Scilab Textbook Companion for Engineering Physics by H. K. Malik, A. Singh[1]

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May 20, 2014

Book Description

Title: Engineering Physics

Author: H. K. Malik, A. Singh

Publisher: Tata McGraw Hill, New Delhi

Edition: 1

Year: 2010

ISBN: 9780070671539

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

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Chapter 1

INTERFERENCE

Scilab code Exa 1.1 Calculation of time Coherence

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

Scilab code Exa 1.2 Calculation No of oscillations of

```
1 clc
```

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

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

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

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

Scilab code Exa 1.4 Calculation of Coherence length

```
1 clc
2 // Given that
3 lambda_D = 5.5e-13 // Doppler width of orange light
      in meter
4 lambda = 6.058e-7 // wavelength of light in meter
5 // Sample Problem 4 on page no. 1.41
6 printf("\n # PROBLEM 4 # \n")
7 printf("\n Standard formula used \n delta_L = lambda
      ^2/delta_lambda. \n")
8 coherence_length = (lambda ^ 2) / lambda_D//
      calculation for coherence light
9 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

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

```
4  band_width1 = 6e8 // band width for mercury vapour
       lamp in Hz
5  lambda2 = 6.328e-7 // the operating wavelength of
       light for He Ne laser
6  band_width2 = 1e6 // band width for laser in Hz
7  // Sample Problem 5 on page no. 1.41
8  printf(")\n # PROBLEM 5 # \n")
9  delta_lambda1 = (lambda1^2 * band_width1) / 3e8 //
       calculation for difference between two wavelength
        for mercury vapour
10 delta_L1 = lambda1^2 / delta_lambda1 // calculation
       for coherence length for mercury vapour lamp
11 delta_lambda2 = (lambda2^2 * band_width2) / 3e8 //
       calculation for difference between two wavelength
        for He Ne laser
12 delta_L2 = lambda2^2 / delta_lambda2 // calculation
       for coherence length for He Ne laser
13 R = delta_L1/delta_L2 // calculation for ratio of
       coherence length of mercury vapour lamp to the
       coherence length of He Ne laser
14 printf(")\n Standard formula used \n delta_lambda =
       lambda^2*band_width / c, \n coherence length =
       lambda^2/delta_lambda.\n")
15 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

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

```
5  printf("\n # PROBLEM 6 # \n")
6  printf("\n Standard formula used \n delta_L = c*
       delta_t. \n")
7  coherence_length = (3 * 10 ^ 8) / band_width// 
       calculation  for  coherence  length
8  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

```
1  clc
2  // Given that
3  lambda = 6.328e-7 // wavelength  of  monochromatic
        light  in  meter
4  t = 1e-10 // chopping  time  in  sec
5  // Sample Problem 7 on page no. 1.42
6  printf("\n # PROBLEM 7 # \n")
7  coherence_length = (3 * 10 ^ 8) * t // calculation
        for  coherence  length  of  monochromatic  light
8  band_width = 1 / t // calculation  for  band  width
9  line_width = ((lambda ^ 2) * band_width) / (3 * 10 ^
        8) // calculation  for  line  width
10 printf("\n Standard formula used \n coherence_length
        = (3 * 10 ^ 8) * t. \n line_width = ((lambda ^
       2) * band_width) / (3 * 10 ^ 8). \n")
11 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

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

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

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

Scilab code Exa 1.10 Calculation of Wavelength of light

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

Scilab code Exa 1.11 Calculation of Fringe width

```
1 clc
```

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

Scilab code Exa 1.12 Calculation of Fringe width

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

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

Scilab code Exa 1.13 Calculation of Thickness of glass

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

Scilab code Exa 1.14 Calculation of Distance between coherent sources

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

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

Scilab code Exa 1.15 Calculation of Wavelength of light

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

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

Scilab code Exa 1.16 Calculation of Wavelength of light

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

Scilab code Exa 1.17 Calculation of Wavelength of light

```
1 clc
```

```
2  // Given That
3  D = 1.20 // distance between source and eye piece in
       meter
4  Xn = 1.9e-2 // distance move by eye piece for 20
       fringe in meter
5  n = 20 // no. of fringes
6  d = 6e-4 // distance between slits in meter
7  // Sample Problem 17 on page no. 1.45
8  printf(" \n # PROBLEM 17 # \n")
9  lambda = (Xn * d) / (D * n)// calculation for
       wavelength
10 printf(" \n Standard formula used \n beta = lambda*D/
       d.")
11 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

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

```
10  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

```
1  clc
2  // Given That
3  lambda = 5.893e-7 // wavelength of light in meter
4  Mu = 1.42 // refractive index of soap film
5  i = 0 // incidence angle in radian
6  r = 0 // refracted angle in radian
7  // Sample Problem 19 on page no. 1.46
8  printf("\n # PROBLEM 19 # \n")
9  n = 1 // for smallest thickness
10 t1 = ((2 * n - 1) * lambda) / (4 * Mu * cos(r)) //
        calculation for east thickness of soap film for
        bright fringe
11 t2 = (n * lambda) / (2 * Mu * cos(r)) // calculation
        for east thickness of soap film for dark fringe
12 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 ")
13 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

```
1  clc
2  // Given That
3  lambda = 5.89e-7 // wavelength of light in meter
4  Mu_o = 1.4 // refractive index of oil film
5  Mu_w = 1.33 // refractive index of water
6  i = %pi / 6 // incidence angle in radian
7  n = 6 // no. of fringes seen
8  // Sample Problem 20 on page no. 1.46
9  printf("\n # PROBLEM 20 # \n")
10 r = asin(sin(i) / Mu_o) // calculation for angle of
       refraction
11 t = (n * lambda) / (2 * Mu_o * cos(r)) //
       calculation for thickness of film
12 printf("\n Standard formula used \n mu = sin(i)/sin(
       r),\n 1*mu*t*cos(r) = n*lambda. \n")
13 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

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

33

```
       * lambda ) / (4 * Mu * cos ( r ) ).\ n ")
12 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

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

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

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

```
4  lambda2 = 5e-7 // min. wavelength of light in meter
5  Mu = 1.4 // refractive index of soap film
6  i = %pi / 4 // incidence angle in radian
7  t = 1e-5 // thickness of oil film in meter
8  // Sample Problem 23 on page no. 1.47
9  printf(" \n # PROBLEM 23 # \n")
10 r = asin(sin(i) / Mu) // calculation for angle of
      refraction
11 n1 = (2 * Mu * t * cos(r)) / lambda1 // calculation
      for no. of dark bands seen in the case of max.
      wavelength
12 n2 = (2 * t * Mu * cos(r)) / lambda2 // calculation
      for no. of dark seen in the case of min.
      wavelength
13 n = floor(n1) - floor(n2) // claculation for no. of
      dark bands seen between wavelengths
14 printf(" \n Standard formula used \n r = asin(sin(i)
      / Mu). \n n = (2 * Mu * t * cos(r)) / lambda. \n")
15 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

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

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

Scilab code Exa 1.25 Calculation of Thickness of the film

```
1  clc
2  // Given  That
3  lambda1  =  6.1e-7  //  max.  wavelength  of  light  in
        meter
4  lambda2  =  6e-7  //  min.  wavelength  of  light  in  meter
5  Mu  =  1.333  //  refractive  index  of   film
6  i  =  %pi  /  4  //  incidence  angle  in  radian
7  //  Sample  Problem  25  on  page  no.  1.48
8  printf("\n  #  PROBLEM  25  #  \n")
9  r  =  asin(sin(i)  /  Mu)  //  calculation  for  angle  of
         refraction
10  n  =  lambda2  /  (lambda1  -  lambda2)  //  calculation  for
           no.  of  bright  band
11  t  =  (n  *  lambda1)  /  (2  *  Mu  *  cos(r))  //  calculation
          for  thickness  of  the  film
12  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")
13  printf("\n  Thickness  of  the  film  =  %e  meter.  ",t)
```

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

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

Scilab code Exa 1.27 Calculation of Thickness of the film

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

37

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

Scilab code Exa 1.28 Calculation of Thickness of wire

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

Scilab code Exa 1.29 Calculation of Fringe width

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

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

Scilab code Exa 1.30 Calculation of Fringe width

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

Scilab code Exa 1.31 Calculation of Fringe width

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

Scilab code Exa 1.32 Calculation of Distance

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

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

Scilab code Exa 1.33 Calculation of Angle of wedge

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

Scilab code Exa 1.34 Calculation of Wavelength of light

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

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

Scilab code Exa 1.35 Calculation of Wavelength of light

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

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

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

Scilab code Exa 1.37 Calculation of Diameter of dark ring

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

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```
5  r = 0.96 // radius of curvature of curved surface of
        lens in meter
6  // Sample Problem 37 on page no. 1.53
7  printf("\n # PROBLEM 37 # \n")
8  n = lambda2 / (lambda1 - lambda2) // calculation for
        order of fringe
9  D = sqrt(4 * (n + 1) * lambda2 * r) // calculation
        for diameter of ring
10 printf("\n Standard formula used \n n^2 = 4n*lambda*
        R. \n")
11 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

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

Scilab code Exa 1.39 Calculation of Refractive index of liquid

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

Scilab code Exa 1.40 Calculation of Refractive index of liquid

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

```
8  mu = D1^2 / D2^2// calculation for refractive index
9  v = 3e8 / mu // calculation for velocity of light
10 printf("\n Standard formula used \n mu = D1^2 / D2
       ^2. \n v = 3e8 / mu. \n")
11 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

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

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

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

```
4 mu = 1.63 // refractive index of liquid
5 R = 0.9 // the radius of curvature of convex lens in
      meter
6 // Sample Problem 42 on page no. 1.55
7 printf("\n # PROBLEM 42 # \n")
8 r = sqrt(lambda*R/mu) // calculation for the radius
      of smallest dark ring
9 printf("\n Standard formula used \n r = sqrt(n*
      lambda*R/mu). \n")
10 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

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

Scilab code Exa 1.44 Calculation of Wavelength of light

```
1 clc
```

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

Scilab code Exa 1.45 Calculation of Refractive index of liquid

```
 1  clc
 2  // Given That
 3  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
 4  // Sample Problem 45 on page no. 1.56
 5  printf("\n # PROBLEM 45 # \n")
 6  R = (1/r)^2 // calculation for refractive index of
        liquid
 7  printf("\n Standard formula used \n mu1/mu2 = D2/D1.
        \n")
 8  printf("\n Refractive index of liquid = %f. ",R)
```

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

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

Scilab code Exa 1.47 Calculation of Refractive index of mica

```
1  clc
2  // Given That
```

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

Scilab code Exa 1.48 Calculation of Wavelength of light

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

Scilab code Exa 1.49 Calculation of Thickness of the plate

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

Scilab code Exa 1.50 Calculation of The path difference

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

Scilab code Exa 1.51 Calculation of Wavelength of monochromatic light

```
1 clc
2 // Given That
3 x = 2.948e-5 // distance moved by movable mirror in
    meter
4 n = 100 // no. of fringes cross the field of view
5 // Sample Problem 51 on page no. 1.58
6 printf("\n # PROBLEM 51 # \n")
7 lambda = 2*x/n // calculation for wavelength of
    monochromatic light
8 printf("\n Standard formula used \n lambda = 2*x/n.
    \n")
9 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

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

```
7 x = lambda1 * lambda2 /(2*(lambda1 - lambda2)) // 
      calculation  for  the  path  difference
8 printf("\n Standard  formula  used  \n x = lambda1 *
      lambda2  /2*(lambda1 − lambda2).\n")
9 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

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

Scilab code Exa 1.54 Calculation of Refractive index of gas

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

```
 4  lambda = 5.46e-7 // wavelength of light in meter
 5  t = 0.2 // length of tube in meter
 6  // Sample Problem 54 on page no. 1.58
 7  printf("\n # PROBLEM 54 # \n")
 8  mu = (n*lambda)/(2*t) + 1 // calculation for
        refractive index of gas
 9  printf("\n Standard formula used \n mu = (n*lambda)
        /(2*t) + 1. \n")
10  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

```
1  clc
2  // Given that
3  lambda = 5e-7 // wavelength of light in meter
4  d = 1 // distance of wavefront received on the
       screen from the opening in meter
5  n = 80 // no. of half period zone
6  // Sample Problem 1 on page no. 2.38
7  printf("\n # PROBLEM 1 # \n")
8  Rn = sqrt(n * lambda * d)// calculation for radius
       of nth half period zone
9  A = %pi * d * lambda// calculation for area of half
       period zone
10 printf("Standard formula used\n Rn = sqrt(n*d*lambda
       ).\n A = pi*d*lambda.\n")
11 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

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

Scilab code Exa 2.3 Calculation of Radius of half period zone

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

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

Scilab code Exa 2.4 Calculation of No of half period zone

```
1  clc
2  // Given that
3  lambda = 6e-7 // wavelength of light in meter
4  d = 0.5 // distance of observation point from
      circular opening in meter
5  r1 = 2e-3 // radius of circular opening in first
      case in meter
6  r2 = 2e-2 // radius of circular opening in second
      case in meter
7  // Sample Problem 4 on page no. 2.39
8  printf("\n # PROBLEM 4 # \n")
9  n1 = (r1^2) / (d * lambda) // calculation for no. of
       half period zone in first case
10 n2 = (r2^2) / (d * lambda) // calculation for no. of
       half period zone in second case
11 printf("\n Standard formula used \n n = (r^2) / (d *
       lambda) \n")
12 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

```
1  clc
2  // Given that
3  lambda = 5e-7 // wavelength of light in meter
4  d = 1e-3 // diameter of the first ring of zone plate
        in meter
5  // Sample Problem 5 on page no. 2.39
6  printf("\n # PROBLEM 5 # \n")
7  n = 1 // no. of half period zone
8  D = (d^2) / (4 * lambda * n) // calculation for
        distance of screen from opening
9  printf("\n Standard formula used \n D = (d^2) / (4 *
        lambda * n). \n")
10 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

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

```
12  R3 = sqrt(n3 * lambda * f) // calculation for Radius
         of third half period zone
13  printf("Standard formula used \n R = sqrt(f*n*lambda
         )\n")
14  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

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

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

