (d * theta)^2 // calculation for
    areal spread
printf("\n Standard formula used \n theta = (0.637 *
     lambda) / r. \n areal_spread = (d * theta)^2. \n
     ")
printf("\n Angular spread = %e radian ,\n Areal
    spread = %e square meter",theta,areal_spread)
```

Scilab code Exa 4.6 Calculation of Areal spread and Intensity

```
clc
// Given that
D = 5e-3 // diameter of laser in meter
lambda = 6.943e-7 // wavelength of light in meter
f =0.1 // focal length in meter
P = 0.1 // power of laser in watt
// Sample Problem 6 on page no. 4.27
printf("\n # PROBLEM 6 # \n")
r = (D / 2)// calculation for
theta = (0.637 * lambda) / r// calculation for
    angular spread
areal_spread = (f * theta)^2// calculation for areal
     spread
I = P / areal_spread// calculation for intensity
printf("Standard formula used \n theta=0.637*lambda/
    r,\n areal spread = (theta*D)^2,\n I=P/A\n")
printf("\n Areal spread = %e square meter,\n
    Intensity = %e watt/square meter",areal_spread,I)
```

Scilab code Exa 4.7 Calculation of Degree of non monochromaticity

```
clc
// Given that
tou = 1e-10 // coherence time in sec
lambda = 5.4e-7 // wavelength of light in meter
// Sample Problem 7 on page no. 4.28
printf("\n # PROBLEM 7 # \n")
delta_v = 1 / tou
v_ = (3e+8) / lambda // calculation for frequency
d = delta_v / v_ // calculation for degree of non-
    monochromaticity
printf("\n Standard formula used \n delta_v = 1 /
    tou. \n v_ = (3e+8) / lambda. \n d = delta_v / v_
    . \n ")
printf("\n Degree of non-monochromaticity = %f ",d)
```

Chapter 5

FIBRE OPTICS

Scilab code Exa 5.1 Calculation of Critical angle and Numerical aperture and Maximum incidence angle

```
clc
// Given that
mu1 = 1.52 // refractive index for core
mu2 = 1.41 // refractive index for cladding
// Sample Problem 1 on page no. 5.15
printf("\n # PROBLEM 1 # \n")
theta_c = asin(mu2 / mu1) * (180 / %pi)
NA = sqrt(mu1^2 - mu2^2)
theta_0 = asin(NA) * (180 / %pi)
printf("\n Standard formula used \n theta_c = asin(
    mu2 / mu1) * (180 / pi). \n NA = sqrt(mu1^2 - mu2
    ^2). \n theta_0 = asin(NA) * (180 / pi). \n")
printf("\n Critical angle = %f degree. \n Numerical
    aperture = %f,\n Maximum incidence angle = %f
    degree.",theta_c,NA,theta_0)
```

Scilab code Exa 5.2 Calculation of Numerical aperture and Maximum incidence angle

```
clc
// Given that
mu1 = 1.6 // refractive index for core
mu2 = 1.5 // refractive index for cladding
// Sample Problem 2 on page no. 5.16
printf("\n # PROBLEM 2 # \n")
NA = sqrt(mu1^2 - mu2^2)//calculation for numerical
    aperture
theta_0 = asin(NA) * (180 / %pi)//calculation for
    maximum incidence angle
printf("Standard formula used \n NA=aqrt(mu1^2-mu2
    ^2),\n sin(theta_)=NA. \n")
printf("\n Numerical aperture = %f.\n Maximum
    incidence angle = %f degree.",NA,theta_0)
```

Scilab code Exa 5.3 Calculation of Critical angle and Numerical aperture and Acceptance angle and Fractional refractive index

```
clc
// Given that
mu_0 = 1 // refractive index of air
mu1 = 1.5 // refractive index for core
mu2 = 1.48 // refractive index for cladding
// Sample Problem 3 on page no. 5.16
printf("\n # PROBLEM 3 # \n")
```

```
theta_c = asin(mu2 / mu1) * (180 / %pi)
delta_mu = (mu1 - mu2) / mu1
NA = sqrt(mu1^2 - mu2^2)
theta_0 = asin(NA) * (180 / %pi)
printf("\n Standard formula used \n theta_c = asin(mu2 / mu1) * (180 / pi). \n delta_mu = (mu1 - mu2) / mu1. \n NA = sqrt(mu1^2 - mu2^2). \n theta_0 = asin(NA) * (180 / pi). \n ")
printf("\n Critical angle = %f degree. \n Numerical aperture = %f. \n Acceptance angle = %f degree.\n Fractional refractive index = %f.",theta_c,NA,theta_0,delta_mu)
```

Scilab code Exa 5.4 Calculation of Numerical aperture and Maximum incidence angle

```
clc
// Given that
mu1 = 1.62 // refractive index for core
mu2 = 1.52 // refractive index for cladding
// Sample Problem 4 on page no. 5.17
printf("\n # PROBLEM 4 # \n")
NA = sqrt(mu1^2 - mu2^2)
theta_0 = asin(NA) * (180 / %pi)
printf("\n Standard formula used \n NA = sqrt(mu1^2 - mu2^2). \n theta_0 = asin(NA) * (180 / pi). \n")
printf("\n Numerical aperture = %f. \n Maximum incidence angle = %f degree.",NA,theta_0)
```

Scilab code Exa 5.5 Calculation of Refractive index for core Refractive index for cladding

```
clc
// Given that
NA = 0.22 // numerical aperture
delta_mu = 0.012 // fractional refractive index
// Sample Problem 5 on page no. 5.17
printf("\n # PROBLEM 5 # \n")
mu1 = sqrt(NA^2 / (1 - (1 - delta_mu)^2))
mu2 = (1 - delta_mu) * mu1
printf("\n Standard formula used \n mu1 = sqrt(NA^2
    / (1 - (1 - delta_mu)^2)). \n mu2 = (1 - delta_mu
    ) * mu1. \n")
printf("\n Refractive index for core = %f.\n
    Refractive index for cladding = %f.",mu1,mu2)
```

Scilab code Exa 5.6 Calculation of Numerical aperture and Acceptance angle and Number of reflections at maximum incidence and Number of reflections

```
clc
// Given that
d = 0.0064 // diameter of fiber in cm
mu1 = 1.53 // refractive index for core
mu2 = 1.39 // refractive index for clad
L = 90 // length of fiber in cm
mu_0 = 1 // refractive index of air
```

```
// Sample Problem 6 on page no. 5.17
printf("\n # PROBLEM 6 # \n")
NA = sqrt(mu1^2 - mu2^2)
theta_0 = asin(NA) * (180 / %pi)
N1 = L / (d * sqrt((mu1 / (mu_0 * sin(theta_0 * (%pi
    / 180))))^2 - 1))
N2 = L / (d * sqrt((mu1 / (mu_0 * sin(theta_0 * (%pi
    / 360))))^2 - 1))
printf("\n Standard formula used \n NA = sqrt(mu1^2
   - mu2^2). \n theta_0 = asin(NA) * (180 / pi). \n
   N = L / (d * sqrt((mu / (mu_0 * sin(theta_0 * (pi
    / 180))))^2 - 1)). \n ")
printf("\n Numerical aperture = %f.\n Acceptance
   angle = %f degree. \n Number of reflections at
   maximum incidence = %f. \n Number of reflections
   in second case = %f. ",NA,theta_0,N1,N2)
```

Scilab code Exa 5.7 Calculation of The normalized frequency and number of guided in the core

```
clc
// Given that
d = 0.05 // diameter of fiber in mm
NA = 0.22 // numerical aperture
lambda = 8.5e-4 // wavelength of light in mm
// Sample Problem 7 on page no. 5.18
printf("\n # PROBLEM 7 # \n")
Vn = (%pi * d * NA) / lambda
Mm = 0.5 * (Vn)^2
printf("\n Standard formula used \n Vn = (pi * d *
   NA) / lambda. \n Mm = 0.5 * (Vn)^2. \n")
printf("\n The normalized frequency = %f,\n number
   of guided in the core = %f",Vn,Mm)
```

Scilab code Exa 5.8 Calculation of Diameter of core and number of modes

```
clc
// Given that
lambda = 1.25e-6 //wavelength of light in meter
mu1 = 1.465 // refractive index for core
mu2 = 1.460 // refractive index for cladding
// Sample Problem 8 on page no. 5.18
printf("\n # PROBLEM 8 # \n")
NA = sqrt(mu1^2 - mu2^2)
k = (2.4 * lambda) / ( %pi * NA)
Mm = 0.5 * ((%pi * 50e-6 * NA) / lambda)^2
printf("\n Standard formula used \n NA = sqrt(mu1^2
    - mu2^2). \n k = (2.4 * lambda) / ( pi * NA). \n
    Mm = 0.5 * ((pi * 50e-6 * NA) / lambda)^2. \n ")
printf("\n Diameter of core < %e meter,\n number of
    modes = %d",k,Mm)
```

Scilab code Exa 5.9 Calculation of Numerical aperture and Number of modes

```
clc
// Given that
lambda = 0.85e-6 //wavelength of light in meter
mu1 = 1.461 // refractive index for core
mu2 = 1.456 // refractive index for clad
d = 4e-5 // diameter of core in meter
```

```
// Sample Problem 9 on page no. 5.19
printf("\n # PROBLEM 9 # \n")
NA = sqrt(mu1^2 - mu2^2)
Mm = 0.5 * ((%pi * d * NA) / lambda)^2
printf("\n Standard formula used \n NA = sqrt(mu1^2 - mu2^2). \n Mm = 0.5 * ((pi * d * NA) / lambda)^2. \n ")
printf("\n Numerical aperture = %f.\n Number of modes = %d. ",NA,Mm)
```

Scilab code Exa 5.10 Calculation of Number of modes

```
clc
// Given that
mu1 = 3.6 // refractive index for core
mu2 = 3.55 // refractive index for cladding
// Sample Problem 10 on page no. 5.19
printf("\n # PROBLEM 10 # \n")
NA = sqrt(mu1^2 - mu2^2)//calculation for numerical aperture
Mm1 = 0.5 * (%pi * 5 * NA)^2//calculation for no. of modes in first case
Mm2 = 0.5 * (%pi * 50 * NA)^2//calculation for no. of modes in second case
printf("\n Standard formula used \n Mm=1/2(pi*d*NA/lambda)^2. NA=sqrt(mu1^2-mu2^2). \n")
printf("\n Number of modes in first case = %d. \n Number of modes in second case = %d.",Mm1,Mm2)
```

Scilab code Exa 5.11 Calculation of Maximum diameter of core

```
clc
// Given that
lambda = 1.25e-6 //wavelength of light in meter
mu1 = 1.46 // refractive index for core
mu2 = 1.457 // refractive index for cladding
// Sample Problem 11 on page no. 5.20
printf("\n # PROBLEM 11 # \n")
NA = sqrt(mu1^2 - mu2^2)//calculation for numerical
    aperture
k = (2.4 * lambda) / ( %pi * NA)
printf("\n Standard formula used \n d<8*lambda/(pi*
    NA)\n")
printf("\n Maximum diameter of core = %f micro meter
    ",k*1e6)
```

Scilab code Exa 5.12 Calculation of Absorption coefficient

```
clc
// Given that
L = 0.1 // length of fiber in km
p = 5e-6 // power of signal in watt
p_ = 1e-6 // power of signal inside the fiber in
    watt
// Sample Problem 12 on page no. 5.20
printf("\n # PROBLEM 12 # \n")
alpha = (10 * log10(p / p_)) / L//calculation for
    absorption coefficient
printf("\n Standard formula used \n alpha=10/L*log(
    Pi/Po).\n")
printf("\n Absorption coefficient = %f dB/km. ",
    alpha)
```

Scilab code Exa 5.13 Calculation of Output power

```
clc
// Given that
L = 3 // length of optical fiber in km
l = 6 // losses in dB
p = 5e-3 // input power in watt
// Sample Problem 13 on page no. 5.20
printf("\n # PROBLEM 13 # \n")
alpha = (l * 3) / L
p_ = p / (exp((2.303 * alpha * L) / 10))
printf("\n Standard formula used \n alpha = (l * 3)
    / L. \n p_ = p / (exp((2.303 * alpha * L) / 10)).
    \n")
printf("\n Output power = %f mW. ",p_*1e3)
```

Chapter 6

ELECTRON OPTICS

Scilab code Exa 6.1 Calculation of Energy gained by electron and Speed of electron and Momentum of electron

```
clc
// Given that
V = 500 // voltage across the electrode in eV
m = 9e-31 // mass of electron in kg
e = 1.6e-19 // charge on an electron in coulomb
// Sample Problem 1 on page no. 6.20
printf("\n # PROBLEM 1 # \n")
E = e * V
v = sqrt((2 * e * V) / m)
p = m * v
printf("\n Standard formula used \n E = e * V. \n v
   = sqrt((2 * e * V) / m). \n p = m * v. \n ")
printf("\n Energy gained by electron = %e J,\n Speed
    of electron = %e meter/sec,\n Momentum of
   electron = %e kg-meter/sec",E,v,p)
```

Scilab code Exa 6.2 Calculation of Momentum of acceleration

```
clc
// Given that
v = 2.5e6 // speed of electron in meter/sec
B = 2e-4 // magnetic field in tesla
r = 1.76e11 // ratio of charge on electron to the
    mass of electron in C/kg
// Sample Problem 2 on page no. 6.20
printf("\n # PROBLEM 2 # \n")
a = (B * r * v)
printf("\n Standard formula used \n a = (B * r * v).
     \n ")
printf("\n Momentum of acceleration = %e meter/
    square sec.",a)
```

Scilab code Exa 6.4 Calculation of Radius of circle traced by the beam and Speed of beam

```
clc
// Given that
v = 5.2e6 // speed of electron in meter/sec
B = 1.3e-4 // magnetic field in tesla
r = 1.76e11 // ratio of charge on electron to the
    mass of electron in C/kg
E = 3.2e-12 // energy of the electron beam in J
M = 9e-31 // mass of an electron in kg
// Sample Problem 4 on page no. 6.22
```

```
printf("\n # PROBLEM 4 # \n")
R = v / (r * B)
v_ = sqrt((2 * E) / M )
printf("\n Standard formula used \n R = v / (r * B). \n v_ = sqrt((2 * E) / M ). \n")
printf("\n Radius of circle traced by the beam = %f cm. \n Speed of beam in second case = %e meter/sec.\n Speed of beam in second case is greater than speed of light so we cannot use above formula.",R*100,v_)
```

Scilab code Exa 6.5 Calculation of Ratio of the charge on an electron to the mass of an electron

```
clc
// Given that
V = 2.500e3 // voltage across the electrode in V
E = 3.6e4 // strength of electric field in V/m
B = 1.2e-3 // magnetic field in tesla
// Sample Problem 5 on page no. 6.22
printf("\n # PROBLEM 5 # \n")
r = (E / B)^2 / (2 * V)//calculation for ratio of the charge on an electron to the mass of an electron
printf("\n Standard formula used \n e/m=(E/B)^2 / (2 V). \n")
printf("\n Ratio of the charge on an electron to the mass of an electron = %e C/kg.",r)
```

Scilab code Exa 6.6 Calculation of Lamoure radius

```
clc
// Given that
M = 9.1e-31 // mass of electron in kg
E = 1.6e-15 // energy of electron in J
B = 5e-5 // magnetic field in tesla
e = 1.6e-19 // charge on an electron in coulomb
// Sample Problem 6 on page no. 6.23
printf("\n # PROBLEM 6 # \n")
v = sqrt((2 * E) / M)
r = (M * v) / (e * B)
printf("\n Standard formula used \n v = sqrt((2 * E) / M). \n r = (M * v) / (e * B). \n")
printf("\n Larmoure radius = %f meter",r)
```

Scilab code Exa 6.7 Calculation of Lamoure radius

```
clc
// Given that
Mp = 1.67e-27 // mass of proton in kg
v = 3e5 // speed of proton in meter/sec
B = 5e-9 // magnetic field in tesla
e = 1.6e-19 // charge on a proton in coulomb
// Sample Problem 7 on page no. 6.23
printf("\n # PROBLEM 7 # \n")
r = (Mp * v) / (e * B)//calculation for Larmour radius
printf("\n Standard formula used \n r=m*v/(e*B). \n")
printf("\n Larmour radius = %e meter",r)
```

Scilab code Exa 6.8 Calculation of Area traced by the trajectory of helium ion

```
clc
// Given that
M = 6.68e-27 // mass of helium ion in kg
E = 1.6e-16 // energy of helium ion in J
B = 5e-2 // magnetic field in tesla
e = 1.6e-19 // charge on helium ion in coulomb
// Sample Problem 8 on page no. 6.23
printf("\n # PROBLEM 8 # \n")
v = sqrt((2 * E) / M)//calculation for velocity
r = (M * v) / (e * B)//calculation for Larmour
    radius
A = %pi * r^2//calculation for area traced by the
    trajectory of helium ion
printf("Standard formula used \n E=1/2*m*v^2,\n Rl=m
    *v/(e*B),\n A=pi*r^2\n")
printf("\n Area traced by the trajectory of helium
    ion = %f square meter",A)
```

Scilab code Exa 6.9 Calculation of The drift of the guiding center

```
clc
// Given that
E = 100 // strength of electric field in V/m
B = 1e-3 // magnetic field in tesla
// Sample Problem 9 on page no. 6.24
```

```
printf("\n # PROBLEM 9 # \n")
v = E / B
printf("\n Standard formula used \n v = E / B. ")
printf("\n The drift of the guiding center = %e m/
    sec",v)
```

Scilab code Exa 6.10 Calculation of Internal electric field

```
clc
// Given that
v = 1e6 // velocity of ion beam in m/sec
B = 1 // magnetic field in tesla
// Sample Problem 10 on page no. 6.24
printf("\n # PROBLEM 10 # \n")
E = B * v
printf("\n Standard formula used \n E = B * v. \n")
printf("\n Internal electric field = %e V/m",E)
```

Scilab code Exa 6.12 Calculation of Ratio of the new focus length to the initial focus length

```
clc
// Given that
r = 1.1 // ratio of new number of turns to the
    initial number of turns
// Sample Problem 12 on page no. 6.24
printf("\n # PROBLEM 12 # \n")
r_ = (1 / r)^2
```

```
printf("\n Standard formula used \n r_ = (1 / r)^2.
   \n")
printf("\n Ratio of the new focus length to the
   initial focus length = %f ",r_)
```

Chapter 7

WAVES AND OSCILLATIONS

Scilab code Exa 7.1 Calculation of Amplitude and Mass of particle

```
clc
// Given that
E = 1.024e-3 // total energy of particle in J
T = 2 * %pi // time period of S.H.M. in sec
x = 0.08 * sqrt(2) // distance of partile in meter
t = %pi / 4 // time in second
// Sample Problem 1 on page no. 7.22
printf("\n # PROBLEM 1 # \n")
A = x / sin((2 * %pi * t) / T)
M = (E * T^2) / (2 * %pi^2 * A^2)
printf("\n Standard formula used \n A = x / sin((2 *
    pi * t) / T). \n M = (E * T^2) / (2 * pi^2 * A
   ^2). \n")
printf("\n Amplitude = %f meter,\n Mass of particle
   = %f g",A,M/1e-3)
```

Scilab code Exa 7.2 Calculation of Maximum amplitude of velocity

```
clc
// Given that
A = 0.05 // amplitude in meter
T = 10 // time period of S.H.M. in sec
// Sample Problem 2 on page no. 7.22
printf("\n # PROBLEM 2 # \n")
v = (A * 2 * %pi) / T
printf("\n Standard formula used \n v = (A * 2 * pi) / T")
printf("\n Maximum amplitude of velocity = %f meter/sec",v)
```

Scilab code Exa 7.3 3Calculation of Force constant and Time period

```
clc
// Given that
E = 9 // total energy of particle in J
U = 5 // potential energy in J
A = 1 // amplitude in meter
m = 2 // mass of harmonic oscillator in kg
// Sample Problem 3 on page no. 7.23
printf("\n # PROBLEM 3 # \n")
kE = E - U// calculation for kinetic energy
k = (2 * kE) / A^2// calculation for force constant
T = (2 * %pi) * sqrt(m / k)// calculation for time period
```

```
printf("Standard formula used \n k.E.=1/2*k*A^2,\n T=2*pi*sqrt(m/k)\n")
printf("\n Force constant = %f J/m,\n Time period = %f sec",k,T)
```

Scilab code Exa 7.4 Calculation of Time taken by the particle

```
clc
// Given that
A = 0.06 // amplitude in meter
T = 6 // time period of S.H.M. in sec
x = 0.03 // position of particle in meter
// Sample Problem 4 on page no. 7.23
printf("\n # PROBLEM 4 # \n")
delta = asin(1) // by the formula x=Asin(wt+delta) and (at t = 0,x=A)
t = x / (A * sin(((2 * %pi) / T) + delta))
printf("\n Standard formula used \n x=Asin(wt+delta). \n ")
printf("\n Time taken by the particle = %f sec",t)
```

Scilab code Exa 7.5 Calculation of Maximum velocity and acceleration

```
clc
// Given that
A = 0.05// amplitude in meter
T = 10 * %pi // time period of s.h.m. in sec
// Sample Problem 5 on page no. 7.24
printf("\n # PROBLEM 5 # \n")
```

```
v = A * (2 * %pi / T)
a = A * (2 * %pi / T)^2
printf("\n Standard formula used \n v = A * (2 * pi
    / T). \n a = A * (2 * pi / T)^2. \n ")
printf("\n Maximum velocity = %e meter/sec,\n
    acceleration = %e m/sec^2",v,a)
```

Scilab code Exa 7.6 Calculation of Maximum velocity

```
clc
// Given that
A = 0.06// amplitude in meter
T = 10 * %pi // time period of s.h.m. in sec
// Sample Problem 6 on page no. 7.24
printf("\n # PROBLEM 6 # \n")
v = A * (2 * %pi / T)
printf("\n Standard formula used \n v = A * (2 * pi
    / T)")
printf("\n Maximum velocity = %e meter/sec",v)
```

Scilab code Exa 7.7 Calculation of natural frequency

```
clc
// Given that
k = 16 // stiffness constant of spring n/m
m = 1 // mass of particle in kg
// Sample Problem 7 on page no. 7.24
printf("\n # PROBLEM 7 # \n")
n = sqrt(k / m) / (2 * %pi)
```

```
printf("\n Standard formula used \n n = sqrt(k / m) / (2 * pi).\n")
printf("\n natural frequency = %f Hz.",n)
```

Scilab code Exa 7.8 Calculation of The time period of pendulum

```
clc
// Given that
l = 1 // length of pendulum in meter
m = 2 // mass of particle in kg
g = 9.8 // acceleration due to gravity in m/sec^2
// Sample Problem 8 on page no. 7.25
printf("\n # PROBLEM 8 # \n")
T = 2 * %pi * sqrt(l / g)
printf("\n Standard formula used \n T = 2 * pi * sqrt(l / g). \n")
printf("\n The time period of pendulum = %f sec.",T)
```

Scilab code Exa 7.9 Calculation of Frequency

```
clc
// Given that
m = 100 // mass of particle in gm
// Sample Problem 9 on page no. 7.25
printf("\n # PROBLEM 9 # \n")
n = (1 / (2 * %pi)) * sqrt(10 / m) // by using given formula
printf("\n Standard formula used \n n = (1 / (2 * pi)) * sqrt(10 / m). \n")
```

```
printf("\n Frequency  = %f Hz.",n)
```

Scilab code Exa 7.10 Calculation of Time period of pendulum

```
clc
// Given that
f = 3 // acceleration of pendulum in m/sec^2
l = 1 // length of pendulum in meter
g = 9.8 // acceleration due to gravity in m/sec^2
// Sample Problem 10 on page no. 7.25
printf("\n # PROBLEM 10 # \n")
T = 2 * %pi * sqrt(l / (g + f))
printf("\n Standard formula used \n T = 2 * pi * sqrt(l / (g + f)). \n ")
printf("\n Time period of pendulum = %f sec.",T)
```

Scilab code Exa 7.11 Calculation of Time period of motion

```
clc
// Given that
x = 0.3 // stretch in spring in meter
m1 = 6 // mass of first body in kg
m2 = 1 // mass of second body in kg
g = 9.8 //  gravitational acceleration of earth in m/sec^2
// Sample Problem 11 on page no. 7.26
printf("\n # PROBLEM 11 # \n")
k = (m1 * g) / x
T = (2 * %pi) * sqrt(m2 / k)
```

```
printf("\n Standard formula used \n k = (m1 * g) / x
    . \n T = (2 * pi) * sqrt(m2 / k).\n")
printf("\n Time period of motion = %f sec. ",T)
```

Scilab code Exa 7.12 Calculation of Time period of motion and Compression of the spring due to the weight of the body

```
clc
// Given that
x = 0.1 // compression in spring in m
F = 10 // restoring force in N
m = 4 // mass of body in kg
g = 9.8 // acceleration due to gravity in m/sec^2
// Sample Problem 12 on page no. 7.26
printf("\n # PROBLEM 12 # \n")
k = F / x
F_ = m * g
x_ = F_ / k
T = (2 * %pi) * sqrt(m / k)
printf("\n Standard formula used \n k = F / x. \n F_
     = m * g. \n x_ = F_ / k. \n T = (2 * pi) * sqrt(
    m / k). \n ")
printf("\n Time period of motion = %f sec. \n
    Compression of the spring due to the weight of
    the body = %f m. ",T,x_)
```

Scilab code Exa 7.13 Calculation of Time