```
4  d1 = 1 // distance of wavefront recieved on the
      screen from the opening in first side in meter
5  d2 = 2 // distance of wavefront recieved on the
      screen from the opening in other side in meter
6  // Sample Problem 8 on page no. 2.40
7  printf("\n # PROBLEM 8 # \n")
8  f = (d1 * d2) / (d1 + d2)
9  p = 1 / f // beacause zone plate act as a convex
      lens
10 n = 1 // for first zone
11 Rn = sqrt(n * lambda * f) // calculation for radius
      of first zone
12 Dn = 2 * Rn // calculation for diameter of first
      zone
13 printf("\n Standard formula used \n ")
14 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

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

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

Scilab code Exa 2.10 Calculation of No of zone of Fresnel

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

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

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

```
4  d = 2.3e-3 // diameter of the central zone of zone
       plate in meter
5  u = 6 // distance between point source from zone
       plate in meter
6  // Sample Problem 11 on page no. 2.42
7  printf("\n # PROBLEM 11 # \n")
8  n = 1 // for central zone
9  f = (d^2) / (4 * lambda * n) // calculation for
       focal length
10 disp(f)
11 v = (f * u) / (u - f)  // calculation for distance
       of first image from zone plate
12 printf("\n Standard formula used \n f = (d^2) / (4 *
       lambda * n). \n v = (f * u) / (u - f). \n ")
13 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

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

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

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

Scilab code Exa 2.14 Calculation of Wavelength of light

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

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

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

```
1  clc
2  // Given that
3  lambda = 5.5e-7 // wavelength of light in meter
4  b = 2.2e-6 // slit -width in meter
5  // Sample Problem 15 on page no. 2.43
6  printf("\n # PROBLEM 15 # \n")
7  m2 = 2 // for second minima
8  theta2 = asin((m2 * lambda) / b) * (180 / %pi) //
       calculation for angular position of second minima
9  m3 = 3 // for third minima
10 theta3 = asin((m3 * lambda) / b) * (180 / %pi) //
       calculation for angular position of third minima
11 printf("\n Standard formula used \n theta = asin((m
       * lambda) / b) * (180 / pi). \n")
12 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

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

Scilab code Exa 2.17 Calculation of Slit width

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

```
9  b1 = (lambda * m) / sin(theta) // calculation for
       slit width in first case
10 b2 = (lambda * m) / sin(theta_) // calculation for
       slit width in second case
11 printf("\n Standard formula used \n b = (lambda * m)
        / sin(theta). \n")
12 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

```
1  clc
2  // Given that
3  lambda = 5.89e-7 // wavelength of light in meter
4  d = 1 // distance of screen from slit in meter
5  b = 1e-4 // slit -width in meter
6  // Sample Problem 18 on page no. 2.44
7  printf("\n # PROBLEM 18 # \n")
8  theta = (asin(lambda / b)) * (180 / %pi) //
       calculation for angular spread
9  x = (2 * d * lambda) / b// calculation for linear
       width
10 printf("\n Standard formula used \n theta = (asin(
       lambda / b)) * (180 / pi). \n x = (2 * d * lambda
       ) / b. \n")
11 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

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

Scilab code Exa 2.21 Calculation of Separation of dark band

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

```
14 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

```
1  clc
2  // Given that
3  lambda = 5.893e-7 // wavelength of light in meter
4  b = 5e-4 // slit-width in meter
5  f = 1 // focal length of convex lens in meter
6  // Sample Problem 22 on page no. 2.47
7  printf("\n # PROBLEM 22 # \n")
8  x = (2 * lambda * f) / b // calculation for
        Separation of dark band on either side of the
        cenral maximum
9  printf("Standard formula used \n. \n")
10 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

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

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

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

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

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```
        r * m. \n")
18 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

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

Scilab code Exa 2.26 Calculation of Wavelength of light

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

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

Scilab code Exa 2.27 Calculation of Wavelength of light

```
1
2  clc
3  // Given that
4  lambda2 = 5.461e-7 // wavelength of  light in second
        case in meter
5  n1 = 4 // no. of order in first case
6  n2 = 3 // no. of order in second case
7  // Sample Problem 27 on page no. 2.48
8  printf("\n # PROBLEM 27 # \n")
9  lambda1 = (n2 * lambda2) / n1 // calculation for
       Wavelength of light in first case
10 printf("Standard formula used \n lambda1 = (n2 *
       lambda2) / n1. \n")
11 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

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

Scilab code Exa 2.29 Calculation of Angle of separation

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

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

Scilab code Exa 2.30 Calculation of Angle of separation

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

Scilab code Exa 2.31 Calculation of No of lines per cm

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

Scilab code Exa 2.32 Calculation of Difference in two wavelength

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

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

Scilab code Exa 2.33 Calculation of Order of spectrum

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

Scilab code Exa 2.34 Calculation of Order of spectrum

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

Scilab code Exa 2.35 Calculation of Observed order

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

Scilab code Exa 2.36 Calculation of Dispersive power

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

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

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

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

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

```
 1  clc
 2  // Given  that
 3  n = 1  // no .  of  order
 4  lambda1 = 5.89e-7  // wavelength  of  light  in  first
        case  in  meter
 5  lambda2 = 5.896e-7  // wavelength  of  light  in  second
        case  in  meter
 6  // Sample  Problem  38  on  page  no .  2.53
 7  printf("\n # PROBLEM  38 # \n")
 8  N = lambda1 / (n * (lambda2 - lambda1)) //
        calculation  for  minimum  no .  of  lines  in  grating
 9  printf("Standard  formula  used  \n lambda/d(lambda)=n*
        N.  \n")
10  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

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

```
4  theta = %pi / 6 // view angle of third order in
       radian
5  lambda1 = 5.89e-7 // min. wavelength of light in
       meter
6  lambda2 = 5.896e-7 // max.wavelength of light in
       meter
7  // Sample Problem 39 on page no. 2.53
8  printf("\n # PROBLEM 39 # \n")
9  mean_lambda = (lambda1 + lambda2) / 2 // calculation
        for mean wavelength
10 s = (n * mean_lambda) / sin(theta) // calculation
       for grating space b+d
11 N = lambda1 / (n * (lambda2 - lambda1)) //
       calculation for minimum no. of lines in grating
12 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")
13 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

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

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

Scilab code Exa 2.41 Calculation of Diameter of telescope objective

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

Scilab code Exa 2.42 Calculation of Diameter of telescope objective

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

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

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

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

Scilab code Exa 2.44 Calculation of The resolving limit of microscope

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

Scilab code Exa 2.45 Calculation of Numerical aperture of objective

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

Chapter 3

POLARISATION

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

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

Scilab code Exa 3.2 Calculation of Angle of Brewster

```
1 clc
2 // Given that
```

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

Scilab code Exa 3.3 Calculation of difference between polarization angle

```
1  clc
2  // Given that
3  mu_w = 1.33 // refractive index of water
4  mu_g = 1.54 // refractive index of glass
5  // Sample Problem 3 on page no. 3.24
6  printf("\n # PROBLEM 3 # \n")
7  Ip_1 = atan(mu_g / mu_w) * (180 / %pi)//calculation
        for polarizing angle for water
8  Ip_2 = atan(mu_w / mu_g) * (180 / %pi) //
        calculation for polarizing angle for glass
9  printf("Standard formula used \n mu=tan(Ip)\n")
10 printf("\n Polarizing angle for water to glass = %f
        degree ,\n Polarizing angle for glass to water =
        %f degree",Ip_1,Ip_2)
11 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

```
1  clc
```

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

Scilab code Exa 3.5 Calculation of Brewster angle

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

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

```
1 clc
2 // Given that
3 mu = 1.732 // refractive index of glass
4 // Sample Problem 6 on page no. 3.25
5 printf("\n # PROBLEM 6 # \n")
6 Ip = atan(mu) * (180 / %pi) // by Brewster's law
7 r = 90 - Ip// calculation for angle of refraction
8 printf("Standard formula used \n mu=tan(Ip)\n")
9 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

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

```
8  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

```
1  clc
2  // Given that
3  r1 = 1/3 // ratio of intensity of transmitted light
        to the intensity of transmitted beam in first
        case
4  r2 = 1/3 // ratio of intensity of transmitted light
        to the intensity of incident beam in second case
5  p = 50 // percentage reduction in intensity of
        unpolarized light by the sheet
6  // Sample Problem 8 on page no. 3.25
7  printf("\n # PROBLEM 8 # \n")
8  theta1 = acosd(sqrt(r1)) // calculation for the
        angle between characteristics directions of the
        sheet in first case
9  theta2 = acosd(sqrt(2*r2)) // calculation for the
        angle between characteristics directions of the
        sheet in second case
10 printf("\n Standard formula used \n theta = acosd(
        sqrt(r)). \n")
11 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

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

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

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

```
7  // Sample Problem 10 on page no. 3.26
8  printf("\n # PROBLEM 10 # \n")
9  I1 = (1 - (cos(theta1))^2) * 100
10 I2 = (1 - (cos(theta2))^2) * 100
11 I3 = (1 - (cos(theta3))^2) * 100
12 I4 = (1 - (cos(theta4))^2) * 100
13  // calculation for percentage reduction in
        intensity of ligth
14  printf("\n Standard formula used \n I = (1 - (cos(
        theta))^2) * 100. \n")
15 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

```
1  clc
2  // Given that
3  i1 = 1 / 2 // reduced intensity ratio in first case
4  i2 = 1 / 4 // reduced intensity ratio in second case
5  // Sample Problem 11 on page no. 3.27
6  printf("\n # PROBLEM 11 # \n")
7  theta1 = acos(sqrt(i1)) * (180 / %pi)// calculation
       for angle between nicols in first case
8  theta2 = acos(sqrt(i2)) * (180 / %pi)// calculation
       for angle between nicols in second case
9  printf("Standard formula used \n I=I_cos(theta)^2\n"
       )
10 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

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

Scilab code Exa 3.13 Calculation of Thickness of quartz plate

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

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

Scilab code Exa 3.14 Calculation of Thickness quartz plate

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

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

Scilab code Exa 3.16 Calculation of Thickness of quartz plate

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

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

Scilab code Exa 3.17 Calculation of Thickness of quartz plate

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

Scilab code Exa 3.18 Calculation of Thickness of quartz plate

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

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

Scilab code Exa 3.19 Calculation of Thickness of quartz plate

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

Scilab code Exa 3.20 Calculation of Concentration of sugar solution

```
1  clc
```

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

Scilab code Exa 3.21 Calculation of Specific rotation of sugar solution

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

Scilab code Exa 3.22 Calculation of Specific rotation of sugar solution

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

Scilab code Exa 3.23 Calculation of Concentration of sugar solution

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

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

Scilab code Exa 3.24 Calculation of Concentration of sugar solution

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

Scilab code Exa 3.25 Calculation of Specific rotation of sugar solution

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

Scilab code Exa 3.26 Calculation of Optical rotation of diluted solution

```
1  clc
2  // Given that
3  theta = 13 // rotation of plane of polarization in
      degree
4  r = (1 / 3) // ratio of the final concentration to
      the initial solution
5  l = 2 // length of Polari meter in decimeter
6  l_ = 3 // length of second polarizing tube in
      decimeter
7  // Sample Problem 26 on page no. 3.30
8  printf(" \n # PROBLEM 26 # \n")
9  theta_ = (l_ * r * theta) / l// calculation for
      optical rotation of diluted solution
10 printf(" Standard formula used \n s=theta/(l*c)\n")
11 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

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

```
14  T_ = (delta_E / (k * 0.693)) // calculation for
        temperature for the second condition
15  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")
16  printf("\n Ratio of population of upper level to the
        lower energy level = %e. \n Temperature for the
        second condition = %f K. ",r,T_)
17  //Answer in the book: 1.3 X 10^-38 and 37800 K
18  //Answer in the program:1.100524 X 10^-38 and
        37836.557301 K"
```

Scilab code Exa 4.2 Calculation of Beam divergence angle

```
1  clc
2  // Given that
3  lambda1 = 6.328e-7 // wavelength of light in first
        case in meter
4  lambda2 =2e-7 // wavelength of light in second case
        in meter
5  r1 = 2.3e-4 // the radius of internal beam of laser
        in first case in meter
6  r2 = 2.4e-3 // the radius of internal beam of laser
        in second case in meter
7  // Sample Problem 2 on page no. 4.24
8  printf("\n # PROBLEM 2 # \n")
9  theta1 = lambda1 / (%pi * r1) // calculation for
        beam divergence angle in first case
10 theta2 = lambda2 / (%pi * r2) // calculation for
        beam divergence angle in second case
11 printf("\n Standard formula used \n theta = lambda /
        (pi * r). \n")
12 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

```
1  clc
2  // Given that
3  l = 6e-2 // length of laser in meter
4  D = 1e-2 // diameter of laser in meter
5  lambda = 6.944e-7 // wavelength of light in meter
6  d = 3700 // density of aluminium oxide in kg/meter
       cube
7  Na = 6e+23 // Avogadro number
8  M = 0.102 // molar mass of aluminium oxide in kg/
       meter cube
9  h = 4.1e-15 // Planck constant in eV-sec
10 c = 3e+8 // speed of light in meter/sec
11 // Sample Problem 3 on page no. 4.25
12 printf("\n # PROBLEM 3 # \n")
13 v = (%pi * (D^2) * l) / 4 // calculation for volume
14 N = (2 * Na * d * v) / M // calculation for no. of
       aluminium ions
15 N_ = N / 3500 // calculation for the no. of chromium
        ions
16 E = (h * c) / lambda // calculation for the energy
       of stimulated emission photon
17 Et = N_ * E * (1.6e-19) // calculation for total
       energy
18 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")
19 printf("\n Total energy = %f J",ceil(Et))
```

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

```
1 clc
2 // Given that
3 p = 4e-3 // energy of laser pulse in meter
4 r = 1.5e-5 // radius of spot in meter
5 t = 1e-9 // pulse length in time in sec
6 // Sample Problem 4 on page no. 4.26
7 printf("\n # PROBLEM 4 # \n")
8 p_ = p / t// calculation for power in watt
9 I = p_ / (%pi * r^2)// calculation for power per
      unit area delivered by the laser
10 printf("Standard formula used \n I=P/a\n")
11 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

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

```
8  r = (D / 2) // calculation for radius
9  theta = (0.637 * lambda) / r // calculation for
       angular spread
10 areal_spread = (d * theta)^2 // calculation for
       areal spread
11 printf(" \n Standard formula used \n theta = (0.637 *
       lambda) / r. \n areal_spread = (d * theta)^2. \n
       ")
12 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