```
clc
```

```
// Given that
t = 50 // relaxation time in sec
r = 1 / exp(1) // falls in amplitude and energy
// Sample Problem 13 on page no. 7.26
printf("\n # PROBLEM 13 # \n")
s = 1 / (2 * t)
T = 1 / s // by using formula A=A_exp(-st) and using r=A/A_
printf("\n Standard formula used \n s = 1 / (2 * t). \n T = 1 / s . \n ")
printf("\n Time = %f sec",T)
```

Scilab code Exa 7.14 Calculation of Time

```
clc
// Given that
n = 260 // frequency in Hz
Q = 2000 // quality factor
r = 1 / (exp(1)^2) // decrease in amplitude
// Sample Problem 14 on page no. 7.27
printf("\n # PROBLEM 14 # \n")
tou = Q / (2 * %pi * n)
t = 2 * tou // by using formula A=A_exp(-st) and using r=A/A_
printf("\n Standard formula used \n tou = Q / (2 * pi * n). \n t = 2 * tou. \n")
printf("\n Time = %f sec.",t)
```

Chapter 8

SOUND WAVES AND ACOUSTICS OF BUILDINGS

Scilab code Exa 8.1 Calculation of Wavelength range of the sound wave

```
clc
// Given that
v = 34500 // speed of sound in cm/sec
f = 20 // lower limit of frequency for human hearing
    ear in Hz
f_ = 20000 // upper limit of frequency for human
   hearing ear in Hz
// Sample Problem 1 on page no. 8.17
printf("\n # PROBLEM 1 # \n")
printf(" Standard formula used \n")
printf(" V = f*lambda \n \n" )
lambda = v / f
lambda_ = v / f_
printf("\n Wavelength range of the sound wave is %f
   cm to %f cm.",lambda_,lambda)
```

Scilab code Exa 8.2 Calculation of Velocity of sound in the air

```
clc
// Given that
T = 373 // temperature in kelvin
d = 1.293e-3 // density of air at S.T.P. in gm/cm^3
d_ = 13.6 // density of mercury in gm/cm^3
s = 0.2417 // specific heat of air at constant pressure
s_ = 0.1715 // specific heat of air at constant volume
g = 980 // gravitational constant i dynes/cm^3
// Sample Problem 2 on page no. 8.18
printf("\n # PROBLEM 2 # \n")
printf(" Standard formula used \n")
printf(" nu = (gamma*p/rho)^1/2  \n gamma = C_p/C_v \n p =rho*g*h \n" )
p = 76 * d_ * g
gama = s / s_
v = sqrt(gama * (p / d))
v_ = v * sqrt(T / 273)
printf("\n Velocity of sound in the air in %f cm/sec.",v_)
```

Scilab code Exa 8.3 Calculation of Ratio of two principal specific heats of air

```
clc
```

```
// Given that
n = 512 // frequency of tuning fork in Hz
T = 290 // temperature in kelvin
lambda = 66.5 // wavelength of the gas emitted by tuning fork in cm
d = 1.293e-3 // density of air at S.T.P. in gm/cm^3
d_ = 13.6 // density of mercury in gm/cm^3
g = 980 // gravitational constant i dynes/cm^3
// Sample Problem 3 on page no. 8.18
printf("\n # PROBLEM 3 # \n")
printf(" Standard formula used \n")
printf(" nu = (gamma*p/rho)^1/2  \n p =rho*g*h \n\n")
p = 76 * d_ * g// calculation for pressure
v_ = n * lambda// calculation for velocity of sound in air at temperature 17 c
v = v_ * sqrt(273 / T)// calculation for velocity of sound in air at temp 0 c
gama = v^2 * (d / p)// calculation for ratio of two specific heat

printf("\n Ratio of  two principal specific heats of air is %f",gama)
```

Scilab code Exa 8.4 Calculation of Coefficient of absorption to be provided by the walls and floor and ceiling when the hall is fully occupied and Reverberation time if only half upholstered seats are occupied

```
clc
// Given that
A = 15 * 30 // area of the floor in square meter
h = 6 // height of hall in meter
N = 500 // no. of people
```

```
t = 1.36 // optimum time for orchestral music in sec
k = 0.44 // absorption coefficient per person
// Sample Problem 4 on page no. 8.19
printf("\n # PROBLEM 4 # \n")
printf(" Standard formula used \n")
printf(" T = 0.161 V/a*S \n" )
aS = 0.161 * ((A * h) / t)
a = N * k
a_ = aS - a
w = a_ + (N / 2) * k + (N / 2) * 0.02
t = (0.161 * (A * h)) / w
printf("\n Coefficient of absorption to be provided
    by the walls , floor and ceiling when the hall is
    fully occupied is %f SI unit.\n Reverberation
    time if only half upholstered seats are occupied
    is %f sec.",a_,t)
```

Scilab code Exa 8.5 Calculation of The total absorption constant

```
clc
// Given that
V = 8000 // volume of hall in meter^3
t = 1.8 // reverberation time in sec
// Sample Problem 5 on page no. 8.19
printf("\n # PROBLEM 5 # \n")
printf(" Standard formula used \n")
printf(" T = 0.161 V/a*S \n" )
aS = (0.161 * V) / t// calculation for the total
    absorption constant
printf("\n The total absorption constant = %f O.W.U.
    ",aS)
```

Scilab code Exa 8.6 Calculation of Reverberation time

```
clc
// Given that
V = 1700 // volume in meter^3
a1 = 98 // area of plastered wall in m^2
a2 = 144 // area of plastered ceiling in m^2
a3 = 15 // area of wooden door in m^2
a4 = 88 // area of cushioned chairs in m^2
a5 = 150 // area of audience (each person) in m^2
k1 = 0.03 // coefficient of absorption for plastered
    wall in O.W.U.
k2 = 0.04 // coefficient of absorption for plastered
    ceiling in O.W.U.
k3 = 0.06 // coefficient of absorption for wooden
    door in O.W.U.
k4 = 1 // coefficient of absorption for cushioned
    chair in O.W.U.
k5 = 4.7 // coefficient of absorption for audience (
    each person) in O.W.U.
// Sample Problem 6 on page no. 8.20
printf("\n # PROBLEM 6 # \n")
printf(" Standard formula used \n")
printf(" T = 0.161 V/a*S \n" )
A1 = a1 * k1// calculation for the absorption by the
    plaster wall
A2 = a2 * k2// calculation for the absorption by the
    plastered ceiling
A3 = a3 * k3// calculation for wooden door
A4 = a4 * k4// calculation for cushioned chairs
A = A1 + A2 + A3 + A4// calculation for total
    absorption
```

```
T = 0.161 * (V / A)// calculation for reverberation time

printf("\n Reverberation time is %f sec.",T)
```

Scilab code Exa 8.7 Calculation of Reverberation time

```
clc
// Given that
V = 1400 // volume of hall in meter^3
C = 110 // seating capacity of hall
a1 = 98 // area of plastered wall in m^2
a2 = 144 // area of plastered ceiling in m^2
a3 = 15 // area of wooden door in m^2
a4 = 88 // area of cushioned chairs in m^2
a5 = 150 // area of audience (each person) in m^2
k1 = 0.03 // coefficient of absorption for plastered wall in O.W.U.
k2 = 0.04 // coefficient of absorption for plastered ceiling in O.W.U.
k3 = 0.06 // coefficient of absorption for wooden door in O.W.U.
k4 = 1 // coefficient of absorption for cushioned chair in O.W.U.
k5 = 4.7 // coefficient of absorption for audience (each person) in O.W.U.
// Sample Problem 7 on page no. 8.20
printf("\n # PROBLEM 7 # \n")
printf(" Standard formula used \n")
printf(" T = 0.161 V/a*S \n" )
A1 = a1 * k1// calculation for the absorption by the plaster wall
A2 = a2 * k2// calculation for the absorption by the
```

```
plastered ceiling
A3 = a3 * k3// calculation for wooden door
A4 = a4 * k4// calculation for cushioned chairs
A5 = C*k5 // the absorption due to persons
A = A1 + A2 + A3 + A4 + A5 // calculation for total absorption
T = (0.161 * V) / A// calculation for the reverberation time
printf("\n Reverberation time is %f sec.",T)
```

Scilab code Exa 8.8 Calculation of Reverberation time

```
clc
// Given that
V = 980 // volume in meter^3
a1 = 150 // area of wall in m^2
a2 = 95 // area of ceiling in m^2
a3 = 90 // area of floor in m^2
k1 = 0.03 // coefficient of absorption for wall in O.W.U.
k2 = 0.80 // coefficient of absorption for ceiling in O.W.U.
k3 = 0.06 // coefficient of absorption for floor in O.W.U.
// Sample Problem 8 on page no. 8.21
printf("\n # PROBLEM 8 # \n")
printf(" Standard formula used \n")
printf(" T = 0.161 V/a*S \n" )
A1 = a1 * k1
A2 = a2 * k2
A3 = a3 * k3
A = A1 + A2 + A3
T = 0.161 * (V / A)
```

```
printf("\n Reverberation time = %f sec",T)
```

Scilab code Exa 8.9 Calculation of Acoustic power

```
clc
// Given that
V = 980 // volume in meter^3
a = 1.58 // area of window in m^2
I_ = 1e-12 // standard intensity level of sound wave
    in W/m^2
l = 60 // intensity level in dB
// Sample Problem 9 on page no. 8.21
printf("\n # PROBLEM 9 # \n")
I = I_ * 10^(l / 10)// calculation for intensity
AP = I * a// calculation for acoustic power
printf("Standard formula used \n Intensity level=10
    log(I/I_),\nAP=I*A\n")
printf("\n Acoustic power = %e watt.",AP)
```

Chapter 9

DIELECTRICS

Scilab code Exa 9.1 Calculation of Polarization vector and Displacement vector

```
clc
// Given that
E = 10^6 // electric field inside the plates in V/m
d = 0.02 // distance between the plates in meter
k = 3 // dielectric constant of slab
e_ = 8.85e-12 // electric permittivity of air in C^2/Nm^2
// Sample Problem 1 on page no. 9.11
printf("\n # PROBLEM 1 # \n")
printf(" Standard formula used \n")
printf(" D = e_*E+p. \n D=e_*k*E.\n\n ")
D = e_*k*E
P = D-e_*E
printf("Polarization vector is %e C/m^2. \n Displacement vector is %e C/m^2",P,D)
```

Scilab code Exa 9.2 Calculation of The included charge density on the surface of the dielectric

```
clc
// Given that
E1 = 3*10^5 // electric intensity when space between
    plates evacuated in V/m
E2 = 1*10^5 // electric intensity when space between
    plates is filled with dielectric in V/m
e_ = 8.85e-12 // electric permittivity of air in C
   ^2/Nm^2
// Sample Problem 2 on page no. 9.11
printf("\n # PROBLEM 2 # \n")
printf(" Standard formula used \n")
printf(" E = E_-P/e_.\n\n ")
sigma = e_*(E1 - E2)
printf("The included charge density on the surface
   of the dielectric is %e C/m^2",sigma )
```

Scilab code Exa 9.3 Calculation of Polarization vector and Displacement vector and Energy density

```
clc
// Given that
E = 1*10^5 // electric field strength inside the
   plates in V/m
d = 6 // distance between the plates in mm
k = 2.8 // dielectric constant of slab
```

```
e_ = 8.85e-12 // electric permittivity of air in C^2/Nm^2
// Sample Problem 3 on page no. 9.11
printf("\n # PROBLEM 3 # \n")
printf(" Standard formula used \n")
printf(" P = e_*(k-1)*E.\n\n ")
P = e_*(k-1)*E
D = e_*k*E
energy_density = 1/2 * k*e_*E^2
printf("Polarization vector is %e C/m^2. \n Displacement vector is %eC/m^2. \n Energy density is %f J/m^3.",P,D,energy_density )
```

Scilab code Exa 9.4 Calculation of Value of relative permittivity and Total dipole moment of the slab

```
clc
// Given that
D = 5e-4 // electric displacement vector in C/m^2
P = 4e-4 // electric polarization vector in C/m^2
v = 0.5 // volume of the slab in m^3
e_ = 8.85e-12 // electric permittivity of air in C^2/Nm^2
// Sample Problem 4 on page no. 9.12
printf("\n # PROBLEM 4 # \n")
printf(" Standard formula used \n")
printf(" D= e_*E.\n\n ")
E= (D-P)/ e_
k = D/(e_*E)
p = P*v
energy_density = 1/2 * k*e_*E^2
printf("Value of relative permittivity is %d. \n Total dipole moment of the slab is %e C-m.",k,p )
```

Scilab code Exa 9.5 Calculation of Induce dipole moment of each

```
clc
// Given that
E = 3e4 // external field in V/m
k = 1.00074 // dielectric constant of gas at N.T.P.
e_ = 8.85e-12 // electric permittivity of air in C
    ^2/Nm^2
// Sample Problem 5 on page no. 9.12
printf("\n # PROBLEM 5 # \n")
printf(" Standard formula used \n")
printf(" P=x*e_*E.\n\n ")
x = k-1
P = x*e_*E
N = 6.023e23/22.4e-3
p = P/N
printf("Induce dipole moment of each is %e C-m",p)
```

Scilab code Exa 9.6 Calculation of Electric susceptibility at 0 degree centigrade

```
clc
// Given that
E = 3e4 // external field in V/m
k = 1.000041 // dielectric constant of gas at 0
    degree centigrate
// Sample Problem 6 on page no. 9.1
```

```
printf("\n # PROBLEM 6 # \n")
printf(" Standard formula used \n")
printf(" P=x*e_*E.\n\n ")
x = k-1
printf("Electric susceptibility at 0 degree centigrate is %e.",x)
```

Chapter 10

ELECTROMAGNETISM

Scilab code Exa 10.15 Calculation of The total charge within volume

```
clc
// Given that
n = 2000 // flux lines enter in given volume  in Vm
n_ = 4000 // flux lines diverge from given volume in
    Vm
e0 = 8.85e-12 // permittivity of space
// Sample Problem 15 on page no. 10.42
printf("\n # PROBLEM 15 # \n")
fi = n_ - n
q = e0 * fi
printf("Standard formula used \n fi = q/e_")
disp(q,' The total charge within volume(in C) = ')
```

Scilab code Exa 10.16 Calculation of The total charge enclosed by closed surface

```
clc
// Given that
n = 20000 // flux lines entering in given volume in Vm
n_ = 45000 // flux lines entering out from given volume in Vm
e0 = 8.85e-12 // permittivity of space
// Sample Problem 16 on page no. 10.42
printf("\n # PROBLEM 16 # \n")
fi = n_ - n
q = e0 * fi
printf("Standard formula used \n fi= q/e_. \n")
printf("The total charge enclosed by closed surface is %e C.",q)
```

Scilab code Exa 10.17 Calculation of Electric flux

```
clc
// Given that
q = 13.5e-6 // charge enclosed at the centre of cube in C
l = 6 // length of the side of cube in cm
e0 = 8.85e-12 // permittivity of space
// Sample Problem 17 on page no. 10.43
printf("\n # PROBLEM 17 # \n")
fi = q / e0
fi_ = fi / 6
q = e0 * fi
printf("Standard formula used \n fi=q/e_.\n")
printf("Electric flux through the whole volume of the cube is %e Nm^2/C.\n Electric flux through one face of the cube is %e Nm^2/C.",fi,fi_)
```

Scilab code Exa 10.18 Calculation of Electric flux through each surface of the cube

```
clc
// Given that
q = 11 // charge enclosed at the centre of cube in C
l = 5 // length of the side of cube in cm
e0 = 8.85e-12 // permittivity of space
// Sample Problem 18 on page no. 10.43
printf("\n # PROBLEM 18 # \n")
fi_ = (q / e0) / 6
printf("\nStandard formula used \n fi=q/e_\n")
printf(" Electric flux through each surface of the
   cube = %e Nm^2/C.",fi_)
```

Scilab code Exa 10.19 Calculation of Electric field intensity

```
clc
// Given that
q = 1e-8 // charge uniformly spread over metallic
   sphere in C
r = .1 //radius of sphere in m
d = 7 // distance of a point from centre of the
   sphere in cm
d_ = .5 // distance of another point from centre of
   the sphere in m
e0 = 8.85e-12 // permittivity of space
// Sample Problem 19 on page no. 10.43
```

```
printf("\n # PROBLEM 19 # \n")
E1 = (1 / (4 * %pi * e0) * (q / r^2))
E2 = 0 //because sphere is metallic
E3 = (1 / (4 * %pi * e0) * (q / d_^2))
printf("Standard formula used \n E = (1 / (4 * pi *
    e0) * (q / r^2)). \n")
printf(" Electric field intensity -\n (1) On the
    surface of the sphere = %e N/C,\n (2) At first
    point = %d N/C,\n (3) At second point = %e N/C",
    E1,E2,E3)
```

Scilab code Exa 10.20 Calculation of Electric field

```
clc
// Given that
q = 1.6e-19 // charge on a proton in C
d = 1e-10 // distance of a point from proton in m
e0 = 8.85e-12 // permittivity of space
// Sample Problem 20 on page no. 10.44
printf("\n # PROBLEM 20 # \n")
E = (1 / (4 * %pi * e0)) * (q / d^2)
printf("Standard formula used \n E = (1 / (4 * pi *
    e0)) * (q / d^2).\n")
printf(" Electric field = %e V/m.",E)
```

Scilab code Exa 10.21 Calculation of Energy gained by alpha particle

```
clc
// Given that
```

```
v = 1000 // potential through which alpha particle accelerated in V
q = 3.2e-19 // charge on an alpha particle in C
e0 = 8.85e-12 // electric permittivity of space
// Sample Problem 21 on page no. 10.44
printf("\n # PROBLEM 21 # \n")
E = q * v
printf("Standard formula used \n E = q * v.\n")
printf(" Energy gained by alpha particle = %e J.",E)
```

Scilab code Exa 10.22 Calculation of Potential and Potential energy and Potential difference

```
clc
// Given that
q = 1.6e-19 // charge on a proton in C
d = 1e-10 // distance of a point from proton in m
d_ = 2e-11 // distance of another point from proton in m
e0 = 8.85e-12 // permittivity of space
// Sample Problem 22 on page no. 10.44
printf("\n # PROBLEM 22 # \n")
v = (1 / (4 * %pi * e0)) * (q / d)//calculation for potential at first point
E = -q * v//calculation for energy at first point in J
delta_v = (1 / (4 * %pi * e0)) * q * ((1 / d_) - (1 / d))//calculation for potential difference between points
printf("Standard formula used \n V=(1/(4*pi*e_))*q/r,\n E=-(1/(4*pi*e_))*q^2/r.\n")
printf(" Potential energy at first point = %f eV.\n Potential difference between points = %f V.",E/q,
```

```
delta_v)
```

Scilab code Exa 10.23 Calculation of Radius of equipotential surface

```
clc
// Given that
q = 1.5e-6 // charge in C
v = 30 // potential of a surface in V
e0 = 8.85e-12 // permittivity of space
// Sample Problem 23 on page no. 10.45
printf("\n # PROBLEM 23 # \n")
r = (1 / (4 * %pi * e0)) * (q / v)
printf("Standard formula used \n v = (1/(4*pi*e_)*(q
    /r)).\n")
printf(" Radius of equipotential surface = %d m.",
    ceil(r))
```

Scilab code Exa 10.24 Calculation of The value of poynting vector at the surface of the sun

```
clc
// Given that
p = 3.8e26 // power radiated by sun in W
r = 7e8 // radius of sun in m
e0 = 8.85e-12 // permittivity of space
// Sample Problem 24 on page no. 10.45
printf("\n # PROBLEM 24 # \n")
s = p / (4 * %pi * r^2)
```

```
printf("Standard formula used \n s = p / (4 * pi * r
   ^2).\n")
printf(" The value of poynting vector at the surface
    of the sun = %e W/m^2.",s)
```

Scilab code Exa 10.28 Calculation of Magnitude of electric field vector and Magnitude of magnetic field vector

```
clc
// Given that
s = 2 // energy received by the earth in cal/cm^2.
   min
e0 = 8.85e-12 // electric permittivity of space
mu0 = 1.2567e-6 // magnetic permittivity of space
c = 3e8 // speed of light in meter/sec
// Sample Problem 28 on page no. 10.47
printf("\n # PROBLEM 28 # \n")
r = sqrt(mu0 / e0)
P = s*4.2/(60*1e-4)
E = sqrt(P*r)
H = E/r
printf("Standard formula used \n P = E*H.\n")
printf(" Magnitude of electric field vector = %f v/m
   .\n Magnitude of magnetic field vector = %f A/m."
   ,E * sqrt(2),H*sqrt(2))
```

Scilab code Exa 10.29 Calculation of Magnitude of electric field vector

```
clc
```

```
// Given that
H = 1 // magnitude of magnetic field vector A/m
e0 = 8.85e-12 // electric permittivity of space
mu0 = 1.2567e-6 // magnetic permittivity of space
c = 3e8 // speed of light in meter/sec
// Sample Problem 29 on page no. 10.48
printf("\n # PROBLEM 29 # \n")
r = sqrt(mu0 / e0) // ratio of E,H
E = H * r
printf("Standard formula used \n H_/E_=sqrt(e_/mu_)
    .\n")
printf(" Magnitude of electric field vector = %f v/m
    .",E)
```

Scilab code Exa 10.31 Calculation of Average value of the intensity of electric field of radiation

```
clc
// Given that
p = 1000 // power of lamp in W
d = 2 // distance of a point from lamp in meter
e0 = 8.85e-12 // electric permittivity of space
mu0 = 1.2567e-6 // magnetic permittivity of space
c = 3e8 // speed of light in meter/sec
// Sample Problem 31 on page no. 10.48
printf("\n # PROBLEM 31 # \n")
s = p / (4 * %pi * d^2) //calculation for
r = sqrt(mu0 / e0) // ratio of E,H
E = sqrt(s * r)//calculation for average value of
    intensity of electric field of radiation
printf("Standard formula used \n E_/H_=sqrt(mu_/e_)
    ,\nP=E*H.\n")
printf(" Average value of the intensity of electric
```

```
field of radiation = %f v/m.",E)
```

Scilab code Exa 10.32 Calculation of Refractive index of distilled water and Speed of light in water

```
clc
// Given that
k = 81 // relative permittivity of water
c = 3e8 // speed of light in meter/sec
// Sample Problem 32 on page no. 10.49
printf("\n # PROBLEM 32 # \n")
printf(" Standard formula used \n")
printf(" mu_ = ( mu*epsilon /(mu_0/*psilon_0))^1/2
    \n \n" )
mu = sqrt(k)
v = c / mu
printf(" Refractive index of distilled water is %d
    .\n Speed of light in water is %e m/sec.",mu,v)
```

Chapter 11

THEORY OF RELATIVITY

Scilab code Exa 11.5 Calculation of Coordinate of the event in reference frame using Galilean transformation and Coordinate of the event in reference frame using Lorentz transformation

```
clc
// Given that
x = 100 // in meter
y = 10 // in meter
z = 5  // in meter
t = 1e-4 // in sec
// coordinates of point in frame F
v = 2.7e8 // velocity of frame F_ w.r.t. frame F in
   m/sed
c=3e8 // speed of light in m/sec
// Sample Problem 5 on page no. 11.19
printf("\n # PROBLEM 5 # \n")
// according to Galilean transformation
x__ = x-v*t
y__=y
z__=z
t__=t
```

```
// according to Lorentz transformation
x_ = (x-v*t)/sqrt(1-(v/c)^2)
y_=y
z_=z
t_=(t-(v*x/c^2))/sqrt(1-(v/c)^2)
printf("\n Coordinate of the event in reference frame F_ using (a)Galilean transformation-x=%f m, y=%f m, z = %f m, t = %e sec. \n (b)Lorentz transformation-x=%f m,y =%f m, z = %f m, t=%e sec. ",x__,y__,z__,t__,x_,y_,z_,t_)
```

Scilab code Exa 11.6 Calculation of Speed of particle

```
clc
// Given that
r = 4 // ratio of mass of particle to the rest mass
// Sample Problem 6 on page no. 11.20
printf("\n # PROBLEM 6 # \n")
printf(" Standard formula used \n")
printf(" m = m_0/((1-v^2/c^2)^1/2) \n ")
v = 3e8 * sqrt(1 - (1 / r)^2)
printf("\n Speed of particle is %e meter/sec.",v)
```

Scilab code Exa 11.7 Calculation of Speed of particle

```
clc
// Given that
r = 1.2 // ratio of mass of particle to the rest mass
```

```
// Sample Problem 7 on page no. 11.20
printf("\n # PROBLEM 7 # \n")
printf(" Standard formula used \n")
printf(" m = m_0/((1-v^2/c^2)^1/2) \n ")
v = 3e8 * sqrt(1 - (1 / r)^2)
printf("\n Speed of particle is %f c.",v/3e8)
```

Scilab code Exa 11.9 Calculation of Speed of electron and Mass of electron

```
clc
// Given that
E = 2 // kinetic energy of electron in Mev
// Sample Problem 9 on page no. 11.20
printf("\n # PROBLEM 9 # \n")
printf(" Standard formula used \n")
printf(" m = m_0/((1-v^2/c^2)^1/2) \n  KE = m*c^2 -
    m_0*c^2 \n")
v = 3e8 * sqrt(1 - (1 / (1 + (1.6e-19 * 2e6) / (9.1e
    -31 * 3e8^2)))^2)
m = (9.1e-31) / sqrt(1 - (v / 3e8)^2)
printf("\n Speed of electron is %f c.\n Mass of
    electron is %e kg.",v/3e8,m)
```

Scilab code Exa 11.10 Calculation of Velocity

```
clc
// Given that
u = 3e8 // speed of signal in meter/sec
```

```
// Sample Problem 10 on page no. 11.21
printf("\n # PROBLEM 10 # \n")
printf(" Standard formula used \n")
printf(" u_x = u_x_ + v / (1+ v*u_x_/c^2). \n ")
u_ = (u + 3e8) / (1 + (u * 3e8) / 3e8^2)
printf("\n Velocity is %d*c, hence we can say that no signal can travel faster than light.",u_/3e8)
```

Scilab code Exa 11.11 Calculation of Speed of particle

```
clc
// Given that
r = 2.25 // ratio of mass of particle to the rest mass
// Sample Problem 11 on page no. 11.22
printf("\n # PROBLEM 11 # \n")
printf(" Standard formula used \n")
printf(" m = m_0/((1-v^2/c^2)^1/2) \n ")
v = 3e8 * sqrt(1 - (1 / r)^2)
printf("\n Speed of particle is %e meter/sec.",v)
```

Scilab code Exa 11.12 Calculation of Velocity of particle

```
clc
// Given that
r = 2 // ratio of kinetic energy of body to its rest mass
// Sample Problem 12 on page no. 11.22
printf("\n # PROBLEM 12 # \n")
```

```
printf(" Standard formula used \n")
printf(" m = m_0/((1-v^2/c^2)^1/2) \n KE = (m-m_0)*c
    ^2  \n ")
v = 3e8 * sqrt(1 - (1 / (r + 1))^2)
printf("\n Velocity of particle is %f c.",v/3e8)
```

Scilab code Exa 11.13 Calculation of Kinetic energy of electron and Momentum of particle

```
clc
// Given that
r = 11 // ratio of mass of particle to the rest mass
     of electron
// Sample Problem 13 on page no. 11.22
printf("\n # PROBLEM 13 # \n")
printf(" Standard formula used \n")
printf(" m = m_0/((1-v^2/c^2)^1/2) \n KE = (m-m_0)*c
    ^2  \n ")
KE = (r - 1) * 9.1e-31 * 3e8^2 / (1.6e-19)
m = 3e8 * sqrt(1 - (1 / r)^2) * 9.1e-31 * 11
printf("\n Kinetic energy of electron is %f MeV.\n
    Momentum of particle is %e N-sec.",KE/1e6,m)
```

Scilab code Exa 11.14 Calculation of Velocity of electron

```
clc
// Given that
m = 1.67e-27  // mass of electron in kg
m_ = 9.1e-31 // rest mass of electron in kg
```

```
// Sample Problem 14 on page no. 11.23
printf("\n # PROBLEM 14 # \n")
printf(" Standard formula used \n")
printf(" m = m_0/((1-v^2/c^2)^1/2) \n ")
v = 3e8 * sqrt(1 - (m_ / m)^2)
printf("\n Velocity of electron is %f meter/sec.",v)
```

Scilab code Exa 11.15 Calculation of Speed according to classical mechanics and Speed according to relativistic mechanics

```
clc
// Given that
E = 0.1 // kinetic speed of electron in Mev
// Sample Problem 15 on page no. 11.23
printf("\n # PROBLEM 15 # \n")
printf(" Standard formula used \n")
printf(" m = m_0/((1-v^2/c^2)^1/2) \n KE = (m-m_0)*c^2  \n KE = 1/2*m*v^2 \n")
v_ = sqrt(2 * (E * 1.6e-13) / 9.1e-31)
v = 3e8 * sqrt(1 - (1 / (1 + (1.6e-13 * E) / (9.1e-31 * 3e8^2)))^2)
printf("\n Speed according to classical mechanics is %e meter/sec.\n Speed according to relativistic mechanics is %e meter/sec.",v_,v)
```

Scilab code Exa 11.17 Calculation of Velocity of particle

```
clc
// Given that
```

```
r1 = 3 // ratio of kinetic energy of body to its
    rest mass in first case
r2 = 1 // ratio of kinetic energy of body to its
    rest mass in second case
// Sample Problem 17 on page no. 11.24
printf("\n # PROBLEM 17 # \n")
printf(" Standard formula used \n")
printf(" m = m_0/((1-v^2/c^2)^1/2) \n KE = (m-m_0)*c
    ^2 \n")
v1 = 3e8 * sqrt(1 - (1 / (r1 + 1))^2)
v2 = 3e8 * sqrt(1 - (1 / (r2 + 1))^2)
printf("\n Velocity of particle if kinetic energy is
     %d times of rest mass energy  is %e meter/sec.\n
     Velocity of particle if kinetic energy is %d
    times of rest mass energy  is %e meter/sec.\n",r1
    ,v1,r2,v2)
```

Scilab code Exa 11.19 Calculation of Speed of electron and Mass of electron

```
clc
// Given that
E = 1.5 // kinetic energy of electron in Mev
// Sample Problem 19 on page no. 11.25
printf("\n # PROBLEM 19 # \n")
printf(" Standard formula used \n")
printf(" m = m_0/((1-v^2/c^2)^1/2) \n KE = (m-m_0)*c
    ^2 \n")
v = 3e8 * sqrt(1 - (1 / (1 + (1.6e-19 * 2e6) / (9.1e
    -31 * 3e8^2)))^2)
m = (E * 1.6e-13 / (3e8)^2) + 9.1e-31
printf("\n Speed of electron is %e meter/sec.\n Mass
     of electron is %e kg.",v,m)
```

Scilab code Exa 11.20 Calculation of Length of meter stick

```
clc
// Given that
r = 3 / 2 // ratio of mass of metre stick to the rest mass of metre stick
// Sample Problem 20 on page no. 11.26
printf("\n # PROBLEM 20 # \n")
printf(" Standard formula used \n")
printf(" m = m_0/((1-v^2/c^2)^1/2) \n l = l_0/((1-v^2/c^2)^1/2)  \n")
l = 1 * (1 / r)
printf("\n Length of meter stick is %f meter if mass is %f times of its rest mass.",l,r)
```

Scilab code Exa 11.21 Calculation of Velocity of a frame with respect to other frame

```
clc
// Given that
r = 1 / 2 // ratio of area of circular lamina in frame S_ to the ratio of area of circular lamina in frame S
// Sample Problem 21 on page no. 11.26
printf("\n # PROBLEM 21 # \n")
printf(" Standard formula used \n")
printf(" d = d_0/((1-v^2/c^2)^1/2)  \n")
```

```
v = 3e8 * sqrt(1 - r^2)
printf("\n Velocity of frame S_ w.r.t. frame S is %e
    meter/sec.",v)
```

Scilab code Exa 11.22 Calculation of Speed of clock

```
clc
// Given that
t = 1 // lose in time in an hour in minute
// Sample Problem 22 on page no. 11.27
printf("\n # PROBLEM 22 # \n")
printf(" Standard formula used \n")
printf(" t = t_0/((1-v^2/c^2)^1/2) \n")
v = 3e8 * sqrt(1 - ((60 - t) / 60)^2)
printf("\n Speed of clock is %e meter/sec.",v)
```

Scilab code Exa 11.23 Calculation of Distance travel by the beam

```
clc
// Given that
t_ = 2.5e-8 // proper life of pi+ mesons in sec
v = 2.4e8 // velocity of beam of mesons in m/sec
r = 1 / exp(2) // ratio of final flux to initial
   flux of the meson beam
// Sample Problem 23 on page no. 11.27
printf("\n # PROBLEM 23 # \n")
printf(" Standard formula used \n")
printf(" t = t_0/((1-v^2/c^2)^1/2) \n N = N_0*e^(-t/
   tau) \n")
```

```
t = t_ / sqrt(1 - (v / 3e8)^2)
T = t * log(1 / r)
d = T * v
printf("\n Distance travel by the beam is %f meter.",d)
```

Scilab code Exa 11.24 Calculation of Velocity of rocket with respect to earth

```
clc
// Given that
v = 1.8e8 // velocity of space ship away from the earth in m/sec
v1 = 2.1e8 // velocity of rocket w.r.t. space ship away from the earth in first case in m/sec
v2 = -2.1e8 // velocity of rocket w.r.t. space ship away from the earth in second case in m/sec
// Sample Problem 24 on page no. 11.27
printf("\n # PROBLEM 24 # \n")
printf(" Standard formula used \n")
printf(" u_x = u_x_ + v / (1+ v*u_x_/c^2) \n ")
u1 = (v1 + v) / (1 + ((v1 * v) / (3e8)^2))
u2 = (v2 + v) / (1 + ((v2 * v) / (3e8)^2))
printf("\n Velocity of rocket w.r.t. earth in first case = %f c away from the earth.\n Velocity of rocket w.r.t. earth in second case = %f c away from the earth ",u1/3e8,u2/3e8)
```

Scilab code Exa 11.25 Calculation of Length as it appear to the observer

```
clc
// Given that
l = 1 // length of the rod in meter
v = 1.8e8 // speed of rod along its length in meter/
    sec
// Sample Problem 25 on page no. 11.28
printf("\n # PROBLEM 25 # \n")
printf(" Standard formula used \n")
printf(" l = l_0/((1-v^2/c^2)^1/2)  \n")
L = l * sqrt(1- (v / 3e8)^2)
printf("\n Length as it appear to the observer is %f
     meter. ",L)
```

Scilab code Exa 11.26 Calculation of Length as it appear to the observer

```
clc
// Given that
l = 2 // length of the rod in meter
v = 2.7e8 // speed of rod along its length in meter/
    sec
// Sample Problem 26 on page no. 11.28
printf("\n # PROBLEM 26 # \n")
printf(" Standard formula used \n")
printf(" l = l_0/((1-v^2/c^2)^1/2)  \n")
L = l * sqrt(1- (v / 3e8)^2)
printf("\n Length as it appear to the observer is %f
     meter.",L)
```

Scilab code Exa 11.27 Calculation of Percentage length contraction

```
clc
// Given that
l = 100 // consider the length of the rod in meter
v = 2.4e8 // speed of rod in meter/sec
theta = %pi / 3 // direction of velocity of rod
    along its length in radian
// Sample Problem 27 on page no. 11.28
printf("\n # PROBLEM 27 # \n")
printf(" Standard formula used \n")
printf(" l = l_0/((1-v^2/c^2)^1/2)  \n l^2 = l_x^2 +
     l_y^2 \n")
Lx = l * cos(theta)
Ly = l * sin(theta)
L_x = Lx * sqrt(1 - (v / 3e8)^2)
L_y = Ly
L = sqrt(L_x^2 + L_y^2)
p_l = ((l - L) / l) * 100
printf("\n Percentage length contraction is %f
    percent.",p_l)
```

Scilab code Exa 11.28 Calculation of Speed of the rod relative to observer

```
clc
// Given that
r = 0.5 // ratio of length of rod when it is in
    motion to the length of the rod when it is in
    rest
// Sample Problem 28 on page no. 11.29
printf("\n # PROBLEM 28 # \n")
printf(" Standard formula used \n")
printf(" l = l_0/((1-v^2/c^2)^1/2)  \n")
v = 3e8 * sqrt(1 - r^2)
printf("\n Speed of the rod relative to observer is
```

```
%f c.",v/3e8)
```

Scilab code Exa 11.29 Calculation of Length of the rod in moving frame and Orientation of the rod

```
clc
// Given that
l = 5 // length of the rod in meter
v = 1.8e8 // speed of rod in meter/sec
theta = %pi / 6 // direction of velocity of rod along its length in radian
// Sample Problem 29 on page no. 11.30
printf("\n # PROBLEM 29 # \n")
printf(" Standard formula used \n")
printf(" l = l_0/((1-v^2/c^2)^1/2)  \n l^2 = l_x^2 + l_y^2 \n")
Lx = l * cos(theta)
Ly = l * sin(theta)
L_x = Lx * sqrt(1 - (v / 3e8)^2)
L_y = Ly
L = sqrt(L_x^2 + L_y^2)
orientation = atan(L_y / L_x) * (180 / %pi)
printf("\n Length of the rod in moving frame is %f meter.\n Orientation of the rod is %f degree.",L, orientation)
```

Scilab code Exa 11.30 Calculation of half life of particle

```
clc
```

```
// Given that
T = 17.8e-9 // half-life of prticle at rest in sec
v = 2.4e8 // speed of particle in meter/sec
// Sample Problem 30 on page no. 11.30
printf("\n # PROBLEM 30 # \n")
printf(" Standard formula used \n")
printf(" t = t_0/((1-v^2/c^2)^1/2) \n")
t = T / (sqrt(1 - (v / 3e8)^2))
printf("\n New half-life of particle is %f nanosec."
    ,t/1e-9)
```

Scilab code Exa 11.31 Calculation of Time lost per day

```

clc
// Given that
T = 24 // no. of hours in a day
v = 1e8 // speed of spaceship in meter/sec
// Sample Problem 31 on page no. 11.30
printf("\n # PROBLEM 31 # \n")
printf(" Standard formula used \n")
printf(" t = t_0/((1-v^2/c^2)^1/2) \n")
t = T * (sqrt(1 - (v / 3e8)^2))
T_ = T - t
m=(T_-1)*60
s=(m-22)*60
printf("\n Time lost per day is %d hours %d minute
    %d sec.",T_,m,s)
//Answer in the book:1 hr 22 min 12 sec
//Answer in the program:1.372583 e+00 hours
```

Scilab code Exa 11.32 Calculation of Speed of rocket

```
clc
// Given that
T = 4 // no. of year when rocket is moving
    corresponding to one year
// Sample Problem 32 on page no. 11.30
printf("\n # PROBLEM 32 # \n")
printf(" Standard formula used \n")
printf(" t = t_0/((1-v^2/c^2)^1/2) \n")
v = 3e8 * sqrt(1 - (1 / T)^2)
printf("\n Speed of rocket is %f c.",v/3e8)
```

Scilab code Exa 11.33 Calculation of Time taken by the rocket

```
clc
// Given that
d = 4 // distance of star from the earth in light
    years
v = 3e8 * sqrt(0.9999) // speed of rocket in meter/
    sec
// Sample Problem 33 on page no. 11.31
printf("\n # PROBLEM 33 # \n")
printf(" Standard formula used \n")
printf(" t = t_0/((1-v^2/c^2)^1/2) \n")
t = (2 * d * 3e8) / v
T_ = t * sqrt(1 - (v / 3e8)^2)
printf("\n Time taken by the rocket is %f year.",T_)
```

Scilab code Exa 11.34 Calculation of Proper life time of particle

```
clc
// Given that
t = 2e-7 // life time of particle when it is moving
   in sec
v = 2.8e8 // speed of particle in meter/sec
// Sample Problem 34 on page no. 11.31
printf("\n # PROBLEM 34 # \n")
printf(" Standard formula used \n")
printf(" t = t_0/((1-v^2/c^2)^1/2) \n")
T_ = t * sqrt(1 - (v / 3e8)^2)
printf("\n Proper life time of particle is %e sec.",
   T_)
```

Scilab code Exa 11.35 Calculation of Velocity of electrons beam with respect to another electron beam according to Newtonian mechanics and Velocity of electrons beam measured by the observer moving with other electron beam

```
clc
// Given that
v1 = 2.7e8 // velocity of first electron beam in
   meter/sec
v2 = -2.7e8 // velocity of second electron beam in
   meter/sec
// Sample Problem 35 on page no. 11.31
```

```
printf("\n # PROBLEM 35 # \n")
printf(" Standard formula used \n")
printf(" u_x = u_x_ + v / (1+ v*u_x_/c^2) \n ")
u = v1 - v2
u_ = (v1 - v2) / (1 - (v1 * v2) / (3e8)^2)
printf("\n Velocity of electrons beam w.r.t. another electron beam according to Newtonian mechanics is %f c.\n Velocity of electrons beam measured by the observer moving with other electron beam = %f c.",u/3e8,u_/3e8)
```

Scilab code Exa 11.36 Calculation of Relative velocity of photons

```
clc
// Given that
c = 3e8 // velocity of photon in meter/sec
// Sample Problem 36 on page no. 11.32
printf("\n # PROBLEM 36 # \n")
printf(" Standard formula used \n")
printf(" u_x = u_x_ + v / (1+ v*u_x_/c^2) \n ")
u = (c + c) / ( 1 + (c / 3e8)^2)
printf("\n Relative velocity of photons is %e meter/sec.",u)
```

Scilab code Exa 11.37 Calculation of Relativistic mass of proton

```
clc
// Given that
```

```
E = 900 // total relativistic energy of proton in
    Mev
m = 1.63-27 // rest mass of proton in kg
c = 3e8 // velocity of photon in meter/sec
// Sample Problem 37 on page no. 11.32
printf("\n # PROBLEM 37 # \n")
printf(" Standard formula used \n")
printf(" E = m*c^2 \n ")
m_ = (E * 1.6e-13) / (c)^2
printf("\n Relativistic mass of proton is %e kg,\n
    Here relativistic mass is same as rest mass\n
    hence proton is at rest and speed and kinetic
    energy of proton will be zero",m_)
```

Scilab code Exa 11.38 Calculation of Fraction of total energy content

```
clc
// Given that
E = 5.4e6 // energy liberates during dynamite
    explosion in J/kg
c = 3e8 // velocity of photon in meter/sec
// Sample Problem 38 on page no. 11.32
printf("\n # PROBLEM 38 # \n")
printf(" Standard formula used \n")
printf(" E = m*c^2 \n ")
E_ = 1 * c^2 // energy liberated by 1 kg content in
    J
f = E / E_
printf("\n Fraction of total energy content in it is
    %e per kg.",f)
```

Scilab code Exa 11.39 Calculation of Speed of the electron

```
clc
// Given that
k = 1.02 // kinetic energy of electron in Mev
E_ = 0.51 // rest mass energy of electron in Mev
c = 3e8 // velocity of photon in meter/sec
// Sample Problem 39 on page no. 11.32
printf("\n # PROBLEM 39 # \n")
printf(" Standard formula used \n")
printf(" E = KE + m*c^2 \n m = m_0/((1-v^2/c^2)^1/2)
    \n")
E = k + E_
v = c * sqrt(1 - (E_ / E)^2)
printf("\n Speed of the electron is %e meter/sec.",v
    )
```

Scilab code Exa 11.40 Calculation of Rate of decrement of mass of the sun

```
clc
// Given that
E = 1400 // solar energy receives by the earth in W/
    square meter
d = 1.5e11 // distance between earth and the sun in
    meter
c = 3e8 // velocity of photon in meter/sec
// Sample Problem 40 on page no. 11.33
```

```
printf("\n # PROBLEM 40 # \n")
printf(" Standard formula used \n")
printf(" E = m*c^2 \n ")
E_ = 4 * %pi * d^2 * E
m = E_ / c^2
printf("\n Rate of decrement of mass of the sun is
    %e kg/sec.",m)
```

Chapter 12

APPLIED NUCLEAR PHYSICS

Scilab code Exa 12.1 Calculation of Mass absorption coefficient of Al and Half value thickness

```
clc
// Given that
E = 1.14 // energy of gamma radiation in Mev
l = 0.2 // length of aluminium in meter
p = 0.03 // reduce in intensity in beam
d = 2700 // density of aluminium in kg/m^3
// Sample Problem 1 on page no. 12.31
printf("\n # PROBLEM 1 # \n")
printf("Standard formula used \n")
printf("I = I_0*e^(-mu*x) \n")
mu = (1 / l) * log(1 / p)
k = mu / d
x = 0.693 / mu
printf("\n Mass absorption coeffiecient of Al for this radiation is %f m^2/kg.\n Half value thickness is %f meter.",k,x)
```

Scilab code Exa 12.2 Calculation of Mass attenuation coefficient of Al

```
clc
// Given that
E = 1.1 // energy of gamma radiation in Mev
l = 0.25 // length of aluminium in meter
p = 0.02 // reduce in intensity in beam
d = 2700 // density of aluminium in kg/m^3
// Sample Problem 2 on page no. 12.32
printf("\n # PROBLEM 2 # \n")
printf("Standard formula used \n")
printf("I = I_0*e^(-mu*x) \n")
mu = (1 / l) * log(1 / p)
k = mu / d
x = 0.693 / mu
printf("\n Mass attenuation coefficient of Al for
    this radiation is %e m^2/kg.\n Half value
    thickness is %f meter.",k,x)
```

Scilab code Exa 12.3 Calculation of Time

```
clc
// Given that
t = 15 // half-life for Na(23) in hours
r = 93.75 // percentage fraction of sample which
    decayed
// Sample Problem 3 on page no. 12.32
```

```
printf("\n # PROBLEM 3 # \n")
printf("Standard formula used \n")
printf(" lambda = 0.693 / t_1/2     (Decay constant)
    \n N =N_0*e^(-lambda*t) \n")
lambda = 0.693 / t
T = (1 / lambda) * (log(100 / (100 - r)))
printf("\n Time taken for 93.75 per decay of sample
   is %d hours.",T)
```

Scilab code Exa 12.4 Calculation of Time

```
clc
// Given that
t = 4 // half-life of radioactive element in years
r = 1 / 64 // ratio of mass of element present in
   specimen to the initial mass of element
// Sample Problem 4 on page no. 12.33
printf("\n # PROBLEM 4 # \n")
printf("Standard formula used \n")
printf(" lambda = 0.693 / t_1/2     (Decay constant)
    \n N =N_0*e^(-lambda*t) \n")
lambda = 0.693 / t
T = (1 / lambda) * log(1 / r)
printf("\n Time after which element present in
   specimen reduce to 1/64 of its original value is
   %d years.",T)
```

Scilab code Exa 12.5 Calculation of Period

```
clc
// Given that
t = 15 // half-life of radioactive element in years
r = 0.025 // ratio of mass of element present in
    specimen to the intial mass of element
// Sample Problem 5 on page no. 12.33
printf("\n # PROBLEM 5 # \n")
printf("Standard formula used \n")
printf(" lambda = 0.693 / t_1/2      (Decay constant)
     \n N =N_0*e^(-lambda*t) \n")
lambda = 0.693 / t
T = (1 / lambda) * log(1 / r)
printf("\n Period in which 2.5 percent of the
    initial quantity left over is %f years.",T)
```

Scilab code Exa 12.6 Calculation of Time

```
clc
// Given that
t = 3.8 // half-life for radon in days
r = 60 // percentage fraction of sample which
    decayed
// Sample Problem 6 on page no. 12.33
printf("\n # PROBLEM 6 # \n")
printf("Standard formula used \n")
printf(" lambda = 0.693 / t_1/2      (Decay constant)
     \n N =N_0*e^(-lambda*t) \n")
lambda = 0.693 / t
T = (1 / lambda) * (log(100 / (100 - r)))
printf("\n Time taken for 60 percent decay of sample
     is %f days.",T)
```

Scilab code Exa 12.7 Calculation of Half life time and Mean life time

```
clc
// Given that
lambda = 4.28e-4 // decay constant in per year
// Sample Problem 7 on page no. 12.34
printf("\n # PROBLEM 7 # \n")
printf("Standard formula used \n")
printf(" lambda = 0.693 / t_1/2     (Decay constant)
    \n tau = 1/lambda \n")
T = 0.693 / lambda
t = 1 / lambda
printf("\n Half life time is %f years.\n Mean life
   time is %f years.",T,t)
```

Scilab code Exa 12.8 Calculation of Half life of radioactive material

```
clc
// Given that
t = 30 // time in years
r = 1 / 64 // ratio of final mass of element to the
   intial mass of element
// Sample Problem 8 on page no. 12.34
printf("\n # PROBLEM 8 # \n")
printf("Standard formula used \n")
printf(" lambda = 0.693 / t_1/2     (Decay constant)
    \n N =N_0*e^(-lambda*t) \n")
lambda = log(1 / r) / t
```

```
T = 0.693 / lambda
printf("\n Half life of radioactive material is %d
    years.",ceil(T))
```

Scilab code Exa 12.9 Calculation of Decay constant

```
clc
// Given that
t = 2.1 // half life in minute
r = 60 // percentage fraction of sample which
    decayed
// Sample Problem 9 on page no. 12.34
printf("\n # PROBLEM 9 # \n")
printf("Standard formula used \n")
printf(" lambda = 0.693 / t_1/2      (Decay constant)
     \n ")
lambda = 0.693 / t
printf("\n Decay constant is %f per minute.",lambda)
```

Scilab code Exa 12.10 Calculation of Activity of sample

```
clc
// Given that
t = 2.7 // half-life of Au(198) in days
m = 1e-6 // mass of sample in gm
T = 8 * 86400 // time in seconds
// Sample Problem 10 on page no. 12.35
printf("\n # PROBLEM 10 # \n")
printf("Standard formula used \n")
```

```
printf(" lambda = 0.693 / t_1/2       (Decay constant) \n A =lambda*N     (Activity of sample) \n")
lambda = 0.693 / (t * 86400)
N = (m * 6.023e23) / 198 // by the formula (N = mass *Avogadro number/molar mass)
A_ = lambda * N
A = A_ * (1 / exp(lambda * T))
printf("\n Activity of sample is %e decays/sec.",A)
```

Scilab code Exa 12.11 Calculation of Fraction of sample

```
clc
// Given that
n = 3 // no. of half lives
// Sample Problem 11 on page no. 12.35
printf("\n # PROBLEM 11 # \n")
printf("Standard formula used \n")
printf(" N = 2^(-n) ...... fraction after n half lives.\n")
f = (1 / 2)^n
printf("\n Fraction of sample left after %d half lives is %f . ",n,f)
```

Scilab code Exa 12.12 Calculation of Substance remained unchanged