```
1  clc
2  // Given that
3  D = 5e-3 // diameter of laser in meter
4  lambda = 6.943e-7 // wavelength of light in meter
5  f =0.1 // focal length in meter
6  P = 0.1 // power of laser in watt
7  // Sample Problem 6 on page no. 4.27
8  printf(" \n # PROBLEM 6 # \n")
9  r = (D / 2)// calculation for
10 theta = (0.637 * lambda) / r// calculation for
       angular spread
11 areal_spread = (f * theta)^2// calculation for areal
       spread
12 I = P / areal_spread// calculation for intensity
13 printf("Standard formula used \n theta=0.637*lambda/
       r,\n areal spread = (theta*D)^2,\n I=P/A\n")
14 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

```
1  clc
2  // Given that
3  tou = 1e-10 // coherence time in sec
4  lambda = 5.4e-7 // wavelength of light in meter
5  // Sample Problem 7 on page no. 4.28
6  printf("\n # PROBLEM 7 # \n")
7  delta_v = 1 / tou
8  v_ = (3e+8) / lambda // calculation for frequency
9  d = delta_v / v_ // calculation for degree of non-
       monochromaticity
10 printf("\n Standard formula used \n delta_v = 1 /
       tou. \n v_ = (3e+8) / lambda. \n d = delta_v / v_
       . \n ")
11 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

```
1  clc
2  // Given that
3  mu1 = 1.52 // refractive index for core
4  mu2 = 1.41 // refractive index for cladding
5  // Sample Problem 1 on page no. 5.15
6  printf("\n # PROBLEM 1 # \n")
7  theta_c = asin(mu2 / mu1) * (180 / %pi)
8  NA = sqrt(mu1^2 - mu2^2)
9  theta_0 = asin(NA) * (180 / %pi)
10 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")
11 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

```
1  clc
2  // Given that
3  mu1 = 1.6 // refractive index for core
4  mu2 = 1.5 // refractive index for cladding
5  // Sample Problem 2 on page no. 5.16
6  printf("\n # PROBLEM 2 # \n")
7  NA = sqrt(mu1^2 - mu2^2)// calculation for numerical
       aperture
8  theta_0 = asin(NA) * (180 / %pi)// calculation for
       maximum incidence angle
9  printf("Standard formula used \n NA=aqrt(mu1^2-mu2
       ^2),\n sin(theta_)=NA. \n")
10 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

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

```
8   theta_c = asin(mu2 / mu1) * (180 / %pi)
9   delta_mu = (mu1 - mu2) / mu1
10  NA = sqrt(mu1^2 - mu2^2)
11  theta_0 = asin(NA) * (180 / %pi)
12  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 ")
13  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

```
1   clc
2   // Given that
3   mu1 = 1.62 // refractive index for core
4   mu2 = 1.52 // refractive index for cladding
5   // Sample Problem 4 on page no. 5.17
6   printf(" \n # PROBLEM 4 # \n")
7   NA = sqrt(mu1^2 - mu2^2)
8   theta_0 = asin(NA) * (180 / %pi)
9   printf(" \n Standard formula used \n NA = sqrt (mu1^2
        - mu2^2). \n theta_0 = asin (NA) * (180 / pi). \n"
        )
10  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

```
1  clc
2  // Given that
3  NA = 0.22 // numerical aperture
4  delta_mu = 0.012 // fractional refractive index
5  // Sample Problem 5 on page no. 5.17
6  printf("\n # PROBLEM 5 # \n")
7  mu1 = sqrt(NA^2 / (1 - (1 - delta_mu)^2))
8  mu2 = (1 - delta_mu) * mu1
9  printf("\n Standard formula used \n mu1 = sqrt(NA^2
       / (1 - (1 - delta_mu)^2)). \n mu2 = (1 - delta_mu
       ) * mu1. \n")
10 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

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

```
 8  // Sample Problem 6 on page no. 5.17
 9  printf("\n # PROBLEM 6 # \n")
10  NA = sqrt(mu1^2 - mu2^2)
11  theta_0 = asin(NA) * (180 / %pi)
12  N1 = L / (d * sqrt((mu1 / (mu_0 * sin(theta_0 * (%pi
        / 180))))^2 - 1))
13  N2 = L / (d * sqrt((mu1 / (mu_0 * sin(theta_0 * (%pi
        / 360))))^2 - 1))
14  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 ")
15  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

```
 1  clc
 2  // Given that
 3  d = 0.05 // diameter of fiber in mm
 4  NA = 0.22 // numerical aperture
 5  lambda = 8.5e-4 // wavelength of light in mm
 6  // Sample Problem 7 on page no. 5.18
 7  printf("\n # PROBLEM 7 # \n")
 8  Vn = (%pi * d * NA) / lambda
 9  Mm = 0.5 * (Vn)^2
10  printf("\n Standard formula used \n Vn = (pi * d *
        NA) / lambda. \n Mm = 0.5 * (Vn)^2. \n")
11  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

```
1  clc
2  // Given that
3  lambda = 1.25e-6 //wavelength of light in meter
4  mu1 = 1.465 // refractive index for core
5  mu2 = 1.460 // refractive index for cladding
6  // Sample Problem 8 on page no. 5.18
7  printf("\n # PROBLEM 8 # \n")
8  NA = sqrt(mu1^2 - mu2^2)
9  k = (2.4 * lambda) / ( %pi * NA)
10 Mm = 0.5 * ((%pi * 50e-6 * NA) / lambda)^2
11 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 ")
12 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

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

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

Scilab code Exa 5.10 Calculation of Number of modes

```
1  clc
2  // Given that
3  mu1 = 3.6 // refractive index for core
4  mu2 = 3.55 // refractive index for cladding
5  // Sample Problem 10 on page no. 5.19
6  printf(")\n # PROBLEM 10 # \n")
7  NA = sqrt(mu1^2 - mu2^2)//calculation for numerical
      aperture
8  Mm1 = 0.5 * (%pi * 5 * NA)^2//calculation for no. of
       modes in first case
9  Mm2 = 0.5 * (%pi * 50 * NA)^2//calculation for no.
      of modes in second case
10 printf(")\n Standard formula used \n Mm=1/2(pi*d*NA/
      lambda)^2. NA=sqrt(mu1^2-mu2^2). \n")
11 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

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

Scilab code Exa 5.12 Calculation of Absorption coefficient

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

Scilab code Exa 5.13 Calculation of Output power

```
1  clc
2  // Given that
3  L = 3 // length of optical fiber in km
4  l = 6 // losses in dB
5  p = 5e-3 // input power in watt
6  // Sample Problem 13 on page no. 5.20
7  printf("\n # PROBLEM 13 # \n")
8  alpha = (l * 3) / L
9  p_ = p / (exp((2.303 * alpha * L) / 10))
10 printf("\n Standard formula used \n alpha = (l * 3)
       / L. \n p_ = p / (exp((2.303 * alpha * L) / 10)).
       \n")
11 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

```
1  clc
2  // Given that
3  V = 500 // voltage across the electrode in eV
4  m = 9e-31 // mass of electron in kg
5  e = 1.6e-19 // charge on an electron in coulomb
6  // Sample Problem 1 on page no. 6.20
7  printf("\n # PROBLEM 1 # \n")
8  E = e * V
9  v = sqrt((2 * e * V) / m)
10  p = m * v
11  printf("\n Standard formula used \n E = e * V. \n v
        = sqrt((2 * e * V) / m). \n p = m * v. \n ")
12  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

```
1  clc
2  // Given that
3  v = 2.5e6 // speed of electron in meter/sec
4  B = 2e-4 // magnetic field in tesla
5  r = 1.76e11 // ratio of charge on electron to the
       mass of electron in C/kg
6  // Sample Problem 2 on page no. 6.20
7  printf("\n # PROBLEM 2 # \n")
8  a = (B * r * v)
9  printf("\n Standard formula used \n a = (B * r * v).
       \n ")
10 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

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

```
9   printf("\n # PROBLEM 4 # \n")
10  R = v / (r * B)
11  v_ = sqrt((2 * E) / M )
12  printf("\n Standard formula used \n R = v / ( r * B).
        \n v_ = sqrt((2 * E) / M ). \n")
13  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

```
1   clc
2   // Given that
3   V = 2.500e3 // voltage across the electrode in V
4   E = 3.6e4 // strength of electric field in V/m
5   B = 1.2e-3 // magnetic field in tesla
6   // Sample Problem 5 on page no. 6.22
7   printf("\n # PROBLEM 5 # \n")
8   r = (E / B)^2 / (2 * V)//calculation for ratio of
        the charge on an electron to the mass of an
        electron
9   printf("\n Standard formula used \n e/m=(E/B)^2 / (2
        V). \n")
10  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

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

Scilab code Exa 6.7 Calculation of Lamoure radius

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

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

```
1  clc
2  // Given that
3  M = 6.68e-27 // mass of helium ion in kg
4  E = 1.6e-16 // energy of helium ion in J
5  B = 5e-2 // magnetic field in tesla
6  e = 1.6e-19 // charge on helium ion in coulomb
7  // Sample Problem 8 on page no. 6.23
8  printf("\n # PROBLEM 8 # \n")
9  v = sqrt((2 * E) / M)//calculation for velocity
10 r = (M * v) / (e * B)//calculation for Larmour
      radius
11 A = %pi * r^2//calculation for area traced by the
      trajectory of helium ion
12 printf("Standard formula used \n E=1/2*m*v^2,\n Rl=m
      *v/(e*B),\n A=pi*r^2\n")
13 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

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

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

Scilab code Exa 6.10 Calculation of Internal electric field

```
1  clc
2  // Given that
3  v = 1e6 // velocity of ion beam in m/sec
4  B = 1 // magnetic field in tesla
5  // Sample Problem 10 on page no. 6.24
6  printf("\n # PROBLEM 10 # \n")
7  E = B * v
8  printf("\n Standard formula used \n E = B * v. \n")
9  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

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

```
7  printf("\n Standard formula used \n r_ = (1 / r)^2.
       \n")
8  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

```
1  clc
2  // Given that
3  E = 1.024e-3 // total energy of particle in J
4  T = 2 * %pi // time period of S.H.M. in sec
5  x = 0.08 * sqrt(2) // distance of partile in meter
6  t = %pi / 4 // time in second
7  // Sample Problem 1 on page no. 7.22
8  printf("\n # PROBLEM 1 # \n")
9  A = x / sin((2 * %pi * t) / T)
10 M = (E * T^2) / (2 * %pi^2 * A^2)
11 printf("\n Standard formula used \n A = x / sin((2 *
       pi * t) / T). \n M = (E * T^2) / (2 * pi^2 * A
       ^2). \n")
12 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

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

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

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

```
12  printf("Standard formula used \n k.E.=1/2*k*A^2,\n T
        =2*pi*sqrt(m/k)\n")
13  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

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

Scilab code Exa 7.5 Calculation of Maximum velocity and acceleration

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

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

Scilab code Exa 7.6 Calculation of Maximum velocity

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

Scilab code Exa 7.7 Calculation of natural frequency

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

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

Scilab code Exa 7.8 Calculation of The time period of pendulum

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

Scilab code Exa 7.9 Calculation of Frequency

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

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

Scilab code Exa 7.10 Calculation of Time period of pendulum

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

Scilab code Exa 7.11 Calculation of Time period of motion

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

```
11  printf("\n Standard formula used \n k = (m1 * g) / x
        . \n T = (2 * pi) * sqrt(m2 / k).\n")
12  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

```
1   clc
2   // Given that
3   x = 0.1 // compression in spring in m
4   F = 10 // restoring force in N
5   m = 4 // mass of body in kg
6   g = 9.8 // acceleration due to gravity in m/sec^2
7   // Sample Problem 12 on page no. 7.26
8   printf("\n # PROBLEM 12 # \n")
9   k = F / x
10  F_ = m * g
11  x_ = F_ / k
12  T = (2 * %pi) * sqrt(m / k)
13  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 ")
14  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

```
1   clc
```

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

Scilab code Exa 7.14 Calculation of Time

```
 1  clc
 2  // Given that
 3  n = 260 // frequency in Hz
 4  Q = 2000 // quality factor
 5  r = 1 / (exp(1)^2) // decrease in amplitude
 6  // Sample Problem 14 on page no. 7.27
 7  printf("\n # PROBLEM 14 # \n")
 8  tou = Q / (2 * %pi * n)
 9  t = 2 * tou // by using formula A=A_exp(-st) and
       using r=A/A_
10  printf("\n Standard formula used \n tou = Q / (2 *
       pi * n). \n t = 2 * tou. \n")
11  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

```
1  clc
2  // Given that
3  v = 34500 // speed of sound in cm/sec
4  f = 20 // lower limit of frequency for human hearing
       ear in Hz
5  f_ = 20000 // upper limit of frequency for human
       hearing ear in Hz
6  // Sample Problem 1 on page no. 8.17
7  printf("\n # PROBLEM 1 # \n")
8  printf(" Standard formula used \n")
9  printf(" V = f*lambda \n \n" )
10 lambda = v / f
11 lambda_ = v / f_
12 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

```
1  clc
2  // Given that
3  T = 373 // temperature in kelvin
4  d = 1.293e-3 // density of air at S.T.P. in gm/cm^3
5  d_ = 13.6 // density of mercury in gm/cm^3
6  s = 0.2417 // specific heat of air at constant
      pressure
7  s_ = 0.1715 // specific heat of air at constant
      volume
8  g = 980 // gravitational constant i dynes/cm^3
9  // Sample Problem 2 on page no. 8.18
10 printf("\n # PROBLEM 2 # \n")
11 printf(" Standard formula used \n")
12 printf(" nu = (gamma*p/rho)^1/2   \n gamma = C_p/C_v
      \n p =rho*g*h \n" )
13 p = 76 * d_ * g
14 gama = s / s_
15 v = sqrt(gama * (p / d))
16 v_ = v * sqrt(T / 273)
17 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