```
clc
// Given that
t = 2 // life period of radioactive substance in years
```

```
T = 4 // time in years
m = 10 // mass of substance in mg
// Sample Problem 12 on page no. 12.35
printf("\n # PROBLEM 12 # \n")
printf("Standard formula used \n")
printf(" N = N_0/2^(n) ...... fraction after n half
   lives.\n")
N = m / T // in mg
printf("\n  Substance remained unchanged after 4
   years is %f mg.",N)
```

Scilab code Exa 12.13 Calculation of Decay constant

```

clc
// Given that
m = 1 // initial mass of radium in gm
m_ = 0.0021 // final mass of radium in gm
t = 5 // time for decay from m to m_ in years
// Sample Problem 13 on page no. 12.36
printf("\n # PROBLEM 13 # \n")
printf("Standard formula used \n")
printf(" lambda = 0.693 / t_1/2      (Decay constant)
    \n N =N_0*e^(-lambda*t) \n")
lambda = log(m / (1 - m_)) / t
T = 0.693 / lambda
T_ = 1 / lambda
printf("\n Decay constant is %f per year.\n Half
   life of sample is %f years.\n Average life of
   sample is %f years.",lambda,T,T_)
//Answer in the book:2500 years
//Answer in the program:2378.451405 years
```

Scilab code Exa 12.14 Calculation of Half life of sample

```
clc
// Given that
t = 10 // time in days
r = 15 // percentage fraction of sample which remain
// Sample Problem 14 on page no. 12.36
printf("\n # PROBLEM 14 # \n")
printf("Standard formula used \n")
printf(" lambda = 0.693 / t_1/2     (Decay constant)
    \n N =N_0*e^(-lambda*t) \n")
lambda = log(100 / 15) / t
T = 0.693 / lambda
printf("\n Half life of sample is %f days.",T)
```

Scilab code Exa 12.15 Calculation of Fraction of radioactive isotope remained

```
clc
// Given that
t = 12.3 // half life in year
T = 50 // time in year
// Sample Problem 15 on page no. 12.36
printf("\n # PROBLEM 15 # \n")
printf("Standard formula used \n")
printf(" lambda = 0.693 / t_1/2     (Decay constant)
    \n N =N_0*e^(-lambda*t) \n")
lambda = 0.693 / t
```

```
f = 1 / exp(lambda * T)
printf("\n Fraction of radioactive isotope remained is %f .",f)
```

Scilab code Exa 12.16 Calculation of Mass of Pb

```
clc
// Given that
R = 1 // radioactivity of Pb(214) in curie
t = 26.8 // half life in minute
// Sample Problem 16 on page no. 12.37
printf("\n # PROBLEM 16 # \n")
printf("Standard formula used \n")
printf(" lambda = 0.693 / t_1/2      (Decay constant) \n A =N*lambda        (Activity of sample) \n")
lambda = 0.693 / (t * 60)
R = 1 * 3.7e10 // in disintegration per sec
m = (R * 214) / (6.023e23 * lambda)
printf("\n Mass of Pb(214)is %e gm.",m)
```

Scilab code Exa 12.17 Calculation of Mass of Pb

```
clc
// Given that
R = 1e6 // radioactivity of Pb(214) in disintegrations per sec
t = 26.8 // half life in minute
// Sample Problem 17 on page no. 12.37
printf("\n # PROBLEM 17 # \n")
```

```
printf("Standard formula used \n")
printf(" lambda = 0.693 / t_1/2      (Decay constant)
    \n A =N*lambda       (Activity of sample) \n")
lambda = 0.693 / (t * 60)
m = (R * 214) / (6.023e23 * lambda)
printf("\n Mass of Pb(214) is %e gm.",m)
```

Scilab code Exa 12.18 Calculation of Mean life of radium and Half life of radium

```
clc
// Given that
m = 1 // mass of Ra(226) in gm
R = 1 // radioactivity of Ra(226) in curie
// Sample Problem 18 on page no. 12.37
printf("\n # PROBLEM 18 # \n")
printf("Standard formula used \n")
printf(" lambda = 0.693 / t_1/2      (Decay constant)
    \n tau = 1/lambda \n A =N*lambda       (Activity
   of sample) \n")
r = R * 3.7e10 // in disintegrations per sec
N = 6.023e23 * m / 226
lambda = r * 226 / 6.023e23
T = 1 / lambda
T_ = 0.693 / lambda
printf("\n Mean life of radium is %e year.\n Half
   life of radium is %e year.",T,T_)
```

Scilab code Exa 12.19 Calculation of Activity of Sr

```

clc
// Given that
m = 0.0001 // mass of Sr(90) in gm
t = 28 // half life of Sr(90) in year
t_ = 9 // time in sec
// Sample Problem 19 on page no. 12.38
printf("\n # PROBLEM 19 # \n")
printf("Standard formula used \n")
printf(" lambda = 0.693 / t_1/2      (Decay constant) \n del_N = N_0*lambda*t (disintegration of sample) \n")
lambda = 0.693 / (t * 86400 * 365)
N_ = 6.023e23 * m / 90
n = N_ * lambda * t_
printf("\n Activity of Sr is %e disintegration/sec.",n)
//Answer in the book:5.25 X 10^8
//Answer in the program:4.726955 e+09
```

Scilab code Exa 12.20 Calculation of Mass of radon

```
clc
// Given that
t = 1600 // the half life of radium(226) in year
t1 = 3.8 // the half life of radon(222) in days
m = 1 // mass of Ra(226) in gm
// Sample Problem 20 on page no. 12.38
printf("\n # PROBLEM 20 # \n")
printf(" Standard formula used \n")
printf(" N_1*lambda_1 = N_2*lambda_2 \n")
m_ = (222 * t1 * m) / (226 * 365 * t) // by the formula N1*t = N2*t1
```

```
printf("\n Mass of radon is %e gm.",m_)
```

Scilab code Exa 12.21 Calculation of Energy of gamma ray photon

```
clc
// Given that
m1 = 4.002603 // mass of He(4) in a.m.u.
m2 = 3.016056 // mass of H(3) in a.m.u.
m3 = 1.007276 // mass of H(1) in a.m.u.
// Sample Problem 21 on page no. 12.39
printf("\n # PROBLEM 21 # \n")
printf("Standard law used \n")
printf(" Law of conservation of Energy \n")
k = m2 + m3 - m1
E = k * 931
printf("\n Energy of gamma ray photon is %f MeV.",E)
```

Scilab code Exa 12.22 Calculation of Q value of reaction

```
clc
// Given that
E = 3 // kinetic energy of proton in Mev
m1 = 1.007276 // mass of H(1) in a.m.u.
m2 = 3.016056 // mass of H(3) in a.m.u.
m3 = 1.008665 // mass of neutron in a.m.u.
m4 = 3.016036 // mass of He(3) in a.m.u.
// Sample Problem 22 on page no. 12.39
printf("\n # PROBLEM 22 # \n")
printf("Standard law used \n")
```

```
printf(" Law of conservation of Energy \n")
k = m1 + m2 - m3 - m4
E = k * 931.5
printf("\n Q value of reaction is %f MeV.",E)
```

Scilab code Exa 12.23 Calculation of Heat produce by complete disintegration and Energy released

```
clc
// Given that
E = 200 // energy released per fission in Mev
m = 0.01 // mass of U(235) in gm
n = 235 // atomic no of sample
N_0=6.023e23 // Avogadro constant
// Sample Problem 23 on page no. 12.40
printf("\n # PROBLEM 23 # \n")
printf("Standard formula used \n")
printf(" E_total = E*N_0/n \n")
E_ = E * 1.6e-13
k = E_ * N_0 * m / n
H = k / 4.168
printf("\n Heat produce by complete disintegration
    is %e cal.\n Energy released is %e J.",H,E_)
```

Scilab code Exa 12.24 Calculation of Energy released by fission

```
clc
// Given that
E = 200 // energy released per fission in Mev
```

```
m = 1 // mass of U(235) in kg
// Sample Problem 24 on page no. 12.40
printf("\n # PROBLEM 24 # \n")
printf("Standard formula used \n")
printf(" E_total = E*N_0/n \n")
E_ = E * 1.6e-13
k = E_ * 6.023e26 * m / 235
printf("\n Energy released  by fission of 1 kg of U(235)is %e J.",k)
```

Scilab code Exa 12.25 Calculation of Amount of fuel required

```
clc
// Given that
P = 1e9 // power required for enlighten the city in watt
e = 30 // percentage efficiency of nuclear reactor
E = 3.2e-11 // energy released per fission in J
// Sample Problem 25 on page no. 12.40
printf("\n # PROBLEM 25 # \n")
printf("Standard formula used \n")
printf(" E_total = E*N_0/n \n")
E_ = E * 30 / 100
N = P / E_
N_ = N * 24 * 3600
m = N_ * 235 / 6.023e26
printf("\n Amount of fuel required per day is %f kg.",m)
```

Scilab code Exa 12.26 Calculation of Power output of reactor

```
clc
// Given that
E = 200 // energy released per fission of U(235)in Mev
m = 3.7 // mass of U(235) consumed in a day in kg
e = 20 // percentage efficiency of reactor
// Sample Problem 26 on page no. 12.41
printf("\n # PROBLEM 26 # \n")
printf("Standard formula used \n")
printf(" E_total = E*N_0/n \n")
E_ = E * 1.6e-13
N = m * 6.023e26 / 235
H = E_ * e / 100
k = H * N / (24 * 3600)
printf("\n Power output of reactor is %f GW.",k * 1e-9)
```

Scilab code Exa 12.27 Calculation of Energy produce by each reaction

```
clc
// Given that
m1 = 4.00260 // mass of He(4) in a.m.u.
m2 = 0.00055 // mass of electron in a.m.u.
m3 = 12 // mass of C(12) in a.m.u.
// Sample Problem 27 on page no. 12.40
printf("\n # PROBLEM 27 # \n")
printf(" Standard formula used \n")
printf(" del_E = del_m * c^2 \n")
delta_m = 3 * m1 - m3
E = delta_m * 931
printf("\n Energy produce by each reaction is %f MeV
```

```
.",E)
```

Scilab code Exa 12.28 Calculation of Mass of deuterium

```
clc
// Given that
P = 5e7 // power in watt
e = 33 // percentage efficiency of nuclear reactor
m1 = 2.01478 // mass of H(2) in a.m.u.
m2 = 4.00388 // mass of He(4) in a.m.u.
// Sample Problem 28 on page no. 12.42
printf("\n # PROBLEM 28 # \n")
printf(" Standard formula used \n")
printf(" del_E = del_m * c^2 \n efficiency = output/
    input \n")
m = (2 * m1) - m2
E = m * 931 * 1.6e-13
E_0 = E * e /(2 * 100)
N = P / E_0
k = N * m1 / 6.023e26
M = k * 24 * 3600
printf("\n Mass of deuterium consumed per day is %f
    kg.",M)
```

Scilab code Exa 12.29 Calculation of Number of revolution

```
clc
// Given that
d = 1.8 // diameter in meter
```

```
B = 0.8 // magnetic field in tesla
m = 6.68e-27 // mass of He(4) in kg
e = 1.6e-19 // charge on an electron in Coulomb
// Sample Problem 29on page no. 12.43
printf("\n # PROBLEM 29 # \n")
printf(" Standard formula used \n")
printf(" E = B^2*q^2*r^2/(2*m) \n f = B*q/(2*pi*m) \n")
r = d / 2
E = (B^2 * (2 * e)^2 * r^2) / (2 * m * 1.6e-19 * 10^6)
f = B * 2 * e / (2 * %pi * m)
N = f / 2
printf("\n Energy  is %f MeV.\n Number of revolution made by particle to obtain above energy is %e per sec",E,N)
```

Scilab code Exa 12.30 Calculation of Value of magnetic induction needed to accelerate deuteron

```
clc
// Given that
f = 12e6 // oscillator frequency of cyclotron in Hz
r = 0.53 // radius of dee in meter
e = 1.6e-19 // charge on an electron in Coulomb
// Sample Problem 30 on page no. 12.43
printf("\n # PROBLEM 30 # \n")
printf(" Standard formula used \n")
printf(" f = B*q/(2*pi*m) \n")
B = (2 * %pi * f * 2 * 1.67e-27) / e
printf("\n Value of magnetic induction needed to accelerate deuteron in it is %f T.",B)
```

Scilab code Exa 12.31 Calculation of Flux density of the magnetic field and Velocity of the deuterons emerging out of the cyclotron

```
clc
// Given that
f = 10e6 // frequency of applied Emf in Hz
r = 0.32 // radius in meter
m = 3.32e-27 // mass of deuteron in kg
e = 1.6e-19 // charge on an electron in Coulomb
// Sample Problem 31 on page no. 12.44
printf("\n # PROBLEM 31 # \n")
printf(" Standard formula used \n")
printf(" q*v*B = m*v^2/r \n f = B*q/(2*pi*m) \n")
B = (2 * %pi * f * m) / e
v = (e * B * r) / m
printf("\n Flux density of the magnetic field is %f
   T.\n Velocity of the deuterons emerging out of
   the cyclotron is %e m/sec. ",B, v)
```

Scilab code Exa 12.32 Calculation of Energy gained per turn and Final energy

```
clc
// Given that
f = 60 // operating frequency in Hz
d = 1.6 // diameter in meter
B = 0.5 // magnetic field at the orbit in tesla
e = 1.6e-19 // charge on an electron in Coulomb
```

```
// Sample Problem 32 on page no. 12.44
printf("\n # PROBLEM 32 # \n")
printf(" Standard formula used \n")
printf(" E_ = 3e8 * r * B / 1e6 \n")
r = d / 2
w = 2 * %pi * f
E = 4 * e * w * r^2 * B
E_ = 3e8 * r * B / 1e6
printf("\n Energy gained per turn is %f eV.\n Final
    energy is %d MeV.",E / e,E_)
```

Scilab code Exa 12.33 Calculation of Magnitude of magnetic field

```
clc
// Given that
E = 70 // energy of betatron synchrotron in Mev
r = 0.28 // radius in meter
e = 1.6e-19 // charge on an electron in C
// Sample Problem 33 on page no. 12.45
printf("\n # PROBLEM 33 # \n")
printf(" Standard formula used \n")
printf(" E = c* e * r* B \n")
E_ = E * 1.6e-13
B = E_ / (3e8 * e * r)
printf("\n Magnitude of magnetic field is %f T.",B)
```

Scilab code Exa 12.34 Calculation of The current produced

```
clc
```

```
// Given that
E = 4.18 // energy of alpha particle in Mev
n = 12 // no. of particle enter the chamber per sec
E_ = 40 // required energy of an ion pair in ev
e = 1.6e-19 // charge on an electron in C
// Sample Problem 34 on page no. 12.45
printf("\n # PROBLEM 34 # \n")
R = n * E * 10^6 // in eV
N = R / E_
i = N * e
printf("Standard formula used \n N = R / E_.\n")
printf("\n The current produced = %e Amp",i)
```

Scilab code Exa 12.35 Calculation of Average current in the circuit

```
clc
// Given that
n = 10^8 // no. of electron per discharge counted by
   GM counter
r = 500 // counting rate in counts per minutes
e = 1.6e-19 // charge on an electron in C
// Sample Problem 35 on page no. 12.46
printf("\n # PROBLEM 35 # \n")
N = r / 60
i = N * n * e
printf("Standard formula used \n i = N * n * e . \n"
   )
printf("\n Average current in the circuit = %e Amp",
   i)
```

Scilab code Exa 12.36 Calculation of Frequency of cyclotron and Larmour radius

```
clc
// Given that
E = 10 // energy of electron in kev
B = 5e-5 // magnetic field of earth in tesla
e = 1.6e-19 // charge on an electron in C
// Sample Problem 36 on page no. 12.46
printf("\n # PROBLEM 36 # \n")
f = e * B / 9.1e-31
E_ = E * 1.6e-16
v = sqrt((2 * E_) / 9.1e-31)
r = v / f
printf("Standard formula used \n f = e * B / 9.1e-31
    . \n")
printf("\n Frequency of cyclotron = %e per sec,\n
   Larmour radius = %f meter",f,r)
```

Scilab code Exa 12.37 Calculation of Larmour radius

```
clc
// Given that
B = 5e-9 // magnetic field in tesla
v = 3e5 // velocity of proton stream in m/sec
e = 1.6e-19 // charge on an electron in C
// Sample Problem 37 on page no. 12.46
printf("\n # PROBLEM 37 # \n")
```

```
printf(" Standard formula used \n")
printf(" E = 1/2*m*v^2  \n")
r = (1.67e-27 * v) / (e * B)
printf("\n Larmour radius is %e meter.",r)
```

Scilab code Exa 12.38 Calculation of Magnetic field

```
clc
// Given that
E = 1 // energy of He+ in kev
r = 0.188 // Larmour radius in meter
e = 1.6e-19 // charge on an electron in C
// Sample Problem 38 on page no. 12.46
printf("\n # PROBLEM 38 # \n")
printf(" Standard formula used \n")
printf(" E = 1/2*m*v^2  \n E = q*B*v \n")
E_ = E * 1.6e-16
v = sqrt((2 * E_) / (4 * 1.67e-27))
B = (4 * 1.67e-27 * v) / (e * r)
printf("\n Magnetic field is %e tesla.",B)
```

Scilab code Exa 12.39 Calculation of Larmour radius

```
clc
// Given that
E = 3.5 // energy of He++ ash particle in Mev
B = 8 // magnetic field in tesla
e = 1.6e-19 // charge on an electron in C
// Sample Problem 39 on page no. 12.47
```

```
printf("\n # PROBLEM 39 # \n")
E_ = E * 1.6e-13
v = sqrt(2 * E_ / (4 * 1.67e-27))
printf(" Standard formula used \n")
printf(" E = 1/2*m*v^2  \n E = q*B*v \n")
r = (4 * 1.67e-27 * v) / (2 * e * B)
printf("\n Larmour radius is %e meter.",r)
```

Scilab code Exa 12.40 Calculation of Debye length and Plasma frequency

```
clc
// Given that
d = 1e12 // electron density in number per m^3
E = 0.1 // thermal energy in eV
e = 1.6e-19 // charge on an electron in C
// Sample Problem 40 on page no. 12.47
printf("\n # PROBLEM 40 # \n")
printf(" Standard formula used \n")
printf(" l_debye = (epsilon_0*K*T/(n*e^2))^1/2  \n f
    = omega/(2*pi) \n")
lambda = sqrt((8.85e-12 * E * e) / (d * e * e))
omega = sqrt(d * e^2 / (9.1e-31 * 8.85e-12))
f = omega / (2 * %pi)
printf("\n Debye length is %e meter.\n Plasma
   frequency is %f MHz.",lambda,f / 1e6)
```

Scilab code Exa 12.41 Calculation of Debye length and Plasma frequency

```
clc
```

```
// Given that
d = 1e16 // density in per m^3
E = 2 // thermal energy in eV
e = 1.6e-19 // charge on an electron in C
// Sample Problem 41 on page no. 12.48
printf("\n # PROBLEM 41 # \n")
lambda = sqrt((8.85e-12 * E * e) / (d * e * e))
printf(" Standard formula used \n")
printf(" l_debye = (epsilon_0*K*T/(n*e^2))^1/2  \n f
    = omega/(2*pi) \n")
omega = sqrt(d * e^2 / (9.1e-31 * 8.85e-12))
f = omega / (2 * %pi)
printf("\n Debye length is %e meter.\n Plasma
   frequency is %e Hz.",lambda,f)
```

Chapter 13

CRYSTAL STRUCTURE

Scilab code Exa 13.1 Calculation of Miller indices of the plane

```
clc
// Given that
x = 2 // intercepts cut by the plane along vector a
    of crystallographic axes
y = 3 // intercepts cut by the plane along vector b
    of crystallographic axes
z = 1 // intercepts cut by the plane along vector c
    of crystallographic axes
// Sample Problem 1 on page no. 13.24
printf("\n # PROBLEM 1 # \n")
printf("Standard formula used \n")
printf(" x_ = a / x \n y_ = b / y \n z_ = c / z \n")
x_ = 6 / x
y_ = 6 / y
z_ = 6 / z
printf("\n Miller indices of the plane are (%d %d %d
    )",x_,y_,z_)
```

Scilab code Exa 13.2 Calculation of Miller indices of the plane

```
clc
// Given that
x = 1 // intercepts cut by the plane along vector a
    of crystallographic axes
y = 2 // intercepts cut by the plane along vector b
    of crystallographic axes
z = -3 / 2 // intercepts cut by the plane along
    vector c of crystallographic axes
// Sample Problem 2 on page no. 13.24
printf("\n # PROBLEM 2 # \n")
printf("Standard formula used \n")
printf(" x_ = a / x \n y_ = b / y \n z_ = c / z \n")
x_ = 6 / x
y_ = 6 / y
z_ = 6 / z
printf("\n Miller indices of the plane are (%d %d %d
    )",x_,y_,z_)
```

Scilab code Exa 13.3 Calculation of Miller indices of the plane

```
clc
// Given that
x1 = 3 // intercepts cut by the plane along vector a
    of crystallographic axes in first case
y1 = 3 // intercepts cut by the plane along vector b
    of crystallographic axes in first case
```

```
z1 = 2 // intercepts cut by the plane along vector c of crystallographic axes in first case
x2 = 1 // intercepts cut by the plane along vector a of crystallographic axes in second case
y2 = 2 // intercepts cut by the plane along vector b of crystallographic axes in second case
k2 = 0 // raciprocal of intercepts cut by the plane along vector c of crystallographic axes in second case
x3 = 1 // intercepts cut by the plane along vector a of crystallographic axes in third case
y3 = 1/2 // intercepts cut by the plane along vector b of crystallographic axes in third case
z3 = 1 // intercepts cut by the plane along vector c of crystallographic axes in third case
// Sample Problem 3 on page no. 13.24
printf("\n # PROBLEM 3 # \n")
printf("Standard formula used \n")
printf(" x_ = a / x \n y_ = b / y \n z_ = c / z \n")
x_1 = 6 / x1
y_1 = 6 / y1
z_1 = 6 / z1
x_2 = 2 / x2
y_2 = 2 / y2
z_2 = 2*k2
x_3 = 1 / x3
y_3 = 1 / y3
z_3 = 1 / z3
printf("\n Miller indices of the plane (i) In first case are (%d %d %d),(ii) In second case are (%d %d %d),(iii)In the third case  are (%d %d %d).",x_1,y_1,z_1,x_2,y_2,z_2,x_3,y_3,z_3)
```

Scilab code Exa 13.4 Calculation of Spacing between the plane

```
clc
// Given that
x1 = 1 // coordinate on x axis for first plane
y1 = 0 // coordinate on y axis for first plane
z1 = 0 // coordinate on z axis for first plane
x2 = 1 // coordinate on x axis for second plane
y2 = 1 // coordinate on y axis for second plane
z2 = 1 // coordinate on z axis for second plane
// Sample Problem 4 on page no. 13.25
printf("\n # PROBLEM 4 # \n")
printf("Standard formula used \n")
printf(" d = 1 / (x1^2 + y1^2 + z1^2)^1/2 \n")
d1 = 1 / sqrt(x1^2 + y1^2 + z1^2)
d2 = 1 / sqrt(x2^2 + y2^2 + z2^2)
printf("\n Spacing between the plane in first case
    is a / %d.\n Spacing between the plane in second
    case is a / %f .",d1,d2)
```

Scilab code Exa 13.5 Calculation of Miller indices of the plane and Inter planer distance

```

clc
// Given that
x = 1 // intercepts cut by the plane along vector a
    of crystallographic axes
y = 2 // intercepts cut by the plane along vector b
    of crystallographic axes
k = 0 // raciprocal of intercepts cut by the plane
    along vector c of crystallographic axes
a = 5 // length of vector a of crystallographic axes
```

```
in angstrom
b = 5 // length of vector b of crystallographic axes in angstrom
c = 5 // length of vector c of crystallographic axes in angstrom
// Sample Problem 5 on page no. 13.26
printf("\n # PROBLEM 5 # \n")
printf("Standard formula used \n")
printf(" d = 1 / (x1^2 + y1^2 + z1^2)^1/2 \n")
x_ = 2 / x
y_ = 2 / y
z_ = 2 * k
d = a / sqrt(x_^2 + y_^2 + z_^2)
D=d^2
printf("\n Miller indices of the plane are (%d %d %d).\n Inter planar distance is sqrt(%d) angstrom.",x_,y_,z_,D)
```

Scilab code Exa 13.6 Calculation of Miller indices of the plane

```
clc
// Given that
x = 2 // intercepts cut by the plane along vector a of crystallographic axes
y = 2 / 3 // intercepts cut by the plane along vector b of crystallographic axes
k = 0 // raciprocal of intercepts cut by the plane along vector c of crystallographic axes
// Sample Problem 6 on page no. 13.26
printf("\n # PROBLEM 6 # \n")
printf("Standard formula used \n")
printf(" x_ = a / x \n y_ = b / y \n z_ = c / z \n")
x_ = 2 / x
```

```
y_ = 2 / y
z_ = 2 * k
printf("\n Miller indices of the plane are (%d %d %d
    )",x_,y_,z_)
```

Scilab code Exa 13.7 Calculation of Miller indices of the plane

```
clc
// Given that
x1 = 2 // coordinate on x axis
y1 = 3 // coordinate on y axis
z1 = 1 // coordinate on z axis
r = 0.175 // atomic radius of fcc structure in nm
// Sample Problem 7 on page no. 13.27
printf("\n # PROBLEM 7 # \n")
printf("Standard formula used \n")
printf(" d = 1 / (x1^2 + y1^2 + z1^2)^1/2 \n")
a = (4 * r) / sqrt(2)
d = a / sqrt(x1^2 + y1^2 + z1^2)
printf("\n Inter planar spacing is %f nm.",d)
```

Scilab code Exa 13.8 Calculation of ratio of intercepts and The ratio of spacing between two planes

```
clc
// Given that
x1 = 1 // coordinate on x axis in first case
y1 = 2 // coordinate on y axis in first case
z1 = 3 // coordinate on z axis in first case
```

```
x2 = 1
y2 = 1
z2 = 0
// coordinate of first plane in second case
x3 = 1
y3= 1
z3 = 1
// coordinate of second plane in second case
// Sample Problem 8 on page no. 13.27
printf("\n # PROBLEM 8 # \n")
printf("Standard formula used \n")
printf(" d = 1 / (x1^2 + y1^2 + z1^2)^1/2 \n")
x_=6/x1
y_=6/y1
z_=6/z1
d1 = 1 / sqrt(x2^2 + y2^2 + z2^2)
d2= 1/ sqrt(x3^2 + y3^2 + z3^2)
d = d1/d2
printf("\n The ratio of intercepts of three axes by the point are %d : %d : %d. \n The ratio of spacing between two planes is %f.",x_,y_,z_,d)
```

Scilab code Exa 13.9 Calculation of Distance between two atoms

```
clc
// Given that
a = 5 // the lattice constant of the structure in angstrom
// Sample Problem 9 on page no. 13.28
printf("\n # PROBLEM 9 # \n")
printf("Standard formula used \n")
printf(" d = a*sqrt(3) /4 \n")
d = (sqrt(3) / 4) * a
```

```
printf("\n Distance between two atoms is %f Angstrom
    . ",d)
```

Scilab code Exa 13.10 Calculation of primitive translation vector

```
clc
// Given that
a = 3.56 // the length of cube edge in angstrom
// Sample Problem 10 on page no. 13.28
printf("\n # PROBLEM 10 # \n")
printf("Standard formula used \n")
printf(" d = a / sqrt(2) \n")
d = a / sqrt(2)
printf("\n Permitive translation vector is %f
    Angstrom.",d)
```

Scilab code Exa 13.11 Calculation of Number of atom per unit cell

```
clc
// Given that
w = 207.2 // atomic weight of Pb
d = 11.36e3 // density of Pb in kg/m^3
a = 3.2e-10 // length of cube edge in meter
N = 6.023e26 // Avogadro's no. in per kg mole
// Sample Problem 11 on page no. 13.28
printf("\n # PROBLEM 11 # \n")
printf("Standard formula used \n")
printf(" n = (a^3 * d * N) / w \n")
n = (a^3 * d * N) / w
```

```
printf("\n Number  of atom per unit cell is %d.",n)
```

Scilab code Exa 13.12 Calculation of Wavelength of x ray

```
clc
// Given that
w = 60.2 // molecular weight
d = 6250 // density in kg/m^3
N = 6.023e+26 // Avogadro's no. in per kg mole
n = 4 // for fcc lattice
// Sample Problem 12 on page no. 13.28
printf("\n # PROBLEM 12 # \n")
printf("Standard formula used \n")
printf(" a = (((4 * w) / (N * d))^(1 / 3)) \n")
a = (((4 * w) / (N * d))^(1 / 3)) * 1e10
printf("\n Lattice constant is %f angstrom.",a)
```

Scilab code Exa 13.13 Calculation of Wavelength of x ray and Glancing angle

```
clc
// Given that
x1 = 1 // coordinate on x axis of plane
y1 = 0 // coordinate on y axis of plane
z1 = 0 // coordinate on z axis of plane
d = 2.82 // the space between successive plane in
    angstrom
theta = 8.8 // glancing angle in degree
// Sample Problem 13 on page no. 13.29
```

```
printf("\n # PROBLEM 13 # \n")
printf(" Standard formula used \n")
printf(" n*lambda = 2 * d * sin(theta) \n")
n = 1
lambda = 2 * d * sind(theta) / n
printf("\n Wavelength of x-ray is %f angstrom.",
   lambda)
```

Scilab code Exa 13.14 Calculation of Lattice constant of NaCl

```
clc
// Given that
d = 2.51 // the space between adjacent plane in
   angstrom
theta = 9 // glancing angle in degree
// Sample Problem 14 on page no. 13.29
printf("\n # PROBLEM 14 # \n")
printf(" Standard formula used \n")
printf(" n*lambda = 2 * d * sin(theta) \n")
n = 1 // for n=1
lambda = 2 * d * sind(theta) / n
n = 2 // for n=2
theta = asind(lambda / d)
printf("\n Wavelength of x-ray is %f angstrom.\n
   Glancing angle for second order diffraction is %f
    degree.",lambda,theta)
```

Scilab code Exa 13.15 Calculation of Angle of incidence of x ray on the plane

```
clc
// Given that
lambda = 1.5 // wavelength of x-ray in angstrom
theta = 60 // glancing angle in degree
// Sample Problem 15 on page no. 13.29
printf("\n # PROBLEM 15 # \n")
printf(" Standard formula used \n")
printf(" n*lambda = 2 * d * sin(theta) \n")
n = 1 // for first order
d = ( n * lambda) / (2 * sind(theta))
printf("\n Lattice constant of NaCl is %f angstrom.",d)
```

Scilab code Exa 13.16 Calculation of Glancing angle

```
clc
// Given that
lambda = 1.4 // wavelength of x-ray in angstrom
x1 = 1 // coordinate on x axis of plane
y1 = 1 // coordinate on y axis of plane
z1 = 1 // coordinate on z axis of plane
a = 5 // lattice parameter of of crystal in angstrom
// Sample Problem 16 on page no. 13.30
printf("\n # PROBLEM 16 # \n")
printf(" Standard formula used \n")
printf(" d = a / (x1^2 + y1^2 + z1^2)^1/2 \n")
n = 1 // for first order
d = a / sqrt(x1^2 + y1^2 + z1^2)
theta = asind((n * lambda) / (2 * d))
printf("\n Angle of incidence of x-ray on the plane is %f degree.",theta)
```

Scilab code Exa 13.17 Calculation of Wavelength of neutron beam and Speed of neutron beam

```

clc
// Given that
lambda = 0.710 // wavelength of x-ray in angstrom
x1 = 1 // coordinate on x axis of plane
y1 = 0 // coordinate on y axis of plane
z1 = 0 // coordinate on z axis of plane
a = 2.814 // lattice parameter of of crystal in
    angstrom
// Sample Problem 17 on page no. 13.30
printf("\n # PROBLEM 17 # \n")
printf(" Standard formula used \n")
printf(" n*lambda = 2 * d * sin(theta)\n")
n = 2 // for second order
d = a / sqrt(x1^2 + y1^2 + z1^2)
theta = asind((n * lambda) / (2 * d))
printf("\n Glancing angle is %f degree.",theta)
```

Scilab code Exa 13.18 Calculation of Lattice parameter

```
clc
// Given that
n = 1 // order of brag reflection
d = 3.84e-10 // the space between successive plane
    in m
```

```
theta = 30 // glancing angle in degree
// Sample Problem 18 on page no. 13.30
printf("\n # PROBLEM 18 # \n")
printf(" Standard formula used \n")
printf(" n*lambda = 2 * d * sin(theta) \n lambda = h/(m*v) \n")
lambda = 2 * d * sind(theta) / n
v = 6.62e-34 / (1.67e-27 * lambda)
printf("\n Wavelength of neutron beam is %f angstrom.\n Speed of neutron beam is %e meter/sec.", lambda * 10^10,v)
```

Scilab code Exa 13.19 Calculation of Inter planner distances

```
clc
// Given that
v = 120 // voltage at which electron is accelerated in v
n = 1 // order of Bragg reflection
x1 = 1 // coordinate on x axis of plane
y1 = 1 // coordinate on y axis of plane
z1 = 1 // coordinate on z axis of plane
theta = 22 // angle at which maximum reflection is obtain in degree
n = 1 // order of reflection
// Sample Problem 19 on page no. 13.31
printf("\n # PROBLEM 19 # \n")
printf(" Standard formula used \n")
printf(" n*lambda = 2 * d * sin(theta) \n lambda = h/(2*m*e*V)^1/2 \n")
lambda = 6.62e-34 / sqrt(2 * 9.1e-31 * 1.6e-19 * v)
d = (n * lambda) / (2 * sind(theta))
a = d * sqrt(3)
```

```
printf("\n Lattice parameter is %f angstrom.",a *
    10^10)
```

Scilab code Exa 13.20 Calculation of Inter planner distance

```
clc
// Given that
lambda = 1.24e-10 // wavelength of X-ray in A
x1 = 1 // coordinate on x axis of first plane
y1 = 0 // coordinate on y axis of first plane
z1 = 0 // coordinate on z axis of first plane
x2 = 1 // coordinate on x axis of second plane
y2 = 1 // coordinate on y axis of second plane
z2 = 0 // coordinate on z axis of second plane
x3 = 1 // coordinate on x axis of third plane
y3 = 1 // coordinate on y axis of third plane
z3 = 1 // coordinate on z axis of third plane
M = 74.5 // molecular weight of KCl
d = 1980 // density of KCl in kg/m^3
N = 6.023e+26 // Avogadro's No per Kg mole
// Sample Problem 20 on page no. 13.31
printf("\n # PROBLEM 20 # \n")
printf(" \n Standard formula used are D = 1/sqrt(x
    ^2+y^2+z^2) and a^3 = n*M/(N*d)")
a = (4*M / (N*d))^(1/3)
D1 = a/sqrt(x1^2 + y1^2 + z1^2)
D2 = a/sqrt(x2^2 + y2^2 + z2^2)
D3 = a/sqrt(x3^2 + y3^2 + z3^2)
printf("\n Inter planner distances are - \n (1) in
    first case %f A, \n (2) in second case %f A ,\n
    (3) in third case %f A",D1*10^10,D2*10^10,D3
    *10^10)
```

Scilab code Exa 13.21 Calculation of Potential energy of molecule

```
clc
// Given that
d = 0.15e-9 // distance between K(+) and Cl(-) in m
// Sample Problem 21 on page no. 13.32
printf("\n # PROBLEM 21 # \n")
printf(" Standard formula used \n")
printf(" v = -1.6e-19 / (4 * pi * 8.85e-12 * d) \n")
v = -1.6e-19 / (4 * %pi * 8.85e-12 * d)
printf("\n Potential energy of molecule is %f eV.",v)
```

Scilab code Exa 13.22 Calculation of Cohesive energy of Nacl

```
clc
// Given that
d = 0.32e-9 // equilibrium separation in m
alpha = 1.748
n = 9
e = 4 // ionization energy in eV
a = -2.16 // electron affinity in eV
// Sample Problem 22 on page no. 13.32
printf("\n # PROBLEM 22 # \n")
printf(" Standard formula used \n")
printf(" E = -((alpha * 1.6e-19) / (4 * pi * 8.85e-12 * d)) * (1 - (1 / n)) \n")
```

```
E = -((alpha * 1.6e-19) / (4 * %pi * 8.85e-12 * d))
    * (1 - (1 / n))
printf("\n Cohesive energy of Nacl is %f eV.",E)
```

Scilab code Exa 13.23 Calculation of Ratio of number of Schottky defects to total number of cation anion pairs

```
clc
// Given that
E = 2.02 // average energy required to produce a
    Schottky defect at room temperature in eV
k = 1.38e-23 // Boltzmann constant in J/k
T = 300 // room temperature in K
// Sample Problem 23 on page no. 13.33
printf("\n # PROBLEM 23 # \n")
printf(" Standard formula used \n")
printf(" r = exp(-(E * 1.6e-19) / (2 * k * T))\n")
r = exp(-(E * 1.6e-19) / (2 * k * T))
printf("\n Ratio of number of Schottky defects to
    total number of cation-anion pairs is %e .",r)
```

Chapter 14

DEVELOPMENT OF QUANTUM MECHANICS

Scilab code Exa 1.1 Calculation of Frequency and Wavelength

```
clc
// Given that
E = 75 // energy of photon in eV
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in J
// Sample Problem 1 on page no. 14.20
printf("\n # PROBLEM 1 # \n")
printf("Standard formula used \n")
printf(" E = h*c/lambda \n")
f = E * e / h
lambda = c / f
printf("\n Frequency is %e Hz.\n Wavelength is %f
    Angstrom.",f,lambda * 10^10)
```

Scilab code Exa 14.2 Calculation of Number of quanta

```
clc
// Given that
P = 2e5 // radiated power in W
f = 98e6 // frequency in Hz
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
// Sample Problem 2 on page no. 14.20
printf("\n # PROBLEM 2 # \n")
printf("Standard formula used \n")
printf(" E = h*mu \n")
E = h * f
n = P / E
printf("\n Number of quanta emitted per sec is %e .",n)
```

Scilab code Exa 14.3 Calculation of Energy of photon

```
clc
// Given that
lambda = 4e-7 // wavelength of spectral line in meter
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
// Sample Problem 3 on page no. 14.20
```

```
printf("\n # PROBLEM 3 # \n")
printf("Standard formula used \n")
printf(" E = h*c/lambda \n")
E = (h * c) / lambda
printf("\n Energy of photon is %e J.",E)
```

Scilab code Exa 14.4 Calculation of Number of photons of green light

```
clc
// Given that
lambda = 5e-7 // wavelength of green light in meter
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
P = 1 // energy in erg
// Sample Problem 4 on page no. 14.21
printf("\n # PROBLEM 4 # \n")
printf("Standard formula used \n")
printf(" E = h*c/lambda \n")
E = ((h * c) / lambda) * (10^7)
n = P / E
printf("\n Number of photons of green light emitted
    is %e .",n)
```

Scilab code Exa 14.5 Calculation of Wavelength

```
clc
// Given that
E = 5e-19 // energy of photon in J
```

```
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
// Sample Problem 5 on page no. 14.21
printf("\n # PROBLEM 5 # \n")
printf("Standard formula used \n")
printf(" E = h*c/lambda \n")
lambda = c * h / E
printf("\n Wavelength is %f Angstrom.",lambda *
   10^10)
```

Scilab code Exa 14.6 Calculation of Energy of an electron

```
clc
// Given that
lambda = 4.35e-7 // wavelength of green light in
   meter
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
P = 1 // energy in erg
// Sample Problem 6 on page no. 14.21
printf("\n # PROBLEM 6 # \n")
printf("Standard formula used \n")
printf(" E = h*c/lambda \n")
E = ((h * c) / lambda)
printf("\n Energy of an electron is %e J.",E)
```

Scilab code Exa 14.7 Calculation of Energy received by the eye

```
clc
// Given that
lambda = 5.6e-7 // wavelength of light in meter
n = 120 // no. of photons per second
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
// Sample Problem 7 on page no. 14.22
printf("\n # PROBLEM 7 # \n")
printf("Standard formula used \n")
printf(" E = h*c/lambda \n")
E = ((h * c) / lambda)
p = E * n
printf("\n Energy received by the eye per second is
    %e W.",p)
```

Scilab code Exa 14.8 Calculation of Number of photons of yellow light

```
clc
// Given that
lambda = 5.5e-7 // wavelength of light in meter
E = 1.5 // energy in J
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
// Sample Problem 8 on page no. 14.22
printf("\n # PROBLEM 8 # \n")
printf("Standard formula used \n")
printf(" E = h*c/lambda \n")
E_ = ((h * c) / lambda)
n = E / E_
printf("\n Number of photons of yellow light = %e ."
    ,n)
```

Scilab code Exa 14.9 Calculation of Work function and Stopping potential and Maximum velocity

```
clc
// Given that
lambda = 4.35e-7 // wavelength of light in meter
lambda_ = 5.42e-7 // threshold wavelength of photoelectron in meter
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of an electron in kg
// Sample Problem 9 on page no. 14.22
printf("\n # PROBLEM 9 # \n")
printf("Standard formula used \n ")
printf(" 1/2 m*v^2 = eV \n  E = h*c/lambda \n")
w = ((h * c) / lambda_)
v = sqrt(((2 * h * c) / m) * (1 / lambda - 1 / lambda_))
V = m * v^2 / (2 * e)
printf("\n Work function is %e J.\n Stopping potential is %f V.\n Maximum velocity is %e m/sec.",w,V,v)
```

Scilab code Exa 14.10 Calculation of Maximum energy of photoelectron

```
clc
```

```
// Given that
f = 1.2e15 // frequency of light in Hz
f_ = 1.1e+15 // threshold frequency of photoelectron emission in copper in Hz
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
// Sample Problem 10 on page no. 14.23
printf("\n # PROBLEM 10 # \n")
printf("Standard formula used \n ")
printf(" 1/2 m*v^2 = h*(mu - mu_0) \n")
E = h * (f - f_) / e
printf("\n Maximum energy of photoelectron is %f eV.",E)
```

Scilab code Exa 14.11 Calculation of Work function

```
clc
// Given that
lambda = 6.2e-7 // threshold wavelength of photoelectron in first case in meter
lambda_ = 5e-7 // threshold wavelength of photoelectron in second case in meter
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
// Sample Problem 11 on page no. 14.23
printf("\n # PROBLEM 11 # \n")
printf("Standard formula used \n ")
printf(" E = h*c/lambda \n")
w = ((h * c) / lambda) * (1 / e)
w_ = ((h * c) / lambda_) * (1 / e)
printf("\n Work function for wavelength %e angstrom
```

```
    is %f eV.\n Work function for wavelength %e
    angstrom is %f eV",lambda,w,lambda_,w_)
```

Scilab code Exa 14.12 Calculation of Work function and Maximum energy and Threshold frequency

```

clc
// Given that
lambda = 3.132e-7 // wavelength of light in meter
V = 1.98 // stopping potential in V
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of an electron in kg
// Sample Problem 12 on page no. 14.24
printf("\n # PROBLEM 12 # \n")
printf("Standard formula used \n ")
printf(" 1/2 m*v^2 = h*(mu - mu_0) \n")
E = e * V
lambda_ = 1 / ((1 / lambda) - (E / (h * c)))
f = c / lambda_
w = ((h * c) / lambda_)
printf("\n Work function is %e J.\n Maximum energy
    is %e J.\n Threshold frequency is %e Hz.",w,E,f)
```

Scilab code Exa 14.13 Calculation of work function

```
clc
```

```
// Given that
w = 4.8 // work function in eV
lambda1 = 5e-7 // wavelength of incident radiation
    in first case in meter
lambda2 = 2e-7 // wavelength of incident radiation
    in second case in meter
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
// Sample Problem 13 on page no. 14.24
printf("\n # PROBLEM 13 # \n")
printf("Standard formula used \n ")
printf(" E_k = h*c/lambda \n")
E_k1 = h*c/lambda1
E_k2 = h*c / lambda2
printf("\n From the above it is clear that the
    energy corresponding to wavelength 5000 A is i.e.
     %f found to be less than the work function i.e.
    4.8 eV . So it will not be able to liberate an
    electron.\n As the energy to wavelength 2000 A i.
    e. %f is greater than the work function. So it is
     sufficient to liberate electrons. ",E_k1/e,E_k2/
    e)
```

Scilab code Exa 14.14 Calculation of Work function and Maximum energy and Threshold frequency

```
clc
// Given that
lambda = 5.893e-7 // wavelength of light in meter
V = 0.36 // stopping potential for emitted electron
    in eV
h = 6.62e-34 // Planck constant in J-sec
```

```
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of an electron in kg
// Sample Problem 14 on page no. 14.25
printf("\n # PROBLEM 14 # \n")
printf("Standard formula used \n ")
printf(" E_k = h*mu - phi \n")
E = h * c / lambda
w = ((h * c) / lambda) * (1 / e) - V
f = w * e / h
printf("\n Maximum energy is %f eV.\n Work function
    is %f eV.\n Threshold frequency is %e Hz. ",E/e,w
    ,f)
```

Scilab code Exa 14.15 Calculation of Stopping potential and Maximum kinetic energy

```
clc
// Given that
lambda = 5.89e-7 // wavelength of light in meter
lambda_ = 7.32e-7 // threshold wavelength of
    photoelectron in meter
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of an electron in kg
// Sample Problem 15 on page no. 14.25
printf("\n # PROBLEM 15 # \n")
printf("Standard formula used \n ")
printf(" E = (h * c) * (1 / lambda1 - 1 / lambda2) \
    n")
E = (h * c) * (1 / lambda - 1 / lambda_)
V = E / e
```

```
printf("\n Stopping potential is %f V.\n Maximum kinetic energy is %e J.",V,E)
```

Scilab code Exa 14.16 Calculation of Wavelength of light

```
clc
// Given that
E = 1.5 // maximum energy in eV
lambda_ = 2.3e-7 // threshold wavelength of photoelectron in meter
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of an electron in kg
// Sample Problem 16 on page no. 14.26
printf("\n # PROBLEM 16 # \n")
printf("Standard formula used \n ")
printf(" E = (h * c) * (1 / lambda1 - 1 / lambda2) \n")
lambda = 1 / ((E * e / (h * c)) + (1 / lambda_))
printf("\n Wavelength of light is %f Angstrom.", lambda * 1e10)
```

Scilab code Exa 14.17 Calculation of Energy of incident photon and Kinetic energy of the emitted electron

```
clc
// Given that
lambda = 1.5e-7 // wavelength of light in in meter
```

```
w = 4.53 // work function of tungsten in eV
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
// Sample Problem 17 on page no. 14.26
printf("\n # PROBLEM 17 # \n")
printf(" Standard formula used \n ")
printf(" E = (h * c)/lambda = 1/2*m*v^2 \n ")
E = ((h * c) / lambda) * (1 / e)
k = E - w
printf("\n Energy of incident photon is %f eV,which
    is greater than the work function \n So it causes
     photoelectric emission.\n Kinetic energy of the
    emitted electron is %f eV.",E,k)
```

Scilab code Exa 14.18 Calculation of Longest wavelength required for photoemission

```
clc
// Given that
w = 2.3 // work function of sodium in eV
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
// Sample Problem 18 on page no. 14.26
printf("\n # PROBLEM 18 # \n")
printf("Standard formula used \n ")
printf(" E = (h * c)/ lambda \n")
lambda = ((h * c) / w) * (1 / e)
printf("\n Longest wavelength required for
    photoemission is %f Angstrom",lambda * 1e10)
```

Scilab code Exa 14.19 Calculation of Threshold wavelength for photo emission

```
clc
// Given that
w = 2 // work function of sodium in eV
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
// Sample Problem 19 on page no. 14.27
printf("\n # PROBLEM 19 # \n")
printf("Standard formula used \n ")
printf(" E = (h * c)/ lambda \n")
lambda = ((h * c) / w) * (1 / e)
printf("\n Threshold wavelength for photo emission
   is %d Angstrom.",lambda * 1e10)
```

Scilab code Exa 14.20 Calculation of Threshold wavelength and Incident electromagnetic wavelength

```
clc
// Given that
k = 4 // maximum kinetic energy of electron in eV
w = 2.2 // work function of sodium in eV
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
// Sample Problem 20 on page no. 14.27
```

```
printf("\n # PROBLEM 20 # \n")
printf("Standard formula used \n ")
printf(" E = (h * c) * (1 / lambda1 - 1 / lambda2) \n E = (h * c)/ lambda \n")
lambda_ = ((h * c) / (w * e))
lambda = (1 / ((((k * e)  / (h * c))) + (1 / lambda_)))
printf("\n Threshold wavelength is %d Angstrom.\n Incident electromagnetic wavelength is %f Angstrom",lambda_ * 1e10,lambda * 1e10)
```

Scilab code Exa 14.21 Calculation of Maximum kinetic energy and Number of electrons emitted per sec

```
clc
// Given that
lambda = 3.5e-7 // wavelength of light in meter
i = 1 // intensity in W/m^2
p = 0.5 // percent of incident photon produce electron
a = 1 // surface area of potassium in cm^2
w = 2.1 // work function of potassium in eV
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of an electron in kg
// Sample Problem 21 on page no. 14.28
printf("\n # PROBLEM 21 # \n")
printf("Standard formula used \n ")
printf(" 1/2*m*v^2 = (h * c)/ lambda\n")
E = (((h * c) / lambda) * (1 / e) - w) * e
E_ = (p * a * 1e-4) / 100 // in W/cm^2
n = E_ / E
```

```
printf("\n Maximum kinetic energy is %e J.\n Number of electrons emitted per sec from 1cm^2 area is %e .",E,n)
```

Scilab code Exa 14.22 Calculation of Value of Planck constant

```
clc
// Given that
lambda = 5.896e-7 // wavelength of first light in meter
lambda_ = 2.83e-7 // wavelength of second light in meter
V1 = 0.12 // stopping potential for emitted electrons for first light in V
V2 = 2.2 // stopping potential for emitted electrons for second light in V
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
// Sample Problem 22 on page no. 14.28
printf("\n # PROBLEM 22 # \n")
printf("Standard formula used \n ")
printf(" E = (h * c) * (1 / lambda1 - 1 / lambda2) \n")
h = (e * (V2 - V1) / c) / (1 / lambda_ - 1 / lambda)
printf("\n Value of Planck constant is %e J-sec.",h)
```

Scilab code Exa 14.23 Calculation of Compton shift