```
1  clc
```

```
2  // Given that
3  n = 512 // frequency of tuning fork in Hz
4  T = 290 // temperature in kelvin
5  lambda = 66.5 // wavelength of the gas emitted by
       tuning fork in cm
6  d = 1.293e-3 // density of air at S.T.P. in gm/cm^3
7  d_ = 13.6 // density of mercury in gm/cm^3
8  g = 980 // gravitational constant i dynes/cm^3
9  // Sample Problem 3 on page no. 8.18
10 printf("\n # PROBLEM 3 # \n")
11 printf(" Standard formula used \n")
12 printf(" nu = (gamma*p/rho)^1/2  \n p =rho*g*h \n\n"
       )
13 p = 76 * d_ * g// calculation for pressure
14 v_ = n * lambda// calculation for velocity of sound
       in air at temperature 17 c
15 v = v_ * sqrt(273 / T)// calculation for velocity of
       sound in air at temp 0 c
16 gama = v^2 * (d / p)// calculation for ratio of two
       specific heat
17
18 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

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

```
6  t = 1.36 // optimum time for orchestral music in sec
7  k = 0.44 // absorption coefficient per person
8  // Sample Problem 4 on page no. 8.19
9  printf(" \n # PROBLEM 4 # \n")
10 printf(" Standard formula used \n")
11 printf(" T = 0.161 V/a*S \n" )
12 aS = 0.161 * ((A * h) / t)
13 a = N * k
14 a_ = aS - a
15 w = a_ + (N / 2) * k + (N / 2) * 0.02
16 t = (0.161 * (A * h)) / w
17 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

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

Scilab code Exa 8.6 Calculation of Reverberation time

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

```
23  T = 0.161 * (V / A)// calculation for reverberation
       time
24
25  printf(")\n Reverberation time is %f sec.",T)
```

Scilab code Exa 8.7 Calculation of Reverberation time

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

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

Scilab code Exa 8.8 Calculation of Reverberation time

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

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

Scilab code Exa 8.9 Calculation of Acoustic power

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

Chapter 9

DIELECTRICS

Scilab code Exa 9.1 Calculation of Polarization vector and Displacement vector

```
1  clc
2  // Given that
3  E = 10^6 // electric field inside the plates in V/m
4  d = 0.02 // distance between the plates in meter
5  k = 3 // dielectric constant of slab
6  e_ = 8.85e-12 // electric permittivity of air in C
       ^2/Nm^2
7  // Sample Problem 1 on page no. 9.11
8  printf("\n # PROBLEM 1 # \n")
9  printf(" Standard formula used \n")
10 printf(" D = e_*E+p. \n D=e_*k*E.\n\n ")
11 D = e_*k*E
12 P = D-e_*E
13 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

```
1  clc
2  // Given that
3  E1 = 3*10^5 // electric intensity when space between
         plates evacuated in V/m
4  E2 = 1*10^5 // electric intensity when space between
         plates is filled with dielectric in V/m
5  e_ = 8.85e-12 // electric permittivity of air in C
         ^2/Nm^2
6  // Sample Problem 2 on page no. 9.11
7  printf("\n # PROBLEM 2 # \n")
8  printf(" Standard formula used \n")
9  printf(" E = E_-P/e_.\n\n ")
10 sigma = e_*(E1 - E2)
11 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

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

```
6  e_ = 8.85e-12 // electric permittivity of air in C
      ^2/Nm^2
7  // Sample Problem 3 on page no. 9.11
8  printf(" \n # PROBLEM 3 # \n")
9  printf(" Standard formula used \n")
10 printf(" P = e_*(k-1)*E.\n\n ")
11 P = e_*(k-1)*E
12 D = e_*k*E
13 energy_density = 1/2 * k*e_*E^2
14 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

```
1  clc
2  // Given that
3  D = 5e-4 // electric displacement vector in C/m^2
4  P = 4e-4 // electric polarization vector in C/m^2
5  v = 0.5 // volume of the slab in m^3
6  e_ = 8.85e-12 // electric permittivity of air in C
      ^2/Nm^2
7  // Sample Problem 4 on page no. 9.12
8  printf(" \n # PROBLEM 4 # \n")
9  printf(" Standard formula used \n")
10 printf(" D= e_*E.\n\n ")
11 E= (D-P)/ e_
12 k = D/(e_*E)
13 p = P*v
14 energy_density = 1/2 * k*e_*E^2
15 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

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

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

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

```
 6  printf(")\n # PROBLEM 6 # \n")
 7  printf(" Standard formula used \n")
 8  printf(" P=x*e_*E.\n\n ")
 9  x = k-1
10  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

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

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

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

Scilab code Exa 10.17 Calculation of Electric flux

```
 1 clc
 2 // Given that
 3 q = 13.5e-6 // charge enclosed at the centre of cube
      in C
 4 l = 6 // length of the side of cube in cm
 5 e0 = 8.85e-12 // permittivity of space
 6 // Sample Problem 17 on page no. 10.43
 7 printf("\n # PROBLEM 17 # \n")
 8 fi = q / e0
 9 fi_ = fi / 6
10 q = e0 * fi
11 printf("Standard formula used \n fi=q/e_.\n")
12 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

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

Scilab code Exa 10.19 Calculation of Electric field intensity

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

```
9  printf("\n # PROBLEM 19 # \n")
10 E1 = (1 / (4 * %pi * e0) * (q / r^2))
11 E2 = 0 //because sphere is metallic
12 E3 = (1 / (4 * %pi * e0) * (q / d_^2))
13 printf("Standard formula used \n E = (1 / (4 * pi *
      e0) * (q / r^2)). \n")
14 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

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

Scilab code Exa 10.21 Calculation of Energy gained by alpha particle

```
1  clc
2  // Given that
```

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

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

```
1  clc
2  // Given that
3  q = 1.6e-19 // charge on a proton in C
4  d = 1e-10 // distance of a point from proton in m
5  d_ = 2e-11 // distance of another point from proton
        in m
6  e0 = 8.85e-12 // permittivity of space
7  // Sample Problem 22 on page no. 10.44
8  printf("\n # PROBLEM 22 # \n")
9  v = (1 / (4 * %pi * e0)) * (q / d)//calculation for
        potential at first point
10 E = -q * v//calculation for energy at first point in
         J
11 delta_v = (1 / (4 * %pi * e0)) * q * ((1 / d_) - (1
        / d))//calculation for potential difference
        between points
12 printf("Standard formula used \n V=(1/(4*pi*e_))*q/r
        ,\n E=-(1/(4*pi*e_))*q^2/r.\n")
13 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

```
1  clc
2  // Given that
3  q = 1.5e-6 // charge in C
4  v = 30 // potential of a surface in V
5  e0 = 8.85e-12 // permittivity of space
6  // Sample Problem 23 on page no. 10.45
7  printf("\n # PROBLEM 23 # \n")
8  r = (1 / (4 * %pi * e0)) * (q / v)
9  printf("Standard formula used \n v = (1/(4*pi*e_)*(q
       /r)).\n")
10 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

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

```
 9  printf(" Standard  formula  used  \n  s  =  p  /  (4  *  pi  *  r
        ^2).\n")
10  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

```
 1  clc
 2  //  Given  that
 3  s  =  2  //  energy  received  by  the  earth  in  cal/cm^2.
        min
 4  e0  =  8.85e-12  //  electric  permittivity  of  space
 5  mu0  =  1.2567e-6  //  magnetic  permittivity  of  space
 6  c  =  3e8  //  speed  of  light  in  meter/sec
 7  //  Sample  Problem  28  on  page  no.  10.47
 8  printf("\n  #  PROBLEM  28  #  \n")
 9  r  =  sqrt(mu0  /  e0)
10  P  =  s*4.2/(60*1e-4)
11  E  =  sqrt(P*r)
12  H  =  E/r
13  printf(" Standard  formula  used  \n  P  =  E*H.\n")
14  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

```
 1  clc
```

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

```
1  clc
2  // Given that
3  p = 1000 // power of lamp in W
4  d = 2 // distance of a point from lamp in meter
5  e0 = 8.85e-12 // electric permittivity of space
6  mu0 = 1.2567e-6 // magnetic permittivity of space
7  c = 3e8 // speed of light in meter/sec
8  // Sample Problem 31 on page no. 10.48
9  printf("\n # PROBLEM 31 # \n")
10 s = p / (4 * %pi * d^2) //calculation for
11 r = sqrt(mu0 / e0) // ratio of E,H
12 E = sqrt(s * r)//calculation for average value of
       intensity of electric field of radiation
13 printf("Standard formula used \n E_/H_=sqrt(mu_/e_)
       ,\nP=E*H.\n")
14 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

```
 1 clc
 2 // Given that
 3 k = 81 // relative permittivity of water
 4 c = 3e8 // speed of light in meter/sec
 5 // Sample Problem 32 on page no. 10.49
 6 printf(" \n # PROBLEM 32 # \n")
 7 printf(" Standard formula used \n")
 8 printf(" mu_ = ( mu*epsilon /(mu_0/*psilon_0))^1/2
      \n \n" )
 9 mu = sqrt(k)
10 v = c / mu
11 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

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

```
17  // according to Lorentz transformation
18  x_ = (x-v*t)/sqrt(1-(v/c)^2)
19  y_=y
20  z_=z
21  t_=(t-(v*x/c^2))/sqrt(1-(v/c)^2)
22  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

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

Scilab code Exa 11.7 Calculation of Speed of particle

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

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

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

```
1  clc
2  // Given that
3  E = 2 // kinetic energy of electron in Mev
4  // Sample Problem 9 on page no. 11.20
5  printf(" \n # PROBLEM 9 # \n")
6  printf(" Standard formula used \n")
7  printf(" m = m_0/((1-v^2/c^2)^1/2) \n   KE = m*c^2 -
       m_0*c^2 \n")
8  v = 3e8 * sqrt(1 - (1 / (1 + (1.6e-19 * 2e6) / (9.1e
       -31 * 3e8^2)))^2)
9  m = (9.1e-31) / sqrt(1 - (v / 3e8)^2)
10 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

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

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```
4 // Sample Problem 10 on page no. 11.21
5 printf("\n # PROBLEM 10 # \n")
6 printf(" Standard formula used \n")
7 printf(" u_x = u_x_ + v / (1+ v*u_x_/c^2). \n ")
8 u_ = (u + 3e8) / (1 + (u * 3e8) / 3e8^2)
9 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

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

Scilab code Exa 11.12 Calculation of Velocity of particle

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

```
6  printf(" Standard formula used \n")
7  printf(" m = m_0/((1-v^2/c^2)^1/2) \n KE = (m-m_0)*c
       ^2  \n ")
8  v = 3e8 * sqrt(1 - (1 / (r + 1))^2)
9  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

```
1  clc
2  // Given that
3  r = 11 // ratio of mass of particle to the rest mass
        of electron
4  // Sample Problem 13 on page no. 11.22
5  printf("\n # PROBLEM 13 # \n")
6  printf(" Standard formula used \n")
7  printf(" m = m_0/((1-v^2/c^2)^1/2) \n KE = (m-m_0)*c
       ^2  \n ")
8  KE = (r - 1) * 9.1e-31 * 3e8^2 / (1.6e-19)
9  m = 3e8 * sqrt(1 - (1 / r)^2) * 9.1e-31 * 11
10 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

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

```
5  // Sample Problem 14 on page no. 11.23
6  printf("\n # PROBLEM 14 # \n")
7  printf(" Standard formula used \n")
8  printf(" m = m_0/((1−v^2/c^2)^1/2) \n ")
9  v = 3e8 * sqrt(1 - (m_ / m)^2)
10 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

```
1  clc
2  // Given that
3  E = 0.1 // kinetic speed of electron in Mev
4  // Sample Problem 15 on page no. 11.23
5  printf("\n # PROBLEM 15 # \n")
6  printf(" Standard formula used \n")
7  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")
8  v_ = sqrt(2 * (E * 1.6e-13) / 9.1e-31)
9  v = 3e8 * sqrt(1 - (1 / (1 + (1.6e-13 * E) / (9.1e
     -31 * 3e8^2)))^2)
10 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

```
1  clc
2  // Given that
```

```
3  r1 = 3 // ratio of kinetic energy of body to its
      rest mass in first case
4  r2 = 1 // ratio of kinetic energy of body to its
      rest mass in second case
5  // Sample Problem 17 on page no. 11.24
6  printf("\n # PROBLEM 17 # \n")
7  printf(" Standard formula used \n")
8  printf(" m = m_0/((1-v^2/c^2)^1/2) \n KE = (m-m_0)*c
      ^2 \n")
9  v1 = 3e8 * sqrt(1 - (1 / (r1 + 1))^2)
10 v2 = 3e8 * sqrt(1 - (1 / (r2 + 1))^2)
11 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

```
1  clc
2  // Given that
3  E = 1.5 // kinetic energy of electron in Mev
4  // Sample Problem 19 on page no. 11.25
5  printf("\n # PROBLEM 19 # \n")
6  printf(" Standard formula used \n")
7  printf(" m = m_0/((1-v^2/c^2)^1/2) \n KE = (m-m_0)*c
      ^2 \n")
8  v = 3e8 * sqrt(1 - (1 / (1 + (1.6e-19 * 2e6) / (9.1e
      -31 * 3e8^2)))^2)
9  m = (E * 1.6e-13 / (3e8)^2) + 9.1e-31
10 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

```
1 clc
2 // Given that
3 r = 3 / 2 // ratio of mass of metre stick to the
     rest mass of metre stick
4 // Sample Problem 20 on page no. 11.26
5 printf("\n # PROBLEM 20 # \n")
6 printf(" Standard formula used \n")
7 printf(" m = m_0/((1−v^2/c^2)^1/2) \n l = l_0/((1−v
     ^2/c^2)^1/2)   \n")
8 l = 1 * (1 / r)
9 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

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

```
8  v = 3e8 * sqrt(1 - r^2)
9  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

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

Scilab code Exa 11.23 Calculation of Distance travel by the beam

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

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```
10  t = t_ / sqrt (1 - (v / 3e8)^2)
11  T = t * log (1 / r)
12  d = T * v
13  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

```
1  clc
2  // Given that
3  v = 1.8e8 // velocity of space ship away from the
        earth in m/sec
4  v1 = 2.1e8 // velocity of rocket w.r.t. space ship
        away from the earth in first case in m/sec
5  v2 = -2.1e8 // velocity of rocket w.r.t. space ship
        away from the earth in second case in m/sec
6  // Sample Problem 24 on page no. 11.27
7  printf ("\n # PROBLEM 24 # \n")
8  printf (" Standard formula used \n")
9  printf (" u_x = u_x_ + v / (1+ v*u_x_/c^2) \n ")
10 u1 = (v1 + v) / (1 + ((v1 * v) / (3e8)^2))
11 u2 = (v2 + v) / (1 + ((v2 * v) / (3e8)^2))
12 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