```
clc
```

```
// Given that
lambda = 1e-10 // wavelength of light in meter
theta = 90 // angle at which scattered radiation is viewed in degree
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of an electron in kg
// Sample Problem 23 on page no. 14.29
printf("\n # PROBLEM 23 # \n")
printf("Standard formula used \n ")
printf(" delta_lambda = (h / (m * c) * (1 - cos(theta))) \n")
delta_lambda = (h * (1 - cosd(theta))) / (m * c)
printf("\n Compton shift is %f Angstrom", delta_lambda * 1e10)
```

Scilab code Exa 14.24 Calculation of Compton shift and Energy of incident beam

```
clc
// Given that
lambda = 1e-10 // wavelength of light in meter
theta = 90 // angle in degree
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of an electron in kg
// Sample Problem 24 on page no. 14.29
printf("\n # PROBLEM 24 # \n")
printf("Standard formula used \n ")
printf(" delta_lambda = (h / (m * c) * (1 - cos(theta))) \n")
```

```
delta_lambda = (h * (1 - cosd(theta))) / (m * c)
E = (h * c) / delta_lambda
printf("\n Compton shift is %f Angstrom.\n Energy of incident beam is %f MeV.",delta_lambda * 1e10,E / 1.6e-13)
```

Scilab code Exa 14.25 Calculation of Wavelength of incident beam

```
clc
// Given that
E = 4 // enrgy of recoil electron in KeV
theta = 180 // scattered angle of photon in degree
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of an electron in kg
// Sample Problem 25 on page no. 14.30
printf("\n # PROBLEM 25 # \n")
printf("Standard formula used \n ")
printf(" 1/2*m*v^2 = h*c*(1/lambda1 - 1/lambda2)\n")
p = sqrt(2 * E * 10^3 * e * m)
lambda = (2 * h * c) / (p * c + E * 10^3 * e)
printf("\n Wavelength of incident beam is %f Angstrom.",lambda * 1e10)
```

Scilab code Exa 14.26 Calculation of Compton shift and Kinetic energy

```
clc
// Given that
```

```
lambda = 1e-10 // wavelength of light in meter
theta = 90 // angle in degree
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of an electron in kg
// Sample Problem 26 on page no. 14.31
printf("\n # PROBLEM 26 # \n")
printf("Standard formula used \n ")
printf(" delta_lambda = (h / (m * c) * (1 - cos(theta))) \n E = h*c*(1/lambda1 - 1/lambda2)\n")
delta_lambda = (h * (1 - cosd(theta))) / (m * c)
E = (h * c) * ((1 / lambda) - (1 / (lambda + delta_lambda)))
printf("\n Compton shift is %e m.\n Kinetic energy is %f eV.",delta_lambda,E / 1.6e-19)
```

Scilab code Exa 14.27 Calculation of Maximum Compton shift and Kinetic energy

```
clc
// Given that
lambda = 0.144e-10 // wavelength of x-ray in meter
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of an electron in kg
// Sample Problem 27 on page no. 14.31
printf("\n # PROBLEM 27 # \n")
printf("Standard formula used \n ")
printf(" delta_lambda = (h / (m * c) * (1 - cos(theta))) \n E = h*c*(1/lambda1 - 1/lambda2)\n")
theta = 180 // for maximum shift
```

```
delta_lambda = (h * (1 - cosd(theta))) / (m * c)
E = (h * c) * ((1 / lambda) - (1 / (lambda + delta_lambda)))
printf("\n Maximum Compton shift is %f A.\n Kinetic energy is %f KeV.",delta_lambda * 1e10,E / 1.6e-16)
```

Scilab code Exa 14.28 Calculation of Wavelength of x ray and Maximum kinetic energy

```
clc
// Given that
lambda = 0.2e-10 // wavelength of x-ray in meter
theta = 45 // scattered angle in degree
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of an electron in kg
// Sample Problem 28 on page no. 14.32
printf("\n # PROBLEM 28 # \n")
printf("Standard formula used \n ")
printf(" delta_lambda = (h / (m * c) * (1 - cos(theta))) \n E = h*c*(1/lambda1 - 1/lambda2)\n")
delta_lambda = (h * (1 - cosd(theta))) / (m * c)
E = (h * c) * ((1 / lambda) - (1 / (lambda + delta_lambda)))
theta_ = 180 // for maximum
delta_lambda_ = (h * (1 - cosd(theta_))) / (m * c)
lambda_ = lambda + delta_lambda_
E_k = h*c*(1/lambda - 1/lambda_)
printf("\n Wavelength of x-ray is %f A.\n Maximum kinetic energy %e J.",lambda_ * 1e10,E_k)
```

Scilab code Exa 14.29 Calculation of deBroglie wavelength

```
clc
// Given that
h = 6.62e-34 // Planck constant in J-sec
v = 96 // speed of automobile in km/hr
e = 1.6e-19 // charge on an electron in C
m = 2e3 // mass of automobile in kg
// Sample Problem 29 on page no. 14.33
printf("\n # PROBLEM 29 # \n")
printf("Standard formula used \n ")
printf(" lambda = h /(m*v)\n")
v_ = v * (5 / 18)
lambda = h / (m * v_)
printf("\n de-Broglie wavelength is %e m.",lambda)
```

Scilab code Exa 14.30 Calculation of deBroglie wavelength

```
clc
// Given that
v = 50 // potential differece in volt
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of an electron in kg
// Sample Problem 30 on page no. 14.33
printf("\n # PROBLEM 30 # \n")
printf("Standard formula used \n ")
```

```
printf(" lambda = h /(m*v)\n 1/2*m*v^2 = eV \n")
lambda =  h  / sqrt(2 * m * v * e)
printf("\n de-Broglie wavelength is %f Angstrom.",
   lambda * 1e10)
```

Scilab code Exa 14.31 Calculation of Wavelength of thermal neutron

```
clc
// Given that
t = 300 // temperature in K
k = 1.37e-23 // Boltzmann's constant in J/K
h = 6.62e-34 // Planck constant in J-sec
e = 1.6e-19 // charge on an electron in C
m = 1.67e-27 // mass of neutron in kg
// Sample Problem 31 on page no. 14.33
printf("\n # PROBLEM 31 # \n")
printf("Standard formula used \n ")
printf(" lambda = h /(m*v)\n 1/2*m*v^2 = 3/2*k*T \n"
   )
lambda = h / sqrt(3 * m * k * t)
printf("\n Wavelength of thermal neutron is %f
   Angstrom.",lambda * 1e10)
```

Scilab code Exa 14.32 Calculation of Wavelength of matter wave

```
clc
// Given that
v = 2e8 // speed of proton in m/sec
h = 6.62e-34 // Planck constant in J-sec
```

```
e = 1.6e-19 // charge on an electron in C
m = 1.67e-27 // mass of proton in kg
// Sample Problem 32 on page no. 14.34
printf("\n # PROBLEM 32 # \n")
printf("Standard formula used \n ")
printf(" lambda = h /(m*v) \n")
lambda = h / (m * v)
printf("\n Wavelength of matter wave associated with
    proton is %e m",lambda)
```

Scilab code Exa 14.33 Calculation of Potential difference

```
clc
// Given that
lambda = 0.1e-10 // DE Broglie wavelength associated
    with electron in M
h = 6.62e-34 // Planck constant in J-sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
// Sample Problem 33 on page no. 14.34
printf("\n # PROBLEM 33 # \n")
printf("Standard formula used \n ")
printf(" lambda = h /(m*v)\n 1/2*m*v^2 = qV \n")
V = h^2 / (2 * m* e * lambda^2)
printf("\n Potential difference is %f KV.",V *
   10^-3)
```

Scilab code Exa 14.34 Calculation of deBroglie wavelength

```
clc
// Given that
v = 200 // potential differece in volt
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
q = 3.2e-19 // charge on an alpha particle in C
m = 4 * 1.67e-27 // mass of alpha particle in kg
// Sample Problem 34 on page no. 14.34
printf("\n # PROBLEM 34 # \n")
printf("Standerd formula used \n ")
printf(" lambda = h /(m*v)\n 1/2*m*v^2 = qV \n")
lambda =  h  / sqrt(2 * m * v * q)
printf("\n de-Broglie wavelength = %e m.",lambda)
```

Scilab code Exa 14.35 Calculation of deBroglie wavelength

```
clc
// Given that
t = 400 // temperature in K
k = 1.38e-23 // Boltzmann's constant in J/K
h = 6.62e-34 // Planck constant in J-sec
e = 1.6e-19 // charge on an electron in C
m = 4 * 1.67e-27 // mass of helium atom in kg
// Sample Problem 35 on page no. 14.34
printf("\n # PROBLEM 35 # \n")
printf("Standard formula used \n ")
printf(" lambda = h /(m*v)\n 1/2*m*v^2 = 3/2*k*T \n")
lambda = h / sqrt(3 * m * k * t)
printf("\n de-Broglie wavelength = %f Angstrom.", lambda * 1e10)
```

Scilab code Exa 14.36 Calculation of deBroglie wavelength

```
clc
// Given that
v = 2000 // velocity of neutron in m/sec
h = 6.62e-34 // Planck constant in J-sec
e = 1.6e-19 // charge on an electron in C
m = 1.67e-27 // mass of neutron in kg
// Sample Problem 36 on page no. 14.35
printf("\n # PROBLEM 36 # \n")
printf("Standard formula used \n ")
printf(" lambda = h /(m*v)\n")
lambda = h / (m * v)
printf("\n de-Broglie wavelength is %f Angstrom.",
   lambda * 1e10)
```

Scilab code Exa 14.37 Calculation of Energy

```
clc
// Given that
lambda = 1e-10 // wavelength in m
h = 6.62e-34 // Planck constant in J-sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
m_ = 1.67e-27 // mass of neutron in kg
// Sample Problem 37 on page no. 14.35
printf("\n # PROBLEM 37 # \n")
printf("Standard formula used \n ")
```

```
printf(" lambda = h /(m*v)\n")
v = h / (m * lambda)
E = h^2 / (2 * m * lambda^2)
E_ = h^2 / (2 * m_ * lambda^2)
printf("\n Energy for electron is %f eV.\n Energy
    for neutron is %f eV.",E / e,E_ / e)
```

Scilab code Exa 14.38 Calculation of deBroglie wavelength

```
clc
// Given that
E1 = 500 // kinetic energy of electron in first case
     in eV
E2 = 50 // kinetic energy of electron in second case
     in eV
E3 = 1 // kinetic energy of electron in third case
    in eV
h = 6.62e-34 // Planck constant in J-sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
// Sample Problem 38 on page no. 14.36
printf("\n # PROBLEM 38 # \n")
printf("Standard formula used \n ")
printf(" lambda = h/(2*m*E)^1/2.\n")
lambda1 = h / sqrt(2 * m * E1 * e)
lambda2 = h / sqrt(2 * m * E2 * e)
lambda3 = h / sqrt(2 * m * E3 * e)
printf("\n de-Broglie wavelength of electron - (1)
    In first case is %f A. \n (2) In second case is
    %f A. \n (3) In third is %f A.",lambda1*1e10,
    lambda2*1e10,lambda3*1e10)
```

Scilab code Exa 14.39 Calculation of Ratio of deBroglie wavelengths

```
clc
// Given that
E1 = 1 // kinetic energy of neutron in first case in
    eV
E2 = 510 // kinetic energy of neutron in second case
    in eV
h = 6.62e-34 // Planck constant in J-sec
e = 1.6e-19 // charge on an electron in C
m = 1.67e-27 // mass of neutron in kg
// Sample Problem 39 on page no. 14.36
printf("\n # PROBLEM 39 # \n")
printf("Standard formula used \n ")
printf(" lambda = h/(2*m*E)^1/2\n")
lambda1 = h / sqrt(2 * m * E1 * e)
lambda2 = h / sqrt(2 * m * E2 * e)
r = lambda1 / lambda2
printf("\n Ratio of de-Broglie wavelengths is %f .",
   r)
```

Scilab code Exa 14.40 Calculation of Ratio of deBroglie wavelengths

```
clc
// Given that
E = 20 // kinetic energy of proton in MeV
E2 = 510 // kinetic energy of neutron in second case
    in eV
```

```
h = 6.62e-34 // Planck constant in J−sec
e = 1.6e-19 // charge on an electron in C
m = 1.67e-27 // mass of proton in kg
m_ = 9.1e-31 // mass of electron in kg
// Sample Problem 40 on page no. 14.37
printf("\n # PROBLEM 40 # \n")
printf("Standard formula used \n ")
printf(" lambda = h/(2*m*E)^1/2\n")
lambda1 = h / sqrt(2 * m * 10^6 * E * e)
lambda2 = h / sqrt(2 * m_ * E * 10^6 * e)
r = lambda2 / lambda1
printf("\n Ratio of de−Broglie wavelengths is %f.",r
   )
```

Scilab code Exa 14.41 Calculation of Velocity

```
clc
// Given that
E = 1 // kinetic energy of proton in MeV
h = 6.62e-34 // Planck constant in J−sec
e = 1.6e-19 // charge on an electron in C
m = 1.67e-27 // mass of proton in kg
// Sample Problem 41 on page no. 14.37
printf("\n # PROBLEM 41 # \n")
printf("Standard formula used \n ")
printf(" E = 1/2 * m*v^2 \n")
v = sqrt(2 * E * 1.6e-13 / m)
printf("\n Velocity is %e m/sec.\n From the above
   result it is clear that the velocity of proton is
    nearly one twentieth of the velocity of light.
   So the relativistic calculation are not required.
   ",v)
```

Scilab code Exa 14.42 Calculation of deBroglie wavelength

```
clc
// Given that
r = 1 / 20 // ratio of velocity of proton to the
    velocity of light
c = 3e8 // velocity of light in m/sec
h = 6.62e-34 // Planck constant in J-sec
e = 1.6e-19 // charge on an electron in C
m = 1.67e-27 // mass of proton in kg
// Sample Problem 42 on page no. 14.38
printf("\n # PROBLEM 42 # \n")
printf("Standard formula used \n ")
printf(" lambda = h/(m*v)\n")
v = r * c
lambda = h / (m * v)
printf("\n de-Broglie wavelength is %e m.",lambda)
```

Scilab code Exa 14.43 Calculation of kinetic energy

```
clc
// Given that
lambda = 5e-7 // wavelength in m
c = 3e8 // velocity of light in m/sec
h = 6.62e-34 // Planck constant in J-sec
e = 1.6e-19 // charge on an electron in C
m = 1.67e-27 // mass of proton in kg
m_ = 9.1e-31 // mass of electron in kg
```

```
// Sample Problem 43 on page no. 14.38
printf("\n # PROBLEM 43 # \n")
printf("Standard formula used \n ")
printf(" lambda = h/(2*m*E)^1/2\n")
E1 = h^2 / (2 * m * lambda^2)
E2 = h^2 / (2 * m_ * lambda^2)
disp(E1,'kinetic energy of proton(in J) =')
disp(E2,'kinetic energy of electron(in J) =')
```

Scilab code Exa 14.44 Calculation of deBrogli wavelength

```
clc
// Given that
n = 1 // no. of Bohr's orbit of hydrogen atom
c = 3e8 // velocity of light in m/sec
h = 6.62e-34 // Planck constant in J-sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
// Sample Problem 44 on page no. 14.38
printf("\n # PROBLEM 44 # \n")
printf("Standard formula used \n ")
printf(" E = (13.6 / n^2)\n")
E = (13.6 / n^2) * e
lambda = h / sqrt(2 * m * E)
printf("\n de-Broglie wavelength is %f Angstrom.",
   lambda*1e10)
```

Scilab code Exa 14.45 Calculation of Ratio of deBroglie wavelengths

```
clc
// Given that
t = 300 // temperature in K
k = 1.376e-23 // Boltzmann's constant in J/K
c = 3e8 // velocity of light in m/sec
h = 6.62e-34 // Planck constant in J-sec
e = 1.6e-19 // charge on an electron in C
m_ = 4 * 1.67e-27 // mass of helium atom in kg
m = 1.67e-27 // mass of hydrogen atom in kg
// Sample Problem 45 on page no. 14.39
printf("\n # PROBLEM 45 # \n")
printf("Standard formula used \n ")
printf(" lambda = h/(3*m*k*T)^1/2\n")
lambda1 = h / sqrt(3 * m * k * t)
lambda2 = h / sqrt(3 * m_ * k * t)
r = lambda1 / lambda2
printf("\n Ratio of de-Broglie wavelengths is %d .",
   r)
```

Scilab code Exa 14.47 Calculation of Group velocity and Phase velocity

```
clc
// Given that
lambda = 1.2e-10 // DE Broglie wavelength in m
c = 3e8 // velocity of light in m/sec
h = 6.62e-34 // Planck constant in J-sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
// Sample Problem 47 on page no. 14.40
printf("\n # PROBLEM 47 # \n")
printf("Standard formula used \n ")
printf(" lambda = h/(m*v)\n")
v1 = h / (m * lambda)
```

```
v2 = h / (2 * m * lambda)
printf("\n Group velocity is %e m/sec.\n Phase
    velocity is %e m/sec.",v1,v2)
```

Chapter 15

QUANTUM MECHANICS

Scilab code Exa 15.1 Calculation of Percentage of uncertainty in momentum

```
clc
// Given that
E = 1000 // energy of electron in eV
delta_x = 1e-10 // error in position in m
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
h = 6.62e-34 // Planck constant in J-sec
// Sample Problem 1 on page no. 15.24
printf("\n # PROBLEM 1 # \n")
printf("Standard formula used \n")
printf(" p = (2 * m * E * e)^(1/2) \n")
p = sqrt(2 * m * E * e)
delta_p = h / (4 * %pi * delta_x)
P = (delta_p / p) * 100
printf("\n Percentage of uncertainty in momentum is
    %f.",P)
```

Scilab code Exa 15.3 Calculation of Percentage of uncertainty in momentum

```
clc
// Given that
E = 500 // energy of electron in eV
delta_x = 2e-10 // error in position in m
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
h = 6.62e-34 // Planck constant in J-sec
// Sample Problem 3 on page no. 15.25
printf("\n # PROBLEM 3 # \n")
printf("Standard formula used \n")
printf(" p = (2 * m * E * e)^(1/2) \n")
p = sqrt(2 * m * E * e)
delta_p = h / (4 * %pi * delta_x)
P = (delta_p / p) * 100
printf("\n Percentage of uncertainty in momentum is
    %f.",P)
```

Scilab code Exa 15.4 Calculation of Uncertainty in position

```
clc
// Given that
delta_lambda = 1e-6 // accuracy in wavelength of its
    one part
lambda = 1e-10 // wavelength of x-ray in m
h = 6.62e-34 // Planck constant in J-sec
```

```
// Sample Problem 4 on page no. 15.25
printf("\n # PROBLEM 4 # \n")
printf("Standard formula used \n")
printf(" del_x*del_p = h/(4*pi) \n")
delta_x = lambda / (4 * %pi * delta_lambda)
printf("\n Uncertainty in position is %f micrometer.",delta_x*10^6)
```

Scilab code Exa 15.5 Calculation of Uncertainty in momentum

```
clc
// Given that
delta_x = 1e-10 // error in position in m
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
h = 6.62e-34 // Planck constant in J-sec
// Sample Problem 5 on page no. 15.26
printf("\n # PROBLEM 5 # \n")
printf("Standard formula used \n")
printf(" del_x*del_p = h/(4*pi) \n")
delta_p = h / (4 * %pi * delta_x)
printf("\n Uncertainty in momentum is %e kg m/sec.",delta_p)
```

Scilab code Exa 15.6 Calculation of Uncertainty in position

```
clc
// Given that
M = 5.4e-26 // momentum of electron in kg-m/sec
```

```
p = 0.05 // percentage accuracy in momentum
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
h = 6.62e-34 // Planck constant in J-sec
// Sample Problem 6 on page no. 15.26
printf("\n # PROBLEM 6 # \n")
printf("Standard formula used \n")
printf(" del_x*del_p = h/(4*pi) \n")
delta_m = p * M / 100
delta_x = h / (4 * %pi * delta_m)
printf("\n Uncertainty in position is %f micrometre.",delta_x * 10^6)
```

Scilab code Exa 15.7 Calculation of Minimum energy of electron

```
clc
// Given that
r = 0.53e-10 // radius of hydrogen atom in m
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
h = 6.62e-34 // Planck constant in J-sec
// Sample Problem 7 on page no. 15.27
printf("\n # PROBLEM 7 # \n")
printf("Standard formula used \n")
printf(" del_x*del_p = h/(4*pi) \n p = (2 * m * E * e)^(1/2) \n")
delta_M = h / (4 * %pi * r)
delta_k = delta_M^2 / (2 * m)
printf("\n Minimum energy of electron is %e J.",delta_k)
```

Scilab code Exa 15.8 Calculation of Uncertainty in determining the position of electron

```
clc
// Given that
v = 5e3 // speed of electron in m/sec
a = 0.003 // percentage accuracy in measurement of
    speed
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
h = 6.62e-34 // Planck constant in J-sec
// Sample Problem 8 on page no. 15.27
printf("\n # PROBLEM 8 # \n")
printf("Standard formula used \n")
printf(" del_x*del_p = h/(4*pi) \n")
delta_v = v * a / 100
delta_p = m * delta_v
delta_x = h / (4 * %pi * delta_p)
printf("\n Uncertainty in determining the position
    of electron is %e m.",delta_x)
```

Scilab code Exa 15.9 Calculation of Uncertainty in determining the position

```
clc
// Given that
v = 6.6e4 // speed of electron in m/sec
```

```
a = 0.01 // percentage accuracy in measurement of speed
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
h = 6.6e-34 // Planck constant in J-sec
// Sample Problem 9 on page no. 15.27
printf("\n # PROBLEM 9 # \n")
printf("Standard formula used \n")
printf(" del_x*del_p = h/(4*pi) \n")
delta_v = v * a / 100
delta_p = m * delta_v
delta_x = h / (4 * %pi * delta_p)
printf("\n Uncertainty in determining the position is %e m.",delta_x)
```

Scilab code Exa 15.10 Calculation of Uncertainty in determining the position

```
clc
// Given that
v = 3e7 // speed of electron in m/sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
h = 6.62e-34 // Planck constant in J-sec
c = 3e8 // speed of light in m/sec
// Sample Problem 10 on page no. 15.28
printf("\n # PROBLEM 10 # \n")
printf("Standard formula used \n")
printf(" del_x*del_p = h/(4*pi) \n m = m_0/(1-(v^2/c^2))^1/2 \n")
delta_p = m * v / sqrt(1 - (v/c)^2)
delta_x = h / (4 * %pi * delta_p)
printf("\n Uncertainty in determining the position
```

```
is %e m.",delta_x)
```

Scilab code Exa 15.11 Calculation of Minimum error in measurement of the energy

```
clc
// Given that
t = 2.5e-14 // life time of hydrogen atom in exited
    state in sec
h = 6.62e-34 // Planck constant in J-sec
// Sample Problem 11 on page no. 15.28
printf("\n # PROBLEM 11 # \n")
printf("Standard formula used \n")
printf(" del_E*del_t = h/(4*pi) \n")
delta_E = h / (4 * %pi * t)
printf("\n Minimum error in measurement of the
    energy is %e J.",delta_E)
```

Scilab code Exa 15.12 Calculation of Minimum uncertainty in frequency

```
clc
// Given that
t = 10^-8 // life time of atom in exited state in
    sec
h = 6.62e-34 // Planck constant in J-sec
// Sample Problem 12 on page no. 15.28
printf("\n # PROBLEM 12 # \n")
printf("Standard formula used \n")
printf(" del_E*del_t = h/(4*pi) \n")
```

```
delta_f = 1 / (4 * %pi * t)
printf("\n Minimum uncertainty in frequency is %e Hz
    .",delta_f)
```

Scilab code Exa 15.13 Calculation of Ratio of uncertainty in velocity of a proton and an electron

```
clc
// Given that
delta_x = 20e-10 // uncertainty in position in m
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
m_ = 1.67e-27 // mass of proton in kg
c = 3e8 // speed of light in m/sec
h = 6.62e-34 // Planck constant in J-sec
// Sample Problem 13 on page no. 15.29
printf("\n # PROBLEM 13 # \n")
printf("Standard formula used \n")
printf(" del_x*del_p = h/(4*pi) \n")
delta_v1 = h / (4 * %pi * m * delta_x)
delta_v2 = h / (4 * %pi * m_ * delta_x)
r = delta_v2 / delta_v1
printf("\n Ratio of uncertainty in velocity of a
    proton and an electron is %e. ",r)
```

Scilab code Exa 15.14 Calculation of Energy of electron

```
clc
// Given that
```

```
delta_x = 1e-10 // width of box in m
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
c = 3e8 // speed of light in m/sec
h = 6.62e-34 // Planck constant in J-sec
// Sample Problem 14 on page no. 15.29
printf("\n # PROBLEM 14 # \n")
printf("Standard formula used \n")
printf(" E = (n^2 * h^2) / (8 * m * L^2)) \n")
n = 1 // for n=1
E = (n^2 * h^2) / (8 * m * delta_x^2)
n = 2 // for n=2
E_ = (n^2 * h^2) / (8 * m * delta_x^2)
printf("\n Energy of electron - \n For (n=1) energy is %e J.\n For (n=2) energy is %e J.",E,E_)
```

Scilab code Exa 15.15 Calculation of Energy difference

```
clc
// Given that
l = 1e-10 // width of box in m
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
c = 3e8 // speed of light in m/sec
h = 6.62e-34 // Planck constant in J-sec
// Sample Problem 15 on page no. 15.30
printf("\n # PROBLEM 15 # \n")
printf("Standard formula used \n")
printf(" E = (n^2 * h^2) / (8 * m * L^2)) \n")
n = 1 // for n=1
E = (n^2 * h^2) / (8 * m * l^2)
n = 2 // for n=2
E_ = (n^2 * h^2) / (8 * m * l^2)
```

```
d = E_ - E
printf("\n Energy difference is %e J.",d)
```

Scilab code Exa 15.16 Calculation of Energy difference

```
clc
// Given that
l = 3e-10 // width of box in m
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
c = 3e8 // speed of light in m/sec
h = 6.62e-34 // Planck constant in J-sec
// Sample Problem 16 on page no. 15.30
printf("\n # PROBLEM 16 # \n")
printf("Standard Formula used \n")
printf(" E = (n^2 * h^2) / (8 * m * L^2)) \n")
n = 1 // For n=1
E = (n^2 * h^2) / (8 * m * l^2)
n = 2 // For n=2
E_ = (n^2 * h^2) / (8 * m * l^2)
n = 3 // For n=3
E__ = (n^2 * h^2) / (8 * m * l^2)
printf("\n Energy of electron -\n For (n=1) is %e J
    .\n For (n=2) is %e J.\n For (n=3) is %e J.",E,E_
    ,E__)
```

Scilab code Exa 15.17 Calculation of Energy difference

```
clc
```

```
// Given that
l = 2.5e-10 // width of box in m
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
c = 3e8 // speed of light in m/sec
h = 6.62e-34 // Planck constant in J-sec
// Sample Problem 17 on page no. 15.30
printf("\n # PROBLEM 17 # \n")
printf("Standard formula used \n")
printf(" E = (n^2 * h^2) / (8 * m * L^2)) \n")
n = 1 // for n=1
E = (n^2 * h^2) / (8 * m * l^2)
n = 2 // for n=2
E_ = (n^2 * h^2) / (8 * m * l^2)
printf("\n Energy of electron -\n For (n=1) is %e J
    .\n For (n=2) is %e J.",E,E_)
```

Scilab code Exa 15.18 Calculation of Lowest energy of neutron confined in the nucleus

```
clc
// Given that
l = 1e-14 // width of box in m
e = 1.6e-19 // charge on an electron in C
m = 1.67e-27 // mass of neutron in kg
c = 3e8 // speed of light in m/sec
h = 6.62e-34 // Planck constant in J-sec
// Sample Problem 18 on page no. 15.31
printf("\n # PROBLEM 18 # \n")
printf("Standard formula used \n")
printf(" E = (n^2 * h^2) / (8 * m * L^2)) \n")
n = 1 // for n=1
E = (n^2 * h^2) / (8 * m * l^2)
```

```
printf("\n Lowest energy of neutron confined in the
    nucleus is %e J.",E)
```

Scilab code Exa 15.19 Calculation of Energy of electron and Momentum of electron

```
clc
// Given that
l = 1e-10 // width of box in m
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
c = 3e8 // speed of light in m/sec
h = 6.63e-34 // Planck constant in J-sec
// Sample Problem 19 on page no. 15.31
printf("\n # PROBLEM 19 # \n")
printf("Standard formula used \n")
printf(" E = (n^2 * h^2) / (8 * m * L^2)) \n p_n = n
    *h/(2*pi) \n")
n = 1 // for n=1
p1 = (n * h) / (2 * l)
E = (n^2 * h^2) / (8 * m * l^2)
n = 2 // for n=2
p2 = (n * h) / (2 * l)
E_ = (n^2 * h^2) / (8 * m * l^2)
printf("\n Energy of electron -\n For (n=1) is %e J
    .\n For (n=2) is %e J.\n Momentum of electron -\n
     For (n=1) is %e kg-m/sec.\n For (n=2) is %e kg-m
    /sec.",E,E_,p1,p2)
```

Scilab code Exa 15.20 Calculation of Energy Eigen value of electron and deBroglie wavelength

```
clc
// Given that
l = 1e-10 // length of box in m
m = 9.1e-31 // mass of electron in kg
c = 3e8 // speed of light in m/sec
h = 6.62e-34 // Planck constant in J-sec
// Sample Problem 20 on page no. 15.32
printf("\n # PROBLEM 20 # \n")
printf("Standard formula used \n")
printf(" E = (n^2 * h^2) / (8 * m * L^2)) \n p_n = n*h/(2*pi) \n")
n = 1 // for n=1
E1 = (n^2 * h^2) / (8 * m * l^2)
lambda1 =2*l
n = 2 // for n=2
E2 = (n^2 * h^2) / (8 * m * l^2)
lambda2 =2*l/2
n = 3 // for n=3
E3 = (n^2 * h^2) / (8 * m * l^2)
lambda3 =2*l/3
printf("\n Energy Eigen value of electron -\n For (n=1) is %e J.\n For (n=2) is %e J.\n For (n=3) is %e J. \nde-Broglie wavelength of electron -\n For (n=1) is %f A.\n For (n=2) is %f A. \n For (n=3) is %f A",E1,E2,E3,lambda1*1e10,lambda2*1e10,lambda3*1e10)
```

Scilab code Exa 15.21 Calculation of Energy Eigen values

```
clc
```

```
// Given that
E1 = 3.2e-18 // minimum energy possible for a
    particle entrapped in a one dimensional box in J
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
c = 3e8 // speed of light in m/sec
h = 6.62e-34 // Planck constant in J-sec
// Sample Problem 21 on page no. 15.32
printf("\n # PROBLEM 21 # \n")
printf("Standard formula used \n")
printf(" E = (n^2 * h^2) / (8 * m * L^2)) \n")
E1 = E1 / e // in eV
n = 2 // for n=2
E2 = n^2 * E1
n = 3 // for n=3
E3 = n^2 * E1
n = 4 // for n=4
E4 = n^2 * E1
printf("\n Energy Eigen values -\n For (n=2) for %f
   eV.\n For (n=3) is %f eV.\n For (n=4) is %f eV.",
   E2,E3,E4)
```

Scilab code Exa 15.22 Calculation of Order of exited state

```

clc
// Given that
l = 4e-10 // width of box in m
E = 9.664e-17 // energy of electron in J
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
c = 3e8 // speed of light in m/sec
h = 6.62e-34 // Planck constant in J-sec
```

```
// Sample Problem 22 on page no. 15.33
printf("\n # PROBLEM 22 # \n")
printf("Standard formula used \n")
printf(" E = (n^2 * h^2) / (8 * m * L^2)) \n p_n = n*h/(2*pi) \n")
n = 1 // for n=1
E1 = (n^2 * h^2) / (8 * m * l^2)
N = sqrt(E / E1)
p = ((N) * h) / (2 * l)
printf("\n Order of exited state is %d.\n Momentum of electron is %e kg-m/sec.",N,p)
```

Scilab code Exa 15.23 Calculation of Energy levels of electron and Energy levels of marble

```
clc
// Given that
l = 10e-10 // width of box containing electron in m
E = 9.664e-17 // energy of electron in J
M = 0.001 // mass of glass marble in kg
l_ = 0.2 // width of box containing marble in m
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
c = 3e8 // speed of light in m/sec
h = 6.62e-34 // Planck constant in J-sec
// Sample Problem 23 on page no. 15.33
printf("\n # PROBLEM 23 # \n")
printf("Standard formula used \n")
printf(" E = (n^2 * h^2) / (8 * m * L^2)) \n p_n = n*h/(2*pi) \n")
// For electron
n = 1 // for n=1
E1 = (n^2 * h^2) / (8 * m * l^2)
```

```
E2 = 2^2* E1
E3 = 3^2 * E1
// For glass marble
E1_ = h^2/(8*M*l_^2)
E2_ = 2^2 * E1_
E3_ = 3^2 *E1_
printf("\n Energy levels of electron \n For (n=1) is
    %e J.\n For (n=2) is %e J.\n For (n=3) is %e J.\
   n Energy levels of marble \n For (n=1) is %e J.\n
    For (n=2) is %e J.\n For (n=3) is %e J.",E1,E2,
   E3,E1_,E2_,E3_)
printf("\n It is clear that the levels in case of
   marble are very small and are nearly zero. So it
   is not possible to measure them experimentally.")
```

Chapter 16

FREE ELECTRON THEORY

Scilab code Exa 16.1 Calculation of Average energy of electron and Speed of electron

```
clc
// Given that
t = 0 // temperature in K
E = 10 // Fermi energy of electron in eV
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
// Sample Problem 1 on page no. 16.14
printf("\n # PROBLEM 1 # \n")
printf("Standard formula used \n")
printf("1/2 * m*v^2 = E_0 \n")
E_ = E * 3 / 5
v = sqrt(2 * E_ * e / m)
printf("\n Average energy of electron is %f eV.\n
    Speed of electron is %e m/sec.",E_,v)
```

Scilab code Exa 16.2 Calculation of Average energy of electron and Speed of electron

```
clc
// Given that
t = 0 // temperature in K
E = 7.9 // Fermi energy in eV
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
// Sample Problem 2 on page no. 16.14
printf("\n # PROBLEM 2 # \n")
printf("Standard formula used \n")
printf("1/2 * m*v^2 = E_0 \n")
E_ = E * 3 / 5
v = sqrt(2 * E_ * e / m)
printf("\n Average energy of electron is %f eV.\n
    Speed of electron is %e m/sec.",E_,v)
```

Scilab code Exa 16.3 Calculation of Fermi energy and Speed of electron

```
clc
// Given that
n = 2.5e28 // no. of free electron in per meter cube
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
h = 6.62e-34 // Planck constant in J-sec
// Sample Problem 3 on page no. 16.15
printf("\n # PROBLEM 3 # \n")
```

```
printf("Standard formula used \n")
printf("1/2 * m*v^2 = E_0 \n ")
printf("E_0 = (h^2 /(8 * pi^2 * m))*(3 * pi^2 * n)
    ^(2/3) * (1 / e)\n")
E = (h^2 / (8 * %pi^2 * m)) * (3 * %pi^2 * n)^(2/3)
    * (1 / e)
v = (h / (2 * %pi * m)) * (3 * %pi^2 * n)^(1/3)
printf("\n Fermi energy is %f eV.\n Speed of
    electron is %e m/sec.",E,v)
```

Scilab code Exa 16.4 Calculation of Fermi energy and Average energy

```
clc
// Given that
d = 8940 // density of copper in kg/m^3
w = 63.55 // atomic weight of copper
t = 0 // temperature in K
N = 6.02e26 // Avogadro no. in per kg
m = 9.1e-31 // mass of electron in kg
h = 6.62e-34 // Planck constant in J-sec
e = 1.6e-19 // charge on an electron in C
// Sample Problem 4 on page no. 16.15
printf("\n # PROBLEM 4 # \n")
printf("Standard formula used \n")
printf("1/2 * m*v^2 = E_0 \n ")
printf("E = (h^2 / (8 * pi^2 * m)) * (3 * pi^2 * N/V
    )^(2/3) \n")
V = w / d
n = N / V
E = (h^2 / (8 * %pi^2 * m)) * (3 * %pi^2 * n)^(2/3)
    * (1 / e)
E_ = 3 * E / 5
printf("\n Fermi energy is %f eV.\n Average energy
```

```
is %f eV.",E,E_)
```

Scilab code Exa 16.5 Calculation of Fermi energy

```
clc
// Given that
d = 10.5e6 // density of silver in g/m^3
w = 108 // atomic weight of silver
t = 0 // temperature in K
N = 6.02e23 // Avogadro no. in per kg
m = 9.1e-31 // mass of electron in kg
h = 6.62e-34 // Planck constant in J-sec
e = 1.6e-19 // charge on an electron in C
// Sample Problem 5 on page no. 16.16
printf("\n # PROBLEM 5 # \n")
printf("Standard formula used \n")
printf("E = (h^2 / (8 * pi^2 * m)) * (3 * pi^2 * N/V
    )^(2/3) \n")
V = w / d
n = N / V
E = (h^2 / (8 * %pi^2 * m)) * (3 * %pi^2 * n)^(2/3)
    * (1 / e)
printf("\n Fermi energy is %f eV.",E)
```

Scilab code Exa 16.6 Calculation of Fermi energy and Fermi vector and Total kinetic energy

```
clc
// Given that
```

```
a = 4e-10 // lattice constant in mr
t = 0 // temperature in K
N = 6.02e23 // Avogadro no. in per kg
m = 9.1e-31 // mass of electron in kg
h = 6.62e-34 // Planck constant in J-sec
e = 1.6e-19 // charge on an electron in C
// Sample Problem 6 on page no. 16.16
printf("\n # PROBLEM 6 # \n")
printf("Standard formula used \n")
printf("E = (h^2 / (8 * pi^2 * m)) * (3 * pi^2 * N/V)^(2/3) \n")
V = a^3
n = 4 / V
E = (h^2 / (8 * %pi^2 * m)) * (3 * %pi^2 * n)^(2/3) * (1 / e)
k = (3 * %pi^2 *n)^(1/3)
KE = (3 * E / 5) * (n)
printf("\n Fermi energy is %f eV.\n Fermi vector is %e per m.\n Total kinetic energy is %e eV.",E,k,KE)
```

Scilab code Exa 16.7 Calculation of Drift velocity of electron

```
clc
// Given that
d = 0.9e-3 // diameter of aluminium in m
i = 6 // current in amp
n = 4.5e28 // no. of electron available for conduction per meter^3
e =  1.6e-19 // charge on an electron in C
// Sample Problem 7 on page no. 16.17
printf("\n # PROBLEM 7 # \n")
printf("Standard formula used \n")
```

```
printf("J = I*A \n v_d = J/ne \n")
J = i * 4 / (%pi * (d)^2)
v = J / (n * e)
printf("\n Drift velocity of electron is %e m/sec.",
   v)
```

Scilab code Exa 16.8 Calculation of Current density and Drift velocity

```
clc
// Given that
d = 8.92e3 // density of copper in kg/m^3
i = 5 // current in amp
w = 63.5 // atomic weight of copper
r = 0.7e-3 // radius in meter
N = 6.02e28 // Avogadro no.
e = 1.6e-19 // charge on an electron in C
// Sample Problem 8 on page no. 16.17
printf("\n # PROBLEM 8 # \n")
printf("Standard formula used \n")
printf(" J = I*A \n v_d = J/ne \n")
V = (w / d)
n = N / V
J = i / (%pi * r^2)
v = J / (n * e)
printf("\n Current density = %e amp/m^2.\n Drift
   velocity is %e m/sec.",J,v)
```

Scilab code Exa 16.9 Calculation of Fermi Energy

```
clc
// Given that
d1= 0.534*10^3 // densiy of Li in kg/m^3
d2= 0.971*10^3 // densiy of Na in kg/m^3
d3= 0.86*10^3 // densiy of K in kg/m^3
w1 = 6.939 // atomic weight of Li
w2 = 22.99 // atomic weight of Na
w3 = 39.202 // atomic weight of K
h = 6.62e-34 // Planck constant in J sec
m = 9.1e-31 // mass of an electron in kg
NA = 6.023e26 // Avogadro no.
e = 1.6e-19 // charge on an electron in C
// Sample Problem 9 on page no. 16.17
printf("\n # PROBLEM 9 # \n")
printf("Standard formula used \n")
printf("E = h^2 / (8 * m * pi^2) * (3*pi^2*N/V)^2/3 \n")
// For Li
n1 = NA * d1/w1
E1 = h^2/(8*%pi^2*m)*(3*%pi^2*n1)^(2/3)
// For Na
n2 = NA * d2/w2
E2 = h^2/(8*%pi^2*m)*(3*%pi^2*n2)^(2/3)
// For K
n3 = NA * d3/w3
E3 = h^2/(8*%pi^2*m)*(3*%pi^2*n3)^(2/3)
printf("\n Fermi Energy \n For Li is %f eV.\n For Na is %f eV. \n For K is %f eV",E1/e,E2/e,E3/e)
```

Scilab code Exa 16.10 Calculation of Energy difference

```
clc
// Given that
```

```
l = 1e-10 //length of box in m
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
h = 6.62e-34 // Planck constant in J-sec
// Sample Problem 10 on page no. 16.18
printf("\n # PROBLEM 10 # \n")
printf("Standard formula used \n")
printf("E = (n^2 * h^2) / (8 * m * l^2) \n")
n = 1 // for n=1
E = (n^2 * h^2) / (8 * m * l^2)
n = 2 // for n=2
E_ = (n^2 * h^2) / (8 * m * l^2)
d = (E_ - E) * (1 / e)
printf("\n Energy difference is %f eV.",d)
```

Chapter 17

BAND THEORY OF SOLIDS

Scilab code Exa 17.1 Calculation of Electron momentum value at the sides of first Brillion zone and Enrgy of free electron

```
clc
// Given that
a = 3e-10 // side of square lattice in m
h = 6.62e-34 // Planck constant in J sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
// Sample Problem 1 on page no. 17.18
printf("\n # PROBLEM 1 # \n")
printf("Standard formula used \n ")
printf("E = P^2 / (2*m) \n P = h_cut*k \n")
p = (h / (2 * a))
E = (p^2 / (2 * m)) * (1 / e)
printf("\n Electron momentum value at the sides of first Brilloin zone is %e kg-m/sec.\n Enrgy of free electron is %f eV.",p,E)
```

Scilab code Exa 17.2 Calculation of Position of Fermi level

```
clc
// Given that
n = 5e22 // no. of atoms per m^3
t = 300 // room temperature in K
k = 1.37e-23 // Boltzmann's constant in J/K
h = 6.62e-34 // Planck constant in J sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
// Sample Problem 2 on page no. 17.19
printf("\n # PROBLEM 2 # \n")
printf("Standard formula used \n")
printf("n_c = 2*(2*pi*m*k*T/h^2)^(3/2) * e^(E_f-E_c)/kT \n")
d = (k * t) * log(n * h^3 / (2 * (2 * %pi * m * k * t)^(3/2)))
printf("\n Position of fermi level is %f eV.",-d/e)
```

Scilab code Exa 17.3 Calculation of New position of Fermi level

```
clc
// Given that
E = 0.3 // Fermi energy in eV
T = 330 // temperature in K
t = 300 // room temperature in K
k = 1.37e-23 // Boltzmann's constant in J/K
h = 6.62e-34 // Planck constant in J sec
```

```
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
// Sample Problem 3 on page no. 17.19
printf("\n # PROBLEM 3 # \n")
printf("Standard formula used \n")
printf("n_c = n_d * e^(E_f-E_c)/kT \n")
d = (T / t) * (E)
printf("\n New position of fermi level is %f eV.",d)
```

Scilab code Exa 17.4 Calculation of Density of holes and electron

```
clc
// Given that
E = 0.7 // band gap for semiconductor in eV
t = 300 // room temperature in K
k = 1.38e-23 // Boltzmann's constant in J/K
h = 6.62e-34 // Planck constant in J sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
// Sample Problem 4 on page no. 17.20
printf("\n # PROBLEM 4 # \n")
printf("Standard formula used \n")
printf("n_c = 2*(2*pi*m*k*T/h^2)^(3/2) * e^(E_f-E_c)
    /kT \n")
n = 2 * ((2 * %pi * k * t * m) / h^2)^(3/2) * exp(-(
    E * e / (2 * k * t)))
printf("\n Density of holes and electron is %e per m
    ^3.",n)
```

Scilab code Exa 17.5 Calculation of Hall coefficient

```
clc
// Given that
n = 5e28 // no. of atoms in per m^3
e = 1.6e-19 // charge on an electron in C
// Sample Problem 5 on page no. 17.20
printf("\n # PROBLEM 5 # \n")
printf("Standard formula used \n")
printf("R_h = 1/(n*e) \n")
R = -(1 / (n * e))
printf("\n Hall coefficient is %e m^3/C.",R)
```

Scilab code Exa 17.6 Calculation of Hall coefficient

```
clc
// Given that
a = 4.28e-10 // cell side of Na in m
e = 1.6e-19 // charge on an electron in C
// Sample Problem 6 on page no. 17.20
printf("\n # PROBLEM 6 # \n")
printf("Standard formula used \n")
printf("R_h = 1/(n*e) \n")
n = (2 / a^3)
R = -(1 / (n * e))
printf("\n Hall coefficient is %e m^3/C.",R)
```

Chapter 18

MAGNETIC PROPERTIES OF SOLIDS

Scilab code Exa 18.1 Calculation of Magnetic moment and Bohr magneton

```
clc
// Given that
r = 0.53e-10 // radius of orbit in m
f = 6.6e15 // frequency of revolution in Hz
h = 6.6e-34 // Planck constant in J sec
e = 1.6e-19 // charge on an electron in C
m = 9.1e-31 // mass of electron in kg
// Sample Problem 1 on page no. 18.21
printf("\n # PROBLEM 1 # \n")
printf("Standard formula used \n ")
printf(" M = I*a \n")
M = e * f * %pi * r^2
mu = (e * h) / (4 * %pi * m)
printf("\n Magnetic moment is %e Am^2.\n Bohr
    magneton is %e J/T.",M,mu)
```

Scilab code Exa 18.2 Calculation of Magnetization and Flux density and Relative permeability

```
clc
// Given that
X = -4.2e-6 // magnetic susceptibility
H = 1.19e5 // magnetic field in A/m
mu_ = 4 * %pi * 1e-7 // magnetic permeability of
    space
// Sample Problem 2 on page no. 18.21
printf("\n # PROBLEM 2 # \n")
printf("Standard formula used \n ")
printf(" I = cai*H  \n")
I = X * H
B = mu_ * (H + I)
mur = (1 + I/H)
printf("\n Magnetisation is %f A/m.\n Flux density
    is %f T.\n Relative permeability is %f .",I,B,mur
    )
```

Scilab code Exa 18.3 Calculation of Percentage increase in magnetic induction

```
clc
// Given that
X = 1.2e-5 // magnetic susceptibility of magnesium
// Sample Problem 3 on page no. 18.22
printf("\n # PROBLEM 3 # \n")
```

```
printf("Standard formula used \n ")
printf(" B = mu_0*H \n")
p = 100 * X
printf("\n Percentage increase in magnetic induction
    is %f percent.",p)
```

Scilab code Exa 18.4 Calculation of Magnetization and Magnetic flux density

```
clc
// Given that
X = -0.4e-5 // magnetic susceptibility of material
H = 1e4 // magnetic field in A/m
mu_ = 4 * %pi * 1e-7 // magnetic permittivity of
    space
// Sample Problem 4 on page no. 18.22
printf("\n # PROBLEM 4 # \n")
printf("Standard formula used \n ")
printf(" I = Chi *H \n")
I = X * H
B = mu_ * (H + I)
printf("\n Magnetisation is %f A/m.\n Magnetic flux
    density is %f T.",I,B)
```

Scilab code Exa 18.5 Calculation of Permeability of aluminium

```
clc
// Given that
X = 2.3e-5 // magnetic susceptibility of aluminium
```

```
mu_ = 4 * %pi * 1e-7 // magnetic permeability of
    space
// Sample Problem 5 on page no. 18.23
printf("\n # PROBLEM 5 # \n")
printf("Standard formula used \n ")
printf(" mu_r = 1 + Chi \n")
mur = 1 + X
mu = mu_ * mur
printf("\n Permeability of aluminium is %e N/A^2.",
    mu)
```

Scilab code Exa 18.6 Calculation of Absolute permeability and Relative permeability

```
clc
// Given that
X = 9.4e-2 // magnetic susceptibility
mu_ = 4 * %pi * 1e-7 // magnetic permeability of
    space
// Sample Problem 6 on page no. 18.23
printf("\n # PROBLEM 6 # \n")
printf("Standard formula used \n ")
printf(" mu_r = 1 + Chi \n")
mu_r = 1 + X
mu = mu_ * mu_r
printf("\n Absolute permeability is %e N/A^2.\n
    Relative permeability is %f.",mu,mu_r)
```

Scilab code Exa 18.7 Calculation of Magnetic susceptibility and Relative permeability

```
clc
// Given that
mu = 0.126 // maximum value of the permeability in N
    /A^2
mu_ = 4 * %pi * 1e-7 // magnetic permeability of
    space
// Sample Problem 7 on page no. 18.23
printf("\n # PROBLEM 7 # \n")
printf("Standard formula used \n ")
printf(" mu_r = 1 + Chi \n")
mu_r = mu / mu_
X = mu_r - 1
printf("\n Magnetic susceptibility is %f .\n
    Relative permeability is %e",X,mu_r)
```

Scilab code Exa 18.8 Calculation of Diamagnetic susceptibility

```
clc
// Given that
r = 0.6e-10 // radius of the atom
N = 28e26 // no. of electron in per m^3
mu_ = 4 * %pi * 1e-7 // magnetic permeability of
    space
Z = 2 // atomic no. of helium
m = 9.1e-31 // mass of an electron in kg
e = 1.6e-19 // charge on an electron in C
// Sample Problem 8 on page no. 18.24
printf("\n # PROBLEM 8 # \n")
printf("Standard formula used \n ")
printf("  Chi = mu_0*Z*e^2 *N*R^2 /(6*m) \n")
```

```
Chi = -(mu_ * Z * N * r^2 * e^2) / (6 * m)
printf("\n Diamagnetic susceptibility is %e .",Chi)
```

Scilab code Exa 18.9 Calculation of Permeability and Susceptibility

```
clc
// Given that
H = 1e3 // magnetisation field in A/m
phi = 2e-5 // magnetic flux in Weber
a = 0.2e-4 // area of cross section in m^2
mu_ = 4 * %pi * 1e-7 // magnetic permeability of
    space
// Sample Problem 9 on page no. 18.24
printf("\n # PROBLEM 9 # \n")
printf("Standard formula used \n ")
printf(" mu_r = 1 + Chi \n")
B = phi / a
mu = B / H
X = mu / mu_ - 1
printf("\n Permeability is %e N/A^2.\n
    Susceptibility is %f .",mu,X)
```

Scilab code Exa 18.10 Calculation of Number of ampere turns