```
1  clc
2  // Given that
3  l = 1 // length of the rod in meter
4  v = 1.8e8 // speed of rod along its length in meter/
       sec
5  // Sample Problem 25 on page no. 11.28
6  printf(" \n # PROBLEM 25 # \n")
7  printf(" Standard formula used \n")
8  printf(" l = l_0/((1-v^2/c^2)^1/2)   \n")
9  L = l * sqrt(1- (v / 3e8)^2)
10 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

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

Scilab code Exa 11.27 Calculation of Percentage length contraction

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

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

```
1 clc
2 // Given that
3 r = 0.5 // ratio of length of rod when it is in
      motion to the length of the rod when it is in
      rest
4 // Sample Problem 28 on page no. 11.29
5 printf(" \n # PROBLEM 28 # \n")
6 printf(" Standard formula used \n")
7 printf(" l = l_0/((1−v^2/c^2)^1/2)   \n")
8 v = 3e8 * sqrt(1 - r^2)
9 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

```
1  clc
2  // Given that
3  l = 5 // length of the rod in meter
4  v = 1.8e8 // speed of rod in meter/sec
5  theta = %pi / 6 // direction of velocity of rod
       along its length in radian
6  // Sample Problem 29 on page no. 11.30
7  printf("\n # PROBLEM 29 # \n")
8  printf(" Standard formula used \n")
9  printf(" l = l_0 /((1-v^2/c^2)^1/2)   \n l^2 = l_x^2 +
       l_y^2 \n")
10 Lx = l * cos(theta)
11 Ly = l * sin(theta)
12 L_x = Lx * sqrt(1 - (v / 3e8)^2)
13 L_y = Ly
14 L = sqrt(L_x^2 + L_y^2)
15 orientation = atan(L_y / L_x) * (180 / %pi)
16 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

```
1  clc
```

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

Scilab code Exa 11.31 Calculation of Time lost per day

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

Scilab code Exa 11.32 Calculation of Speed of rocket

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

Scilab code Exa 11.33 Calculation of Time taken by the rocket

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

Scilab code Exa 11.34 Calculation of Proper life time of particle

```
1 clc
2 // Given that
3 t = 2e-7 // life time of particle when it is moving
    in sec
4 v = 2.8e8 // speed of particle in meter/sec
5 // Sample Problem 34 on page no. 11.31
6 printf(" \n # PROBLEM 34 # \n")
7 printf(" Standard formula used \n")
8 printf(" t = t_0 /((1-v^2/c^2)^1/2) \n")
9 T_ = t * sqrt(1 - (v / 3e8)^2)
10 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

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

```
 6  printf("\n # PROBLEM 35 # \n")
 7  printf(" Standard formula used \n")
 8  printf(" u_x = u_x_ + v / (1+ v*u_x_/c^2) \n ")
 9  u = v1 - v2
10  u_ = (v1 - v2) / (1 - (v1 * v2) / (3e8)^2)
11  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

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

Scilab code Exa 11.37 Calculation of Relativistic mass of proton

```
 1  clc
 2  // Given that
```

```
3  E = 900 // total relativistic energy of proton in
       Mev
4  m = 1.63-27 // rest mass of proton in kg
5  c = 3e8 // velocity of photon in meter/sec
6  // Sample Problem 37 on page no. 11.32
7  printf("\n # PROBLEM 37 # \n")
8  printf(" Standard formula used \n")
9  printf(" E = m*c^2 \n ")
10 m_ = (E * 1.6e-13) / (c)^2
11 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

```
1  clc
2  // Given that
3  E = 5.4e6 // energy liberates during dynamite
       explosion in J/kg
4  c = 3e8 // velocity of photon in meter/sec
5  // Sample Problem 38 on page no. 11.32
6  printf("\n # PROBLEM 38 # \n")
7  printf(" Standard formula used \n")
8  printf(" E = m*c^2 \n ")
9  E_ = 1 * c^2 // energy liberated by 1 kg content in
       J
10 f = E / E_
11 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

```
1  clc
2  // Given that
3  k = 1.02 // kinetic energy of electron in Mev
4  E_ = 0.51 // rest mass energy of electron in Mev
5  c = 3e8 // velocity of photon in meter/sec
6  // Sample Problem 39 on page no. 11.32
7  printf("\n # PROBLEM 39 # \n")
8  printf(" Standard formula used \n")
9  printf(" E = KE + m*c^2 \n m = m_0/((1-v^2/c^2)^1/2)
        \n")
10 E = k + E_
11 v = c * sqrt(1 - (E_ / E)^2)
12 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

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

```
 7  printf("\n # PROBLEM 40 # \n")
 8  printf(" Standard formula used \n")
 9  printf(" E = m*c^2 \n ")
10  E_ = 4 * %pi * d^2 * E
11  m = E_ / c^2
12  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

```
1  clc
2  // Given that
3  E = 1.14 // energy of gamma radiation in Mev
4  l = 0.2 // length of aluminium in meter
5  p = 0.03 // reduce in intensity in beam
6  d = 2700 // density of aluminium in kg/m^3
7  // Sample Problem 1 on page no. 12.31
8  printf("\n # PROBLEM 1 # \n")
9  printf("Standard formula used \n")
10 printf("I = I_0*e^(-mu*x) \n")
11 mu = (1 / l) * log(1 / p)
12 k = mu / d
13 x = 0.693 / mu
14 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

```
1  clc
2  // Given that
3  E = 1.1 // energy of gamma radiation in Mev
4  l = 0.25 // length of aluminium in meter
5  p = 0.02 // reduce in intensity in beam
6  d = 2700 // density of aluminium in kg/m^3
7  // Sample Problem 2 on page no. 12.32
8  printf("\n # PROBLEM 2 # \n")
9  printf("Standard formula used \n")
10 printf("I = I_0*e^(-mu*x) \n")
11 mu = (1 / l) * log(1 / p)
12 k = mu / d
13 x = 0.693 / mu
14 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

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

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

Scilab code Exa 12.4 Calculation of Time

```
1  clc
2  // Given that
3  t = 4 // half-life of radioactive element in years
4  r = 1 / 64 // ratio of mass of element present in
        specimen to the initial mass of element
5  // Sample Problem 4 on page no. 12.33
6  printf("\n # PROBLEM 4 # \n")
7  printf("Standard formula used \n")
8  printf(" lambda = 0.693 / t_1/2        (Decay constant)
        \n N =N_0*e^(-lambda*t) \n")
9  lambda = 0.693 / t
10 T = (1 / lambda) * log(1 / r)
11 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

```
1  clc
2  // Given that
3  t = 15 // half−life of radioactive element in years
4  r = 0.025 // ratio of mass of element present in
       specimen to the intial mass of element
5  // Sample Problem 5 on page no. 12.33
6  printf(”\n # PROBLEM 5 # \n”)
7  printf(”Standard formula used \n”)
8  printf(” lambda = 0.693 / t_1/2      (Decay constant)
       \n N =N_0*e^(−lambda*t) \n”)
9  lambda = 0.693 / t
10 T = (1 / lambda) * log(1 / r)
11 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

```
1  clc
2  // Given that
3  t = 3.8 // half−life for radon in days
4  r = 60 // percentage fraction of sample which
       decayed
5  // Sample Problem 6 on page no. 12.33
6  printf(”\n # PROBLEM 6 # \n”)
7  printf(”Standard formula used \n”)
8  printf(” lambda = 0.693 / t_1/2      (Decay constant)
       \n N =N_0*e^(−lambda*t) \n”)
9  lambda = 0.693 / t
10 T = (1 / lambda) * (log(100 / (100 - r)))
11 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

```
1  clc
2  // Given that
3  lambda = 4.28e-4 // decay constant in per year
4  // Sample Problem 7 on page no. 12.34
5  printf("\n # PROBLEM 7 # \n")
6  printf("Standard formula used \n")
7  printf(" lambda = 0.693 / t_1/2      (Decay constant)
       \n tau = 1/lambda \n")
8  T = 0.693 / lambda
9  t = 1 / lambda
10 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

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

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

Scilab code Exa 12.9 Calculation of Decay constant

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

Scilab code Exa 12.10 Calculation of Activity of sample

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

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

Scilab code Exa 12.11 Calculation of Fraction of sample

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

Scilab code Exa 12.12 Calculation of Substance remained unchanged

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

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

Scilab code Exa 12.13 Calculation of Decay constant

```
1
2  clc
3  // Given that
4  m = 1  // initial mass of radium in gm
5  m_ = 0.0021  // final mass of radium in gm
6  t = 5  // time for decay from m to m_ in years
7  // Sample Problem 13 on page no. 12.36
8  printf("\n # PROBLEM 13 # \n")
9  printf("Standard formula used \n")
10 printf(" lambda = 0.693 / t_1/2     (Decay constant)
       \n N =N_0*e^(-lambda*t) \n")
11 lambda = log(m / (1 - m_)) / t
12 T = 0.693 / lambda
13 T_ = 1 / lambda
14 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_)
15 //Answer in the book:2500 years
16 //Answer in the program:2378.451405 years
```

Scilab code Exa 12.14 Calculation of Half life of sample

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

Scilab code Exa 12.15 Calculation of Fraction of radioactive isotope remained

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

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

Scilab code Exa 12.16 Calculation of Mass of Pb

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

Scilab code Exa 12.17 Calculation of Mass of Pb

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

```
 7  printf("Standard formula used \n")
 8  printf(" lambda = 0.693 / t_1/2        (Decay constant)
        \n A =N*lambda         (Activity of sample) \n")
 9  lambda = 0.693 / (t * 60)
10  m = (R * 214) / (6.023e23 * lambda)
11  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

```
 1  clc
 2  // Given that
 3  m = 1 // mass of Ra(226) in gm
 4  R = 1 // radioactivity of Ra(226) in curie
 5  // Sample Problem 18 on page no. 12.37
 6  printf("\n # PROBLEM 18 # \n")
 7  printf("Standard formula used \n")
 8  printf(" lambda = 0.693 / t_1/2        (Decay constant)
        \n tau = 1/lambda \n A =N*lambda         (Activity
      of sample) \n")
 9  r = R * 3.7e10 // in disintegrations per sec
10  N = 6.023e23 * m / 226
11  lambda = r * 226 / 6.023e23
12  T = 1 / lambda
13  T_ = 0.693 / lambda
14  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

```
1
2  clc
3  // Given that
4  m = 0.0001 // mass of Sr(90) in gm
5  t = 28 // half life of Sr(90) in year
6  t_ = 9 // time in sec
7  // Sample Problem 19 on page no. 12.38
8  printf("\n # PROBLEM 19 # \n")
9  printf("Standard formula used \n")
10 printf(" lambda = 0.693 / t_1/2      (Decay constant)
        \n del_N = N_0*lambda*t (disintegration of
       sample) \n")
11 lambda = 0.693 / (t * 86400 * 365)
12 N_ = 6.023e23 * m / 90
13 n = N_ * lambda * t_
14 printf("\n Activity of Sr is %e disintegration/sec."
       ,n)
15 //Answer in the book:5.25 X 10^8
16 //Answer in the program:4.726955 e+09
```

Scilab code Exa 12.20 Calculation of Mass of radon

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

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

Scilab code Exa 12.21 Calculation of Energy of gamma ray photon

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

Scilab code Exa 12.22 Calculation of Q value of reaction

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

```
11  printf(" Law of conservation of Energy \n")
12  k = m1 + m2 - m3 - m4
13  E = k * 931.5
14  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

```
1   clc
2   // Given that
3   E = 200 // energy released per fission in Mev
4   m = 0.01 // mass of U(235) in gm
5   n = 235 // atomic no of sample
6   N_0=6.023e23 // Avogadro constant
7   // Sample Problem 23 on page no. 12.40
8   printf("\n # PROBLEM 23 # \n")
9   printf("Standard formula used \n")
10  printf(" E_total = E*N_0/n \n")
11  E_ = E * 1.6e-13
12  k = E_ * N_0 * m / n
13  H = k / 4.168
14  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

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

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```
4  m = 1 // mass of U(235) in kg
5  // Sample Problem 24 on page no. 12.40
6  printf(" \n # PROBLEM 24 # \n")
7  printf(" Standard formula used \n")
8  printf(" E_total = E*N_0/n \n")
9  E_ = E * 1.6e-13
10 k = E_ * 6.023e26 * m / 235
11 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

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

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Scilab code Exa 12.26 Calculation of Power output of reactor

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

Scilab code Exa 12.27 Calculation of Energy produce by each reaction

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

```
.",E)
```

Scilab code Exa 12.28 Calculation of Mass of deuterium

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

Scilab code Exa 12.29 Calculation of Number of revolution

```
1  clc
2  // Given that
3  d = 1.8 // diameter in meter
```

```
4  B = 0.8 // magnetic field in tesla
5  m = 6.68e-27 // mass of He(4) in kg
6  e = 1.6e-19 // charge on an electron in Coulomb
7  // Sample Problem 29 on page no. 12.43
8  printf(" \n # PROBLEM 29 # \n")
9  printf(" Standard formula used \n")
10 printf(" E = B^2*q^2*r^2/(2*m) \n f = B*q/(2*pi*m) \
      n")
11 r = d / 2
12 E = (B^2 * (2 * e)^2 * r^2) / (2 * m * 1.6e-19 *
      10^6)
13 f = B * 2 * e / (2 * %pi * m)
14 N = f / 2
15 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

```
1  clc
2  // Given that
3  f = 12e6 // oscillator frequency of cyclotron in Hz
4  r = 0.53 // radius of dee in meter
5  e = 1.6e-19 // charge on an electron in Coulomb
6  // Sample Problem 30 on page no. 12.43
7  printf(" \n # PROBLEM 30 # \n")
8  printf(" Standard formula used \n")
9  printf(" f = B*q/(2*pi*m) \n")
10 B = (2 * %pi * f * 2 * 1.67e-27) / e
11 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

```
1  clc
2  // Given that
3  f = 10e6 // frequency of applied Emf in Hz
4  r = 0.32 // radius in meter
5  m = 3.32e-27 // mass of deuteron in kg
6  e = 1.6e-19 // charge on an electron in Coulomb
7  // Sample Problem 31 on page no. 12.44
8  printf("\n # PROBLEM 31 # \n")
9  printf(" Standard formula used \n")
10 printf(" q*v*B = m*v^2/r \n f = B*q/(2*pi*m) \n")
11 B = (2 * %pi * f * m) / e
12 v = (e * B * r) / m
13 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

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