```
clc
// Given that
l = 1 // length of iron rod in m
a = 4e-4 // area in m^2
mu = 50e-4 // permeability of iron in H/m
```

```
Phi = 4e-4 // magnetic flux in Weber
// Sample Problem 10 on page no. 18.24
printf("\n # PROBLEM 10 # \n")
printf("Standard formula used \n ")
printf("B = mu*N*I \n")
B = Phi / a
NI = B / mu
printf("\n Number of ampere turns is %d A/m. ",NI)
```

Scilab code Exa 18.11 Calculation of Current through the winding

```
clc
// Given that
n = 200 // no. of turns
l = 0.5 // the mean length of iron wire in m
phi = 4e-4 // magnetic flux in Weber
a = 4e-4 // area of cross section in m^2
mu = 6.5e-4 // permeability of iron in wb/Am
mu_ = 4 * %pi * 1e-7 // magnetic permeability of
    space
// Sample Problem 11 on page no. 18.25
printf("\n # PROBLEM 11 # \n")
printf("Standard formula used \n ")
printf("B = mu*N*I \n")
B = phi / a
N = n / l
I = B / (mu * N)
printf("\n Current through the winding is %f A. ",I)
```

Scilab code Exa 18.12 Calculation of Radius of atom

```
clc
// Given that
X = -5.6e-6 // magnetic susceptibility of material
a = 2.55e-10 // lattice constant in m
H = 1e4 // magnetic field in A/m
mu_ = 4 * %pi * 1e-7 // magnetic permittivity of
    space
m = 9.1e-31 // mass of electron in kg
e = 1.6e-19 // charge in an electron in C
// Sample Problem 12 on page no. 18.25
printf("\n # PROBLEM 12 # \n")
printf("Standard formula used \n ")
printf("  Chi = mu_0*Z*e^2 *N*R^2 /(6*m) \n")
N = 2 / a^3
z = 1
R = ((-X * 6 * m) / (mu_ * z * e^2 * N))^(1/2)
printf("\n Radius of  atom is %f A.",R * 1e10)
```

Scilab code Exa 18.13 Calculation of Susceptibility

```
clc
// Given that
N = 6.5e25 // no. of atom per m^3
T = 300 // room temperature in K
mu_ = 4 * %pi * 1e-7 // magnetic permittivity of
    space
k = 1.38e-23 // Boltzmann's constant in J/K
m = 9.1e-31 // mass of electron in kg
e = 1.6e-19 // charge in an electron in C
h = 6.62e-34 // Planck constant in J sec
// Sample Problem 13 on page no. 18.25
```

```
printf("\n # PROBLEM 13 # \n")
printf("Standard formula used \n ")
printf("   Chi = mu_0*N*M^2 /(3*k*t) \n")
M = (e * h) / (4 * %pi * m)
X = (mu_ * N * M^2) / (3 * k * T)
printf("\n Susceptibility is %e",X)
```

Scilab code Exa 18.14 Calculation of Magnetization

```
clc
// Given that
w = 168.5 // molecular weight
d = 4370 // density of material in kg/m^3
H = 2e5 // magnetic field in A/m
T = 300 // room temperature in K
mu_ = 4 * %pi * 1e-7 // magnetic permittivity of
    space]
NA = 6.02e26 // Avogadro no. in per kg
mu_b = 9.24e-24 // Bohr magnetons in Am^2
k = 1.38e-23 // Boltzmann's constant in J/K
// Sample Problem 14 on page no. 18.26
printf("\n # PROBLEM 14 # \n")
printf("Standard formula used \n ")
printf("   Chi = mu_0*N*M^2 /(3*k*t) \n")
N = d * NA / w
X = (mu_ * N * (2 * mu_b)^2) / (3 * k * T)
I = X * H
printf("\n Magnetisation is %f A/m",I)
```

Scilab code Exa 18.15 Calculation of Total loss of energy

```
clc
// Given that
A = 2500 // area of hysteresis loop
m = 10000 // weight in kg
d = 7.5 // density of material in g/cm^3
f = 50 // frequency in Hz
// Sample Problem 15 on page no. 18.26
printf("\n # PROBLEM 15 # \n")
printf("Standard formula used \n ")
printf("  M = V*d \n")
E = f * A * 3600
V = m / d
L = E * V
printf("\n Total loss of energy per hour is %e ergs.
    ",L)
```

Scilab code Exa 18.16 Calculation of Current in solenoid

```
clc
// Given that
H = 5e3 // coercivity in A/m
l = 0.10 // length of solenoid in m
n = 50 // no. of turns
// Sample Problem 16 on page no. 18.27
printf("\n # PROBLEM 16 # \n")
printf("Standard formula used \n ")
printf(" H=N*i \n")
N = n / l
i = H / N
printf("\n Current in solenoid should be %d A.",i)
```

Scilab code Exa 18.17 Calculation of Number of turns

```
clc
// Given that
l = 0.50 // length of iron rod in m
a = 4e-4 // area of cross section of rod in m^2
mu = 65e-4 // permeability of iron in H/m
fi = 4e-5 // flux in weber
// Sample Problem 17 on page no. 18.27
printf("\n # PROBLEM 17 # \n")
printf("Standard formula used \n ")
printf("   N =H*l \n")
B = fi / a
H = B / mu
N = H * l
printf("\n Number of turns are %f",N)
```

Scilab code Exa 18.18 Calculation of Permeability and Susceptibility

```
clc
// Given that
H = 600 // magnetic flux in A/m
a = 0.2e-4 // area of cross section of rod in m^2
phi = 2.4e-5 // flux in weber
mu_ = 4*%pi * 1e-7 // permeability of space in N/A^2
// Sample Problem 18 on page no. 18.27
printf("\n # PROBLEM 18 # \n")
printf("Standard formula used \n ")
```

```
printf(" mu_r = 1 + Chi \n")
B = phi / a
mu = B / H
X = mu / mu_ - 1
printf("\n Permeability is %f N/A^2.\n
   Susceptibility is %f.",mu,X)
```

Scilab code Exa 18.19 Calculation of Relative permeability

```
clc
// Given that
X = 9.5e-9 // susceptibility of medium
mu_ = 4*%pi * 1e-7 // permeability of space in N/A^2
// Sample Problem 19 on page no. 18.28
printf("\n # PROBLEM 19 # \n")
printf("Standard formula used \n ")
printf(" mu_r = 1 + Chi \n")
mu = mu_ * (1 + X)
mu_r = mu / mu_
printf("\n Relative permeability is 1 + %e",mu_r -1)
```

Scilab code Exa 18.20 Calculation of Energy loss

```
clc
// Given that
a = 250 // area of the B-H loop in J/m^3
f = 50 // frequency in Hz
d = 7.5e3 // density of iron in kg/m^3
m = 100 // mass of core in kg
```

```
// Sample Problem 20 on page no. 18.28
printf("\n # PROBLEM 20 # \n")
printf("Standard formula used \n ")
printf(" M = V*d \n")
V = m / d
n = 3600 * f
A = a * V * n
printf("\n Energy loss per hour is %e J.",A)
```

Scilab code Exa 18.21 Calculation of Hysteresis loss

```
clc
// Given that
B_max = 1.375 // maximum value of B in Wb/m^2
a = 0.513 // area of the loop in cm^2
k = 1000 // value of 1 cm on x axis in A/m
k_ = 1 // value of 1 cm on y axis in Wb/m^2
B = 1.375 // alternating magnetic flux density in Wb
    /m^2
v = 1e-3 // volume of specimen in m^3
f = 50 // frequency in Hz
// Sample Problem 21 on page no. 18.28
printf("\n # PROBLEM 21 # \n")
printf("Standard formula used \n K = a * k * k_.\n")
K = a * k * k_
L = K * v * f
printf("\n Hysteresis loss per sec is %f W",L)
```

Chapter 19

SUPERCONDUCTIVITY

Scilab code Exa 19.1 Calculation of Penetration depth

```
clc
// Given that
T_c = 7.2 // critical temperature in K
T = 5.1 // temperature in K
lambda_ = 380 // penetration depth at 0 K in A
// Sample Problem 1 on page no. 19.13
printf("\n # PROBLEM 1 # \n")
printf("Standard formula used \n ")
printf(" lambda = lambda_0 * (1 - (T / T_c)^4)
    ^(-1/2) \n")
lambda = lambda_ * (1 - (T / T_c)^4)^(-1/2)
printf("\n Penetration depth is %f Angstrom.",lambda
    )
```

Scilab code Exa 19.2 Calculation of Transition temperature and Critical field at temperate

```
clc
// Given that
Hc1 = 1.41e5 // first critical field at 14.1K
Hc2 = 4.205e5 // second critical field at 12.9K
T1 = 14.11 // temperature in K
T2 = 12.9 // temperature in K
T = 4.2 // temperature in K
lambda_ = 380 // penetration depth at 0 K in A
// Sample Problem 2 on page no. 19.13
printf("\n # PROBLEM 2 # \n")
printf("Standard formula used \n ")
printf(" H = H_0 * (1 - (T / T_c)^2) \n")
Tc = sqrt((Hc2*T1^2 - Hc1*T2^2) / (Hc2 - Hc1))
H_ = Hc1 / (1 - (T1 / Tc)^2)
Hc = H_ * (1 - (T/Tc)^2)
printf("\n Transition temperature is %f K.\n
   Critical field at temperate at 4.2 k is %e A/m.",
   Tc,Hc)
```

Scilab code Exa 19.3 Calculation of Critical current density

```
clc
// Given that
d = 1e-3 // diameter of wire in m
T1 = 4.2 // temperature in K
T2 = 7.18 // temperature in K
H_ = 6.51e4 // critical magnetic field at 0 K
// Sample Problem 3 on page no. 19.14
printf("\n # PROBLEM 3 # \n")
printf("Standard formula used \n ")
```

```
printf(" H = H_0 * (1 - (T / T_c)^2) \n I = 2*pi*r*H
    \n")
r = d / 2
Hc = H_ * (1 - (T1 / T2)^2)
Jc = (2 * %pi * r * Hc) / (%pi * r^2)
printf("\n Critical current density is %e A/m^2",Jc)
```

Scilab code Exa 19.4 Calculation of Critical temperature

```
clc
// Given that
w = 199.5 // isotopic mass of Hg
Tc = 4.186 // critical temperature in K
w_ = 203.4 // increased isotope mass of Hg
// Sample Problem 4 on page no. 19.15
printf("\n # PROBLEM 4 # \n")
printf("Standard formula used \n ")
printf(" T_c*M^(1/2) = constant \n")
Tc_ = Tc * (w / w_)^(1/2)
printf("\n Critical temperature is %f K.",Tc_)
```

Scilab code Exa 19.5 Calculation of Penetration depth

```
clc
// Given that
T_c = 4.2 // critical temperature in K
T = 2.9 // temperature in K
lambda = 57 // penetration depth at 2.9 K in nm
// Sample Problem 5 on page no. 19.15
```

```
printf("\n # PROBLEM 5 # \n")
printf("Standard formula used \n ")
printf(" lambda_0 = lambda * (1 - (T / T_c)^4)^(1/2)
    \n")
lambda_ = lambda * (1 - (T / T_c)^4)^(1/2)
printf("\n Penetration depth at 0 K is %f nm.",
   lambda_)
```

Scilab code Exa 19.6 Calculation of Critical temperature

```
clc
// Given that
T1 = 2.18 // temperature in first case in K
lambda1 = 16 // penetration depth at 2.18 K in nm
T2 = 8.1 // temperature in second case in K
lambda2 = 96 // penetration depth at 8.1 K in nm
// Sample Problem 6 on page no. 19.15
printf("\n # PROBLEM 6 # \n")
printf("Standard formula used \n ")
printf(" lambda = lambda_0 * (1 - (T / T_c)^4)
   ^(-1/2) \n")
Tc = (((lambda2^2 * T2^4) - (T1^4 * lambda1^2)) / (
   lambda2^2 - lambda1^2))^(1/4)
printf("\n Critical temperature is %f K.",Tc)
```

Scilab code Exa 19.7 Calculation of Critical temperature

```
clc
// Given that
```

```
w = 26.91 // isotopic mass of superconducting sample
Tc = 1.19 // first critical temperature in K
w_ = 32.13 // increased isotope mass of superconducting sample
// Sample Problem 7 on page no. 19.16
printf("\n # PROBLEM 7 # \n")
printf("Standard formula used \n ")
printf(" T_c*M^(1/2) = constant \n")
Tc_ = Tc * (w / w_)^(1/2)
printf("\n Critical temperature is %f K.",Tc_)
```

Scilab code Exa 19.8 Calculation of Energy gap

```
clc
// Given that
k = 1.38e-23 // Boltzmann's constant in J/K
h = 6.62e-34 // Planck constant in J sec
Tc = 4.2 // critical temperature of Hg in K
c = 3e8 // speed of light in m/sec
// Sample Problem 8 on page no. 19.16
printf("\n # PROBLEM 8 # \n")
printf("Standard formula used \n ")
printf(" E = 3 * k * Tc \n")
E = 3 * k * Tc
lambda = h * c / E
printf("\n Energy gap is %e eV.\n Wavelength of photon is %e m.\n From the value of above lambda it is clear that these photons are in the very short wavelength part of the microwave region.",E/1.6e-19,lambda)
```

Chapter 20

X RAY

Scilab code Exa 20.1 Calculation of Max speed and Shortest wavelength

```
clc
// Given that
V1 = 40e3 // voltage in first case in V
V2 = 20e3 // voltage in second case in V
V3 = 100e3 // voltage in second in V
// Sample Problem 1 on page no. 20.7
printf("\n # PROBLEM 1 # \n")
printf("Standard formula used \n ")
printf("1/2*m*v^2 = eV \n")
v1 = 0.593e6 * sqrt(V1)
lambda1 = 12400 / V1
v2 = 0.593e6 * sqrt(V2)
lambda2 = 12400 / V2
v3 = 0.593e6 * sqrt(V3)
lambda3 = 12400 / V3
printf("\n Max. speed of electrons at %d Volts is %e
    m/sec.\n Max. speed of electrons at %d Volts is
    %e m/sec./sec.\n Max. speed of electrons at %d
    Volts is %e m/sec. \n Shortest wavelength of x-
```

```
ray = %f Angstrom.\n Shortest wavelength of x-ray
 = %f Angstrom.\n Shortest wavelength of x-ray =
%f Angstrom.",V1,v1,V2,v2,V3,v3,lambda1,lambda2,
lambda3)
```

Scilab code Exa 20.2 Calculation of Planck constant

```
clc
// Given that
V = 30e3 // voltage in V
lambda_min = 0.414e-10 // shortest wavelength in m
e = 1.6e-19 // charge on an electron in C
c = 3e8 // speed of light in m/sec
// Sample Problem 2 on page no. 20.7
printf("\n # PROBLEM 2 # \n")
printf("Standard formula used \n ")
printf("h*c/lambda = eV \n")
h = (e * V * lambda_min) / c
printf("\n Planck constant is %e J sec.",h)
```

Scilab code Exa 20.3 Calculation of Minimum wavelength

```
clc
// Given that
V = 25e3 // voltage in V
// Sample Problem 3 on page no. 20.8
printf("\n # PROBLEM 3 # \n")
printf("Standard formula used \n ")
printf("Lambda_min = 12400/V \n")
```

```
lambda_min = 12400 / V
printf("\n Minimum wavelength of x-ray is %f
   Angstrom.",lambda_min)
```

Scilab code Exa 20.4 Calculation of Maximum speed of electron

```
clc
// Given that
V = 13.6e3 // voltage in V
// Sample Problem 4 on page no. 20.8
printf("\n # PROBLEM 4 # \n")
printf("Standard formula used \n ")
printf("1/2*m*v^2 = eV \n")
v = 0.593e6*sqrt(V)
printf("\n Maximum speed of electron is %e m/sec.",v
   )
```

Scilab code Exa 20.5 Calculation of Velocity of electron

```
clc
// Given that
V = 10e3 // voltage in V
i = 2e-3 // current in amp
// Sample Problem 5 on page no. 20.8
printf("\n # PROBLEM 5 # \n")
printf("Standard formula used \n ")
printf("1/2*m*v^2 = eV \n")
v = 0.593e6*sqrt(V)
printf("\n Velocity of electron is %e m/sec.",v)
```

Scilab code Exa 20.6 Calculation of Highest frequency and Minimum wavelength

```
clc
// Given that
V = 9.8e3 // voltage in V
i = 2e-3 // current in amp
c = 3e8 // speed of light in m/sec
// Sample Problem 6 on page no. 20.8
printf("\n # PROBLEM 6 # \n")
printf("Standard formula used \n ")
printf("h*c/lambda = eV \n")
lambda = 12400 / V
f = c / lambda
printf("\n Highest frequency is %e Hz.\n Minimum
    wavelength is %f Angstrom.",f,lambda)
```

Scilab code Exa 20.7 Calculation of Number of electrons striking the target and Speed of electrons

```
clc
// Given that
V = 12.4e3 // voltage in V
i = 2e-3 // current in amp
e = 1.6e-19 // charge on an electron in C
// Sample Problem 7 on page no. 20.9
printf("\n # PROBLEM 7 # \n")
```

```
printf("Standard formula used \n ")
printf("I = ne \n 1/2*m*v^2 = eV \n")
n = i / e
v = 0.593e6*sqrt(V)
printf("\n Number of electrons striking the target per sec is %e.\n Speed of electrons is %e m/sec.",n,v)
```

Scilab code Exa 20.8 Calculation of Number of electrons striking the anode and Minimum wavelength

```
clc
// Given that
V = 10e3 // voltage in V
i = 15e-3 // current in amp
e = 1.6e-19 // charge on an electron in C
// Sample Problem 8 on page no. 20.9
printf("\n # PROBLEM 8 # \n")
printf("Standard formula used \n ")
printf("I = ne \n 1/2*m*v^2 = eV \n")
n = i / e
lambda = 12400 / V
printf("\n Number of electrons striking the anode per sec is %e.\n Minimum wavelength produced  is %f Angstrom.",n,lambda)
```

Scilab code Exa 20.9 Calculation of Number of electrons striking the anode

```
clc
// Given that
V = 50e3 // voltage in V
i = 1e-3 // current in amp
e = 1.6e-19 // charge on an electron in C
// Sample Problem 9 on page no. 20.9
printf("\n # PROBLEM 9 # \n")
printf("Standard formula used \n ")
printf("I = ne \n")
n = i / e
printf("\n Number of electrons striking the anode
   per sec is %e.",n)
```

Scilab code Exa 20.10 Calculation of Applied voltage

```
clc
// Given that
lambda1 = 40e-12 // minimum wavelength in first case
    in m
lambda2 = 1e-10 // minimum wavelength in second case
    in m
// Sample Problem 10 on page no. 20.10
printf("\n # PROBLEM 10 # \n")
printf("Standard formula used \n ")
printf("lambda_min = 12400/V \n")
V1 = 12400e-10 / lambda1
V2 = 12400e-10 / lambda2
printf("\n Applied voltage to get wavelength of %e
   meter is %f KV. \n Applied voltage to get
   wavelength of %e meter is %f KV.",lambda1,V1
   /10^3,lambda2,V2/10^3)
```

Scilab code Exa 20.11 Calculation of Planck constant

```
clc
// Given that
V1 = 44e3 // voltage in first case in V
V2 = 50e3 // voltage in second case in V
lambda1 = 0.284e-10 // shortest wavelength in first
    case in m
lambda2 = 0.248e-10 // shortest wavelength in second
     case in m
e = 1.6e-19 // charge on an electron in C
c = 3e8 // speed of light in m/sec
// Sample Problem 11 on page no. 20.10
printf("\n # PROBLEM 11 # \n")
printf("Standard formula used \n ")
printf(" h*c/Lambda = eV \n")
h1 = e * V1 * lambda1 / c
h2 = e * V2 * lambda2 / c
printf("\n Planck constant is %e J sec if shortest
    wavelength is %e m .\n Planck constant is %e Jsec
     if shortest wavelength is %e m. ",h1,lambda1,h2,
    lambda2)
```

Scilab code Exa 20.12 Calculation of Excitation potential

```
clc
// Given that
```

```
lambda = 1e-11 // K-absorption limit for uranium in m
// Sample Problem 12 on page no. 20.10
printf("\n # PROBLEM 12 # \n")
printf("Standard formula used \n ")
printf("lambda_min = 12400/V \n")
V = 12400e-10 / lambda
printf("\n Excitation potential is %d kV.",V/10^3)
```

Scilab code Exa 20.13 Calculation of the value of the ratio of plank constant and charge of electron

```
clc
// Given that
lambda = 1.4e-11 // K-absorption edge for lead in m
V = 88.6e3 // minimum voltage required for producing k-lines in V
c = 3e8 // speed of light in m/sec
// Sample Problem 13 on page no. 20.11
printf("\n # PROBLEM 13 # \n")
printf("Standard formula used \n ")
printf(" h*c/Lambda = eV \n")
r = V * lambda / c
printf("\n The value of the ratio of h/e = %e Jsec/C.",r)
```

Scilab code Exa 20.14 Calculation of Wavelength of K line

```
clc
```

```
// Given that
Z = 92 // atomic no. of atom
Rh = 1.1e5 // Rydberg constant in cm^-1
c = 3e8 // speed of light in m/sec
// Sample Problem 14 on page no. 20.11
printf("\n # PROBLEM 14 # \n")
printf("Standard formula used \n ")
printf(" Moseley Law \n ")
lambda = 1 / (Rh *(Z-1)^2 * (1 - (1 / 2^2)))
printf("\n Wavelength of K line = %f A",lambda*1e8)
```

Scilab code Exa 20.15 Calculation of Wavelength

```
clc
// Given that
Z = 42 // atomic no. of Mo
lambda = 0.71e-10 // wavelength in m
Z_ = 29 // atomic no. of Cu
// Sample Problem 15 on page no. 20.11
printf("\n # PROBLEM 15 # \n")
printf("Standard formula used \n ")
printf(" nu = a*(Z-b)^2 ........Moseley law \n")
lambda_ = (Z-1)^2 * lambda / (Z_-1)^2
printf("\n Wavelength of the corresponding radiation of Cu is %f Angstrom.",lambda_*1e10)
```

Scilab code Exa 20.16 Calculation of Wavelength of xray

```
clc
```

```
// Given that
Z = 79 // atomic no. of element
b = 1 // a constant
a = 2.468e15 // a constant in per sec
c = 3e8 // speed of light in m/sec
// Sample Problem 16 on page no. 20.12
printf("\n # PROBLEM 16 # \n")
printf("Standard formula used \n ")
printf(" nu = a*(Z-b)^2 ........Moseley law \n")
f = a * (Z - b)^2
lambda = c / f
printf("\n Wavelength of x-ray is %f Angstrom.",
   lambda*1e10)
```

Scilab code Exa 20.17 Calculation of Ionization potential of K shell electron of Cu

```
clc
// Given that
Z = 29 // atomic no. of Cu
R = 1.097e7 // Rydberg constant in m^-1
c = 3e8 // speed of light in m/sec
h = 6.62e-34 // Planck constant in J sec
// Sample Problem 17 on page no. 20.12
printf("\n # PROBLEM 17 # \n")
printf("Standard formula used \n ")
printf(" nu = a*(Z-b)^2 ........Moseley law \n")
f = 3/4 * (R * c) * (Z-1)^2
E = h * f / 1.6e-16
E_L = 0.931 // let E_L = 0.931 KeV
E_ = E + E_L
printf("\n Ionization potential of K-shell electron
   of Cu is %f keV.",E_)
```

Scilab code Exa 20.18 Calculation of Frequency of k line

```
clc
// Given that
Z = 79 // atomic no. of anticathode
R = 1.097e7 // Rydberg constant in m^-1
c = 3e8 // speed of light in m/sec
// Sample Problem 18 on page no. 20.13
printf("\n # PROBLEM 18 # \n")
printf("Standard formula used \n ")
printf(" nu = a*(Z-b)^2 ........Moseley law \n")
f = 3/4 * (R * c) * (Z-1)^2
printf("\n Frequency of k line is %e Hz.",f)
```

Scilab code Exa 20.19 Calculation of Energy and Wavelength of xray

```
clc
// Given that
Z = 27 // atomic no. of Co
R = 1.097e7 // Rydberg constant in m^-1
c = 3e8 // speed of light in m/sec
h = 6.62e-34 // Planck constant in J sec
// Sample Problem 19 on page no. 20.13
printf("\n # PROBLEM 19 # \n")
printf("Standard formula used \n")
printf(" nu = a*(Z-b)^2 ........Moseley law \n")
f = 3/4 * (R * c) * (Z-1)^2
```

```
E = h * f
lambda = c / f
printf("\n Energy is %f keV.\n Wavelength of x-ray is %f Angstrom.",E / 1.6e-16,lambda*1e10)
```

Chapter 22

NANOPHYSICS

Scilab code Exa 22.1 of The ratio of the value of Nb divided by Ns of spherical particle and nanoparticle

```
clc
// Given that
d = 12e-6 // diameter in m
d_ = 90e-9 // diameter of nanoparticle in m
// Sample Problem 1 on page no. 22.13
printf("\n # PROBLEM 1 # \n")
r = d / 2
r_ = d_ / 2
k = r / 3
k_ = r_ / 3
R = k_ / k
printf("\n The ratio of the value of Nb/Ns of
   spherical particle and nanoparticle = %e .",R)
```