```
7  // Sample Problem 32 on page no. 12.44
8  printf("\n # PROBLEM 32 # \n")
9  printf(" Standard formula used \n")
10 printf(" E_ = 3e8 * r * B / 1e6 \n")
11 r = d / 2
12 w = 2 * %pi * f
13 E = 4 * e * w * r^2 * B
14 E_ = 3e8 * r * B / 1e6
15 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

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

Scilab code Exa 12.34 Calculation of The current produced

```
1  clc
```

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

Scilab code Exa 12.35 Calculation of Average current in the circuit

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

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

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

Scilab code Exa 12.37 Calculation of Larmour radius

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

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

Scilab code Exa 12.38 Calculation of Magnetic field

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

Scilab code Exa 12.39 Calculation of Larmour radius

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

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

Scilab code Exa 12.40 Calculation of Debye length and Plasma frequency

```
1  clc
2  // Given that
3  d = 1e12 // electron density in number per m^3
4  E = 0.1 // thermal energy in eV
5  e = 1.6e-19 // charge on an electron in C
6  // Sample Problem 40 on page no. 12.47
7  printf("\n # PROBLEM 40 # \n")
8  printf(" Standard formula used \n")
9  printf(" l_debye = (epsilon_0*K*T/(n*e^2))^1/2   \n f
       = omega/(2*pi) \n")
10 lambda = sqrt((8.85e-12 * E * e) / (d * e * e))
11 omega = sqrt(d * e^2 / (9.1e-31 * 8.85e-12))
12 f = omega / (2 * %pi)
13 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

```
1  clc
```

```
2  // Given that
3  d = 1e16 // density in per m^3
4  E = 2 // thermal energy in eV
5  e = 1.6e-19 // charge on an electron in C
6  // Sample Problem 41 on page no. 12.48
7  printf("\n # PROBLEM 41 # \n")
8  lambda = sqrt((8.85e-12 * E * e) / (d * e * e))
9  printf(" Standard formula used \n")
10 printf(" l_debye = ( epsilon_0 *K*T/(n*e^2))^1/2   \n f
       = omega/(2*pi) \n")
11 omega = sqrt(d * e^2 / (9.1e-31 * 8.85e-12))
12 f = omega / (2 * %pi)
13 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

```
1  clc
2  // Given that
3  x = 2 // intercepts cut by the plane along vector a
       of crystallographic axes
4  y = 3 // intercepts cut by the plane along vector b
       of crystallographic axes
5  z = 1 // intercepts cut by the plane along vector c
       of crystallographic axes
6  // Sample Problem 1 on page no. 13.24
7  printf(" \n # PROBLEM 1 # \n")
8  printf("Standard formula used \n")
9  printf(" x_ = a / x \n y_ = b / y \n z_ = c / z \n")
10 x_ = 6 / x
11 y_ = 6 / y
12 z_ = 6 / z
13 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

```
1  clc
2  // Given that
3  x = 1 // intercepts cut by the plane along vector a
       of crystallographic axes
4  y = 2 // intercepts cut by the plane along vector b
       of crystallographic axes
5  z = -3 / 2 // intercepts cut by the plane along
       vector c of crystallographic axes
6  // Sample Problem 2 on page no. 13.24
7  printf("\n # PROBLEM 2 # \n")
8  printf("Standard formula used \n")
9  printf(" x_ = a / x \n y_ = b / y \n z_ = c / z \n")
10 x_ = 6 / x
11 y_ = 6 / y
12 z_ = 6 / z
13 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

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

```
5  z1 = 2 // intercepts cut by the plane along vector c
          of crystallographic axes in first case
6  x2 = 1 // intercepts cut by the plane along vector a
          of crystallographic axes in second case
7  y2 = 2 // intercepts cut by the plane along vector b
          of crystallographic axes in second case
8  k2 = 0 // raciprocal of intercepts cut by the plane
        along vector c of crystallographic axes in second
          case
9  x3 = 1 // intercepts cut by the plane along vector a
          of crystallographic axes in third case
10 y3 = 1/2 // intercepts cut by the plane along vector
          b of crystallographic axes in third case
11 z3 = 1 // intercepts cut by the plane along vector c
          of crystallographic axes in third case
12 // Sample Problem 3 on page no. 13.24
13 printf("\n # PROBLEM 3 # \n")
14 printf("Standard formula used \n")
15 printf(" x_ = a / x \n y_ = b / y \n z_ = c / z \n")
16 x_1 = 6 / x1
17 y_1 = 6 / y1
18 z_1 = 6 / z1
19 x_2 = 2 / x2
20 y_2 = 2 / y2
21 z_2 = 2*k2
22 x_3 = 1 / x3
23 y_3 = 1 / y3
24 z_3 = 1 / z3
25 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

```
1  clc
2  // Given that
3  x1 = 1 // coordinate on x axis for first plane
4  y1 = 0 // coordinate on y axis for first plane
5  z1 = 0 // coordinate on z axis for first plane
6  x2 = 1 // coordinate on x axis for second plane
7  y2 = 1 // coordinate on y axis for second plane
8  z2 = 1 // coordinate on z axis for second plane
9  // Sample Problem 4 on page no. 13.25
10 printf("\n # PROBLEM 4 # \n")
11 printf("Standard formula used \n")
12 printf(" d = 1 / (x1^2 + y1^2 + z1^2)^1/2 \n")
13 d1 = 1 / sqrt(x1^2 + y1^2 + z1^2)
14 d2 = 1 / sqrt(x2^2 + y2^2 + z2^2)
15 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

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

```
          in  angstrom
 8  b = 5 // length of vector b of crystallographic axes
          in  angstrom
 9  c = 5 // length of vector c of crystallographic axes
          in  angstrom
10  // Sample Problem 5 on page no. 13.26
11  printf (" \n # PROBLEM 5 # \n")
12  printf (" Standard formula used \n")
13  printf (" d = 1 / (x1^2 + y1^2 + z1^2)^1/2 \n")
14  x_  = 2 / x
15  y_  = 2 / y
16  z_  = 2 * k
17  d = a / sqrt (x_^2 + y_^2 + z_^2)
18  D=d^2
19  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

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

```
11  y_ = 2 / y
12  z_ = 2 * k
13  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

```
1  clc
2  // Given that
3  x1 = 2 // coordinate on x axis
4  y1 = 3 // coordinate on y axis
5  z1 = 1 // coordinate on z axis
6  r = 0.175 // atomic radius of fcc structure in nm
7  // Sample Problem 7 on page no. 13.27
8  printf ("\n # PROBLEM 7 # \n")
9  printf ("Standard formula used \n")
10 printf (" d = 1 / (x1^2 + y1^2 + z1^2)^1/2 \n")
11 a = (4 * r) / sqrt(2)
12 d = a / sqrt(x1^2 + y1^2 + z1^2)
13 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

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

```
 6  x2 = 1
 7  y2 = 1
 8  z2 = 0
 9  // coordinate of first plane in second case
10  x3 = 1
11  y3= 1
12  z3 = 1
13  // coordinate of second plane in second case
14  // Sample Problem 8 on page no. 13.27
15  printf ("\n # PROBLEM 8 # \n")
16  printf ("Standard formula used \n")
17  printf (" d = 1 / (x1^2 + y1^2 + z1^2)^1/2 \n")
18  x_=6/x1
19  y_=6/y1
20  z_=6/z1
21  d1 = 1 / sqrt(x2^2 + y2^2 + z2^2)
22  d2= 1/ sqrt(x3^2 + y3^2 + z3^2)
23  d = d1/d2
24  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

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

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

Scilab code Exa 13.10 Calculation of primitive translation vector

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

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

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

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

Scilab code Exa 13.12 Calculation of Wavelength of x ray

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

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

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

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

Scilab code Exa 13.14 Calculation of Lattice constant of NaCl

```
1   clc
2   // Given that
3   d = 2.51 // the space between adjacent plane in
         angstrom
4   theta = 9 // glancing angle in degree
5   // Sample Problem 14 on page no. 13.29
6   printf("\n # PROBLEM 14 # \n")
7   printf(" Standard formula used \n")
8   printf(" n*lambda = 2 * d * sin(theta) \n")
9   n = 1 // for n=1
10  lambda = 2 * d * sind(theta) / n
11  n = 2 // for n=2
12  theta = asind(lambda / d)
13  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

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

Scilab code Exa 13.16 Calculation of Glancing angle

```
1  clc
2  // Given that
3  lambda = 1.4 // wavelength of x-ray in angstrom
4  x1 = 1 // coordinate on x axis of plane
5  y1 = 1 // coordinate on y axis of plane
6  z1 = 1 // coordinate on z axis of plane
7  a = 5 // lattice parameter of of crystal in angstrom
8  // Sample Problem 16 on page no. 13.30
9  printf("\n # PROBLEM 16 # \n")
10 printf(" Standard formula used \n")
11 printf(" d = a / (x1^2 + y1^2 + z1^2)^1/2 \n")
12 n = 1 // for first order
13 d = a / sqrt(x1^2 + y1^2 + z1^2)
14 theta = asind((n * lambda) / (2 * d))
15 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

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

Scilab code Exa 13.18 Calculation of Lattice parameter

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

```
5  theta = 30 // glancing angle in degree
6  // Sample Problem 18 on page no. 13.30
7  printf("\n # PROBLEM 18 # \n")
8  printf(" Standard formula used \n")
9  printf(" n*lambda = 2 * d * sin(theta) \n lambda = h
       /(m*v) \n")
10 lambda = 2 * d * sind(theta) / n
11 v = 6.62e-34 / (1.67e-27 * lambda)
12 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

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

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

Scilab code Exa 13.20 Calculation of Inter planner distance

```
 1  clc
 2  // Given that
 3  lambda = 1.24e-10 // wavelength of X-ray in A
 4  x1 = 1 // coordinate on x axis of first plane
 5  y1 = 0 // coordinate on y axis of first plane
 6  z1 = 0 // coordinate on z axis of first plane
 7  x2 = 1 // coordinate on x axis of second plane
 8  y2 = 1 // coordinate on y axis of second plane
 9  z2 = 0 // coordinate on z axis of second plane
10  x3 = 1 // coordinate on x axis of third plane
11  y3 = 1 // coordinate on y axis of third plane
12  z3 = 1 // coordinate on z axis of third plane
13  M = 74.5 // molecular weight of KCl
14  d = 1980 // density of KCl in kg/m^3
15  N = 6.023e+26 // Avogadro's No per Kg mole
16  // Sample Problem 20 on page no. 13.31
17  printf("\n # PROBLEM 20 # \n")
18  printf(" \n Standard formula used are D = 1/sqrt(x
        ^2+y^2+z^2) and a^3 = n*M/(N*d)")
19  a = (4*M / (N*d))^(1/3)
20  D1 = a/sqrt(x1^2 + y1^2 + z1^2)
21  D2 = a/sqrt(x2^2 + y2^2 + z2^2)
22  D3 = a/sqrt(x3^2 + y3^2 + z3^2)
23  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

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

Scilab code Exa 13.22 Calculation of Cohesive energy of Nacl

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

```
12 E = -(( alpha * 1.6e-19) / (4 * %pi * 8.85e-12 * d))
      * (1 - (1 / n))
13 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

```
1 clc
2 // Given that
3 E = 2.02 // average energy required to produce a
      Schottky defect at room temperature in eV
4 k = 1.38e-23 // Boltzmann constant in J/k
5 T = 300 // room temperature in K
6 // Sample Problem 23 on page no. 13.33
7 printf("\n # PROBLEM 23 # \n")
8 printf(" Standard formula used \n")
9 printf(" r = exp(-(E * 1.6e-19) / (2 * k * T))\n")
10 r = exp(-(E * 1.6e-19) / (2 * k * T))
11 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

```
1  clc
2  // Given that
3  E = 75 // energy of photon in eV
4  h = 6.62e-34 // Planck constant in J-sec
5  c = 3e8 // speed of light in m/sec
6  e = 1.6e-19 // charge on an electron in J
7  // Sample Problem 1 on page no. 14.20
8  printf("\n # PROBLEM 1 # \n")
9  printf("Standard formula used \n")
10 printf(" E = h*c/lambda \n")
11 f = E * e / h
12 lambda = c / f
13 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

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

Scilab code Exa 14.3 Calculation of Energy of photon

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

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

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

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

Scilab code Exa 14.5 Calculation of Wavelength

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

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

Scilab code Exa 14.6 Calculation of Energy of an electron

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

Scilab code Exa 14.7 Calculation of Energy received by the eye

```
1  clc
2  // Given that
3  lambda = 5.6e-7 // wavelength of light in meter
4  n = 120 // no. of photons per second
5  h = 6.62e-34 // Planck constant in J-sec
6  c = 3e8 // speed of light in m/sec
7  e = 1.6e-19 // charge on an electron in C
8  // Sample Problem 7 on page no. 14.22
9  printf(" \n # PROBLEM 7 # \n")
10 printf("Standard formula used \n")
11 printf(" E = h*c/lambda \n")
12 E = ((h * c) / lambda)
13 p = E * n
14 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

```
1  clc
2  // Given that
3  lambda = 5.5e-7 // wavelength of light in meter
4  E = 1.5 // energy in J
5  h = 6.62e-34 // Planck constant in J-sec
6  c = 3e8 // speed of light in m/sec
7  e = 1.6e-19 // charge on an electron in C
8  // Sample Problem 8 on page no. 14.22
9  printf(" \n # PROBLEM 8 # \n")
10 printf("Standard formula used \n")
11 printf(" E = h*c/lambda \n")
12 E_ = ((h * c) / lambda)
13 n = E / E_
14 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

```
1  clc
2  // Given that
3  lambda = 4.35e-7 // wavelength of light in meter
4  lambda_ = 5.42e-7 // threshold wavelength of
       photoelectron in meter
5  h = 6.62e-34 // Planck constant in J-sec
6  c = 3e8 // speed of light in m/sec
7  e = 1.6e-19 // charge on an electron in C
8  m = 9.1e-31 // mass of an electron in kg
9  // Sample Problem 9 on page no. 14.22
10 printf("\n # PROBLEM 9 # \n")
11 printf("Standard formula used \n ")
12 printf(" 1/2 m*v^2 = eV \n   E = h*c/lambda \n")
13 w = ((h * c) / lambda_)
14 v = sqrt(((2 * h * c) / m) * (1 / lambda - 1 /
       lambda_))
15 V = m * v^2 / (2 * e)
16 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

```
1  clc
```

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

Scilab code Exa 14.11 Calculation of Work function

```
1  clc
2  // Given that
3  lambda = 6.2e-7  // threshold wavelength of
        photoelectron in first case in meter
4  lambda_ = 5e-7  // threshold wavelength of
        photoelectron in second case in meter
5  h = 6.62e-34  // Planck constant in J−sec
6  c = 3e8  // speed of light in m/sec
7  e = 1.6e-19  // charge on an electron in C
8  // Sample Problem 11 on page no. 14.23
9  printf("\n # PROBLEM 11 # \n")
10 printf("Standard formula used \n ")
11 printf(" E = h*c/lambda \n")
12 w = ((h * c) / lambda) * (1 / e)
13 w_ = ((h * c) / lambda_) * (1 / e)
14 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

```
1
2  clc
3  // Given that
4  lambda = 3.132e-7 // wavelength of light in meter
5  V = 1.98 // stopping potential in V
6  h = 6.62e-34 // Planck constant in J-sec
7  c = 3e8 // speed of light in m/sec
8  e = 1.6e-19 // charge on an electron in C
9  m = 9.1e-31 // mass of an electron in kg
10 // Sample Problem 12 on page no. 14.24
11 printf("\n # PROBLEM 12 # \n")
12 printf("Standard formula used \n ")
13 printf(" 1/2 m*v^2 = h*(mu - mu_0) \n")
14 E = e * V
15 lambda_ = 1 / ((1 / lambda) - (E / (h * c)))
16 f = c / lambda_
17 w = ((h * c) / lambda_)
18 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

```
1  clc
```

```
2  // Given that
3  w = 4.8 // work function in eV
4  lambda1 = 5e-7 // wavelength of incident radiation
       in first case in meter
5  lambda2 = 2e-7 // wavelength of incident radiation
       in second case in meter
6  h = 6.62e-34 // Planck constant in J-sec
7  c = 3e8 // speed of light in m/sec
8  e = 1.6e-19 // charge on an electron in C
9  // Sample Problem 13 on page no. 14.24
10 printf("\n # PROBLEM 13 # \n")
11 printf("Standard formula used \n ")
12 printf(" E_k = h*c/lambda \n")
13 E_k1 = h*c/lambda1
14 E_k2 = h*c / lambda2
15 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

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

```
6  c = 3e8 // speed of light in m/sec
7  e = 1.6e-19 // charge on an electron in C
8  m = 9.1e-31 // mass of an electron in kg
9  // Sample Problem 14 on page no. 14.25
10 printf("\n # PROBLEM 14 # \n")
11 printf("Standard formula used \n ")
12 printf(" E_k = h*mu - phi \n")
13 E = h * c / lambda
14 w = ((h * c) / lambda) * (1 / e) - V
15 f = w * e / h
16 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

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

```
15  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

```
1  clc
2  // Given that
3  E = 1.5 // maximum energy in eV
4  lambda_ = 2.3e-7 // threshold wavelength of
        photoelectron in meter
5  h = 6.62e-34 // Planck constant in J-sec
6  c = 3e8 // speed of light in m/sec
7  e = 1.6e-19 // charge on an electron in C
8  m = 9.1e-31 // mass of an electron in kg
9  // Sample Problem 16 on page no. 14.26
10 printf("\n # PROBLEM 16 # \n")
11 printf("Standard formula used \n ")
12 printf(" E = (h * c) * (1 / lambda1 - 1 / lambda2) \
        n")
13 lambda = 1 / ((E * e / (h * c)) + (1 / lambda_))
14 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

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

```
4  w = 4.53 // work function of tungsten in eV
5  h = 6.62e-34 // Planck constant in J−sec
6  c = 3e8 // speed of light in m/sec
7  e = 1.6e-19 // charge on an electron in C
8  // Sample Problem 17 on page no. 14.26
9  printf("\n # PROBLEM 17 # \n")
10 printf(" Standard formula used \n ")
11 printf(" E = (h * c)/lambda = 1/2*m*v^2 \n ")
12 E = ((h * c) / lambda) * (1 / e)
13 k = E - w
14 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

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

Scilab code Exa 14.19 Calculation of Threshold wavelength for photo emission

```
1  clc
2  // Given that
3  w = 2 // work function of sodium in eV
4  h = 6.62e-34 // Planck constant in J-sec
5  c = 3e8 // speed of light in m/sec
6  e = 1.6e-19 // charge on an electron in C
7  // Sample Problem 19 on page no. 14.27
8  printf("\n # PROBLEM 19 # \n")
9  printf("Standard formula used \n ")
10 printf(" E = (h * c)/ lambda \n")
11 lambda = ((h * c) / w) * (1 / e)
12 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

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

```
9   printf("\n # PROBLEM 20 # \n")
10  printf("Standard formula used \n ")
11  printf(" E = (h * c) * (1 / lambda1 - 1 / lambda2) \
        n E = (h * c)/ lambda \n")
12  lambda_ = ((h * c) / (w * e))
13  lambda = (1 / (((( k * e)  / (h * c))) + (1 / lambda_
        )))
14  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

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

```
19  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

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

Scilab code Exa 14.23 Calculation of Compton shift

```
1  clc
```

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

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

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

```
13  delta_lambda = (h * (1 - cosd(theta))) / (m * c)
14  E = (h * c) / delta_lambda
15  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

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

Scilab code Exa 14.26 Calculation of Compton shift and Kinetic energy

```
1  clc
2  // Given that
```

```
3  lambda = 1e-10 // wavelength of light in meter
4  theta = 90 // angle in degree
5  h = 6.62e-34 // Planck constant in J−sec
6  c = 3e8 // speed of light in m/sec
7  e = 1.6e-19 // charge on an electron in C
8  m = 9.1e-31 // mass of an electron in kg
9  // Sample Problem 26 on page no. 14.31
10 printf("\n # PROBLEM 26 # \n")
11 printf("Standard formula used \n ")
12 printf(" delta_lambda = (h / (m * c) * (1 − cos(
       theta))) \n E = h*c*(1/lambda1 − 1/lambda2)\n")
13 delta_lambda = (h * (1 - cosd(theta))) / (m * c)
14 E = (h * c) * ((1 / lambda) - (1 / (lambda +
       delta_lambda)))
15 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

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

```
13  delta_lambda = (h * (1 - cosd(theta))) / (m * c)
14  E = (h * c) * ((1 / lambda) - (1 / (lambda +
        delta_lambda)))
15  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

```
1   clc
2   // Given that
3   lambda = 0.2e-10 // wavelength of x-ray in meter
4   theta = 45 // scattered angle in degree
5   h = 6.62e-34 // Planck constant in J-sec
6   c = 3e8 // speed of light in m/sec
7   e = 1.6e-19 // charge on an electron in C
8   m = 9.1e-31 // mass of an electron in kg
9   // Sample Problem 28 on page no. 14.32
10  printf(" \n # PROBLEM 28 # \n")
11  printf(" Standard formula used \n ")
12  printf(" delta_lambda = (h / (m * c) * (1 - cos(
        theta))) \n E = h*c*(1/lambda1 - 1/lambda2)\n")
13  delta_lambda = (h * (1 - cosd(theta))) / (m * c)
14  E = (h * c) * ((1 / lambda) - (1 / (lambda +
        delta_lambda)))
15  theta_ = 180 // for maximum
16  delta_lambda_ = (h * (1 - cosd(theta_))) / (m * c)
17  lambda_ = lambda + delta_lambda_
18  E_k = h*c*(1/lambda - 1/lambda_)
19  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

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

Scilab code Exa 14.30 Calculation of deBroglie wavelength

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

```
11  printf (" lambda = h /(m*v)\n 1/2*m*vˆ2 = eV \n")
12  lambda =  h  / sqrt (2 * m * v * e)
13  printf ("\n de−Broglie wavelength is %f Angstrom .",
        lambda * 1e10)
```

Scilab code Exa 14.31 Calculation of Wavelength of thermal neutron

```
1  clc
2  // Given that
3  t = 300 // temperature in K
4  k = 1.37e-23 // Boltzmann ' s constant in J/K
5  h = 6.62e-34 // Planck constant in J−sec
6  e = 1.6e-19 // charge on an electron in C
7  m = 1.67e-27 // mass of neutron in kg
8  // Sample Problem 31 on page no. 14.33
9  printf ("\n # PROBLEM 31 # \n")
10 printf ("Standard formula used \n ")
11 printf (" lambda = h /(m*v)\n 1/2*m*vˆ2 = 3/2*k*T \n"
        )
12 lambda = h / sqrt (3 * m * k * t)
13 printf ("\n Wavelength of thermal neutron is %f
        Angstrom .",lambda * 1e10)
```

Scilab code Exa 14.32 Calculation of Wavelength of matter wave

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

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

Scilab code Exa 14.33 Calculation of Potential difference

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

Scilab code Exa 14.34 Calculation of deBroglie wavelength

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

Scilab code Exa 14.35 Calculation of deBroglie wavelength

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

Scilab code Exa 14.36 Calculation of deBroglie wavelength

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

Scilab code Exa 14.37 Calculation of Energy

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

```
11  printf(" lambda = h  /(m*v)\n")
12  v = h / (m * lambda)
13  E = h^2 / (2 * m * lambda^2)
14  E_ = h^2 / (2 * m_ * lambda^2)
15  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

```
1  clc
2  // Given that
3  E1 = 500 // kinetic energy of electron in first case
        in eV
4  E2 = 50 // kinetic energy of electron in second case
        in eV
5  E3 = 1 // kinetic energy of electron in third case
        in eV
6  h = 6.62e-34 // Planck constant in J-sec
7  e = 1.6e-19 // charge on an electron in C
8  m = 9.1e-31 // mass of electron in kg
9  // Sample Problem 38 on page no. 14.36
10 printf("\n # PROBLEM 38 # \n")
11 printf("Standard formula used \n ")
12 printf(" lambda = h/(2*m*E)^1/2.\n")
13 lambda1 = h / sqrt(2 * m * E1 * e)
14 lambda2 = h / sqrt(2 * m * E2 * e)
15 lambda3 = h / sqrt(2 * m * E3 * e)
16 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

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

Scilab code Exa 14.40 Calculation of Ratio of deBroglie wavelengths

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

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

Scilab code Exa 14.41 Calculation of Velocity

```
1  clc
2  // Given that
3  E = 1 // kinetic energy of proton in MeV
4  h = 6.62e-34 // Planck constant in J−sec
5  e = 1.6e-19 // charge on an electron in C
6  m = 1.67e-27 // mass of proton in kg
7  // Sample Problem 41 on page no. 14.37
8  printf("\n # PROBLEM 41 # \n")
9  printf("Standard formula used \n ")
10 printf(" E = 1/2 * m*v^2 \n")
11 v = sqrt(2 * E * 1.6e-13 / m)
12 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

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

Scilab code Exa 14.43 Calculation of kinetic energy

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

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

Scilab code Exa 14.44 Calculation of deBrogli wavelength

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

Scilab code Exa 14.45 Calculation of Ratio of deBroglie wavelengths

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

Scilab code Exa 14.47 Calculation of Group velocity and Phase velocity

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

```
13  v2 = h / (2 * m * lambda)
14  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

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

Scilab code Exa 15.3 Calculation of Percentage of uncertainty in momentum

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

Scilab code Exa 15.4 Calculation of Uncertainty in position

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

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

Scilab code Exa 15.5 Calculation of Uncertainty in momentum

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

Scilab code Exa 15.6 Calculation of Uncertainty in position

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

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

Scilab code Exa 15.7 Calculation of Minimum energy of electron

```
1  clc
2  // Given that
3  r = 0.53e-10 // radius of hydrogen atom in m
4  e = 1.6e-19 // charge on an electron in C
5  m = 9.1e-31 // mass of electron in kg
6  h = 6.62e-34 // Planck constant in J−sec
7  // Sample Problem 7 on page no. 15.27
8  printf("\n # PROBLEM 7 # \n")
9  printf("Standard formula used \n")
10 printf(" del_x*del_p = h/(4*pi) \n p = (2 * m * E *
      e)^(1/2) \n")
11 delta_M = h / (4 * %pi * r)
12 delta_k = delta_M^2 / (2 * m)
13 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

```
1  clc
2  // Given that
3  v = 5e3 // speed of electron in m/sec
4  a = 0.003 // percentage accuracy in measurement of
       speed
5  e = 1.6e-19 // charge on an electron in C
6  m = 9.1e-31 // mass of electron in kg
7  h = 6.62e-34 // Planck constant in J-sec
8  // Sample Problem 8 on page no. 15.27
9  printf("\n # PROBLEM 8 # \n")
10 printf("Standard formula used \n")
11 printf(" del_x*del_p = h/(4*pi) \n")
12 delta_v = v * a / 100
13 delta_p = m * delta_v
14 delta_x = h / (4 * %pi * delta_p)
15 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

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

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

Scilab code Exa 15.10 Calculation of Uncertainty in determining the position

```
1  clc
2  // Given that
3  v = 3e7 // speed of electron in m/sec
4  e = 1.6e-19 // charge on an electron in C
5  m = 9.1e-31 // mass of electron in kg
6  h = 6.62e-34 // Planck constant in J−sec
7  c = 3e8 // speed of light in m/sec
8  // Sample Problem 10 on page no. 15.28
9  printf(" \n # PROBLEM 10 # \n")
10 printf("Standard formula used \n")
11 printf(" del_x*del_p = h/(4*pi) \n m = m_0/(1−(v^2/c
      ^2))^1/2 \n")
12 delta_p = m * v / sqrt(1 - (v/c)^2)
13 delta_x = h / (4 * %pi * delta_p)
14 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

```
1  clc
2  // Given that
3  t = 2.5e-14 // life time of hydrogen atom in exited
      state in sec
4  h = 6.62e-34 // Planck constant in J−sec
5  // Sample Problem 11 on page no. 15.28
6  printf(" \n # PROBLEM 11 # \n")
7  printf(" Standard formula used \n")
8  printf(" del_E*del_t = h/(4* pi) \n")
9  delta_E = h / (4 * %pi * t)
10 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

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

```
9  delta_f = 1 / (4 * %pi * t)
10 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

```
1  clc
2  // Given that
3  delta_x = 20e-10 // uncertainty  in  position  in  m
4  e = 1.6e-19 // charge  on  an  electron  in  C
5  m = 9.1e-31 // mass  of  electron  in  kg
6  m_ = 1.67e-27 // mass  of  proton  in  kg
7  c = 3e8 // speed  of  light  in  m/sec
8  h = 6.62e-34 // Planck  constant  in  J−sec
9  // Sample  Problem  13  on  page  no.  15.29
10 printf("\n # PROBLEM 13 # \n")
11 printf("Standard  formula  used  \n")
12 printf("  del_x*del_p  =  h/(4*pi)  \n")
13 delta_v1 = h / (4 * %pi * m * delta_x)
14 delta_v2 = h / (4 * %pi * m_ * delta_x)
15 r = delta_v2 / delta_v1
16 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

```
1  clc
2  // Given that
```

```
3  delta_x = 1e-10 // width of box in m
4  e = 1.6e-19 // charge on an electron in C
5  m = 9.1e-31 // mass of electron in kg
6  c = 3e8 // speed of light in m/sec
7  h = 6.62e-34 // Planck constant in J-sec
8  // Sample Problem 14 on page no. 15.29
9  printf("\n # PROBLEM 14 # \n")
10 printf("Standard formula used \n")
11 printf(" E = (n^2 * h^2) / (8 * m * L^2)) \n")
12 n = 1 // for n=1
13 E = (n^2 * h^2) / (8 * m * delta_x^2)
14 n = 2 // for n=2
15 E_ = (n^2 * h^2) / (8 * m * delta_x^2)
16 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

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

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

Scilab code Exa 15.16 Calculation of Energy difference

```
1 clc
2 // Given that
3 l = 3e-10 // width of box in m
4 e = 1.6e-19 // charge on an electron in C
5 m = 9.1e-31 // mass of electron in kg
6 c = 3e8 // speed of light in m/sec
7 h = 6.62e-34 // Planck constant in J-sec
8 // Sample Problem 16 on page no. 15.30
9 printf("\n # PROBLEM 16 # \n")
10 printf("Standard Formula used \n")
11 printf(" E = (n^2 * h^2) / (8 * m * L^2)) \n")
12 n = 1 // For n=1
13 E = (n^2 * h^2) / (8 * m * l^2)
14 n = 2 // For n=2
15 E_ = (n^2 * h^2) / (8 * m * l^2)
16 n = 3 // For n=3
17 E__ = (n^2 * h^2) / (8 * m * l^2)
18 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

```
1 clc
```

```
2  // Given that
3  l = 2.5e-10 // width of box in m
4  e = 1.6e-19 // charge on an electron in C
5  m = 9.1e-31 // mass of electron in kg
6  c = 3e8 // speed of light in m/sec
7  h = 6.62e-34 // Planck constant in J−sec
8  // Sample Problem 17 on page no. 15.30
9  printf("\n # PROBLEM 17 # \n")
10 printf("Standard formula used \n")
11 printf(" E = (n^2 * h^2) / (8 * m * L^2)) \n")
12 n = 1 // for n=1
13 E = (n^2 * h^2) / (8 * m * l^2)
14 n = 2 // for n=2
15 E_ = (n^2 * h^2) / (8 * m * l^2)
16 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

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

```
14  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

```
1  clc
2  // Given that
3  l = 1e-10 // width of box in m
4  e = 1.6e-19 // charge on an electron in C
5  m = 9.1e-31 // mass of electron in kg
6  c = 3e8 // speed of light in m/sec
7  h = 6.63e-34 // Planck constant in J−sec
8  // Sample Problem 19 on page no. 15.31
9  printf("\n # PROBLEM 19 # \n")
10  printf("Standard formula used \n")
11  printf(" E = (n^2 * h^2) / (8 * m * L^2)) \n p_n = n
        *h/(2*pi) \n")
12  n = 1 // for n=1
13  p1 = (n * h) / (2 * l)
14  E = (n^2 * h^2) / (8 * m * l^2)
15  n = 2 // for n=2
16  p2 = (n * h) / (2 * l)
17  E_ = (n^2 * h^2) / (8 * m * l^2)
18  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

```
1  clc
2  // Given that
3  l = 1e-10 // length of box in m
4  m = 9.1e-31 // mass of electron in kg
5  c = 3e8 // speed of light in m/sec
6  h = 6.62e-34 // Planck constant in J-sec
7  // Sample Problem 20 on page no. 15.32
8  printf("\n # PROBLEM 20 # \n")
9  printf("Standard formula used \n")
10 printf(" E = (n^2 * h^2) / (8 * m * L^2)) \n p_n = n
      *h/(2*pi) \n")
11 n = 1 // for n=1
12 E1 = (n^2 * h^2) / (8 * m * l^2)
13 lambda1 =2*l
14 n = 2 // for n=2
15 E2 = (n^2 * h^2) / (8 * m * l^2)
16 lambda2 =2*l/2
17 n = 3 // for n=3
18 E3 = (n^2 * h^2) / (8 * m * l^2)
19 lambda3 =2*l/3
20 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

```
1  clc
```

```
2  // Given  that
3  E1 = 3.2e-18 // minimum  energy  possible  for  a
       particle  entrapped  in  a  one  dimensional  box  in  J
4  e = 1.6e-19 // charge  on  an  electron  in  C
5  m = 9.1e-31 // mass  of  electron  in  kg
6  c = 3e8 // speed  of  light  in m/sec
7  h = 6.62e-34 // Planck  constant  in  J-sec
8  // Sample  Problem  21  on  page  no.  15.32
9  printf(" \n # PROBLEM 21 # \n")
10 printf("Standard  formula  used  \n")
11 printf(" E = (n^2 * h^2) / (8 * m * L^2)) \n")
12 E1 = E1 / e // in  eV
13 n = 2 // for  n=2
14 E2 = n^2 * E1
15 n = 3 // for  n=3
16 E3 = n^2 * E1
17 n = 4 // for  n=4
18 E4 = n^2 * E1
19 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

```
1
2  clc
3  // Given  that
4  l = 4e-10 // width  of  box  in  m
5  E = 9.664e-17 // energy  of  electron  in  J
6  e = 1.6e-19 // charge  on  an  electron  in  C
7  m = 9.1e-31 // mass  of  electron  in  kg
8  c = 3e8 // speed  of  light  in m/sec
9  h = 6.62e-34 // Planck  constant  in  J-sec
```

```
10  // Sample Problem 22 on page no. 15.33
11  printf("\n # PROBLEM 22 # \n")
12  printf("Standard formula used \n")
13  printf(" E = (n^2 * h^2) / (8 * m * L^2)) \n p_n = n
        *h/(2*pi) \n")
14  n = 1 // for n=1
15  E1 = (n^2 * h^2) / (8 * m * l^2)
16  N = sqrt(E / E1)
17  p = ((N) * h) / (2 * l)
18  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

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

```
18  E2 = 2^2* E1
19  E3 = 3^2 * E1
20  // For glass marble
21  E1_ = h^2/(8*M*l_^2)
22  E2_ = 2^2 * E1_
23  E3_ = 3^2 *E1_
24  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_)
25  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

```
1  clc
2  // Given that
3  t = 0  // temperature in K
4  E = 10  // Fermi energy of electron in eV
5  e = 1.6e-19  // charge on an electron in C
6  m = 9.1e-31  // mass of electron in kg
7  // Sample Problem 1 on page no. 16.14
8  printf("\n # PROBLEM 1 # \n")
9  printf("Standard formula used \n")
10 printf("1/2 * m*v^2 = E_0 \n")
11 E_ = E * 3 / 5
12 v = sqrt(2 * E_ * e / m)
13 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

```
1  clc
2  // Given that
3  t = 0 // temperature in K
4  E = 7.9 // Fermi energy in eV
5  e = 1.6e-19 // charge on an electron in C
6  m = 9.1e-31 // mass of electron in kg
7  // Sample Problem 2 on page no. 16.14
8  printf("\n # PROBLEM 2 # \n")
9  printf("Standard formula used \n")
10 printf("1/2 * m*v^2 = E_0 \n")
11 E_ = E * 3 / 5
12 v = sqrt(2 * E_ * e / m)
13 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

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

```
9  printf("Standard formula used \n")
10 printf("1/2 * m*v^2 = E_0 \n ")
11 printf("E_0 = (h^2 /(8 * pi^2 * m))*(3 * pi^2 * n)
       ^(2/3) * (1 / e)\n")
12 E = (h^2 / (8 * %pi^2 * m)) * (3 * %pi^2 * n)^(2/3)
       * (1 / e)
13 v = (h / (2 * %pi * m)) * (3 * %pi^2 * n)^(1/3)
14 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

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

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

Scilab code Exa 16.5 Calculation of Fermi energy

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

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

```
1  clc
2  // Given that
```

```
3  a = 4e-10 // lattice constant in mr
4  t = 0 // temperature in K
5  N = 6.02e23 // Avogadro no. in per kg
6  m = 9.1e-31 // mass of electron in kg
7  h = 6.62e-34 // Planck constant in J-sec
8  e = 1.6e-19 // charge on an electron in C
9  // Sample Problem 6 on page no. 16.16
10 printf("\n # PROBLEM 6 # \n")
11 printf("Standard formula used \n")
12 printf("E = (h^2 / (8 * pi^2 * m)) * (3 * pi^2 * N/V
       )^(2/3) \n")
13 V = a^3
14 n = 4 / V
15 E = (h^2 / (8 * %pi^2 * m)) * (3 * %pi^2 * n)^(2/3)
       * (1 / e)
16 k = (3 * %pi^2 *n)^(1/3)
17 KE = (3 * E / 5) * (n)
18 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

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

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

Scilab code Exa 16.8 Calculation of Current density and Drift velocity

```
1  clc
2  // Given that
3  d = 8.92e3 // density of copper in kg/m^3
4  i = 5 // current in amp
5  w = 63.5 // atomic weight of copper
6  r = 0.7e-3 // radius in meter
7  N = 6.02e28 // Avogadro no.
8  e = 1.6e-19 // charge on an electron in C
9  // Sample Problem 8 on page no. 16.17
10 printf("\n # PROBLEM 8 # \n")
11 printf("Standard formula used \n")
12 printf(" J = I*A \n v_d = J/ne \n")
13 V = (w / d)
14 n = N / V
15 J = i / (%pi * r^2)
16 v = J / (n * e)
17 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

```
1  clc
2  // Given that
3  d1= 0.534*10^3 // densiy of Li in kg/m^3
4  d2= 0.971*10^3 // densiy of Na in kg/m^3
5  d3= 0.86*10^3 // densiy of K in kg/m^3
6  w1 = 6.939 // atomic weight of Li
7  w2 = 22.99 // atomic weight of Na
8  w3 = 39.202 // atomic weight of K
9  h = 6.62e-34 // Planck constant in J sec
10 m = 9.1e-31 // mass of an electron in kg
11 NA = 6.023e26 // Avogadro no.
12 e = 1.6e-19 // charge on an electron in C
13 // Sample Problem 9 on page no. 16.17
14 printf("\n # PROBLEM 9 # \n")
15 printf("Standard formula used \n")
16 printf("E = h^2 / (8 * m * pi^2) * (3*pi^2*N/V)^2/3
      \n")
17 // For Li
18 n1 = NA * d1/w1
19 E1 = h^2/(8*%pi^2*m)*(3*%pi^2*n1)^(2/3)
20 // For Na
21 n2 = NA * d2/w2
22 E2 = h^2/(8*%pi^2*m)*(3*%pi^2*n2)^(2/3)
23 // For K
24 n3 = NA * d3/w3
25 E3 = h^2/(8*%pi^2*m)*(3*%pi^2*n3)^(2/3)
26 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

```
1  clc
2  // Given that
```

```
3  l = 1e-10 //length of box in m
4  e = 1.6e-19 // charge on an electron in C
5  m = 9.1e-31 // mass of electron in kg
6  h = 6.62e-34 // Planck constant in J-sec
7  // Sample Problem 10 on page no. 16.18
8  printf("\n # PROBLEM 10 # \n")
9  printf("Standard formula used \n")
10 printf("E = (n^2 * h^2) / (8 * m * l^2) \n")
11 n = 1 // for n=1
12 E = (n^2 * h^2) / (8 * m * l^2)
13 n = 2 // for n=2
14 E_ = (n^2 * h^2) / (8 * m * l^2)
15 d = (E_ - E) * (1 / e)
16 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

```
1  clc
2  // Given that
3  a = 3e-10  // side of square lattice in m
4  h = 6.62e-34  // Planck constant in J sec
5  e = 1.6e-19  // charge on an electron in C
6  m = 9.1e-31  // mass of electron in kg
7  // Sample Problem 1 on page no. 17.18
8  printf("\n # PROBLEM 1 # \n")
9  printf("Standard formula used \n ")
10 printf("E = P^2 / (2*m) \n P = h_cut*k \n")
11 p = (h / (2 * a))
12 E = (p^2 / (2 * m)) * (1 / e)
13 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

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

Scilab code Exa 17.3 Calculation of New position of Fermi level

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

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

Scilab code Exa 17.4 Calculation of Density of holes and electron

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

Scilab code Exa 17.5 Calculation of Hall coefficient

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

Scilab code Exa 17.6 Calculation of Hall coefficient

```
1  clc
2  // Given that
3  a = 4.28e-10 // cell side of Na in m
4  e = 1.6e-19 // charge on an electron in C
5  // Sample Problem 6 on page no. 17.20
6  printf(" \n # PROBLEM 6 # \n")
7  printf(" Standard formula used \n")
8  printf(" R_h = 1/(n*e) \n")
9  n = (2 / a^3)
10 R = -(1 / (n * e))
11 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

```
1 clc
2 // Given that
3 r = 0.53e-10 // radius of orbit in m
4 f = 6.6e15 // frequency of revolution in Hz
5 h = 6.6e-34 // Planck constant in J sec
6 e = 1.6e-19 // charge on an electron in C
7 m = 9.1e-31 // mass of electron in kg
8 // Sample Problem 1 on page no. 18.21
9 printf("\n # PROBLEM 1 # \n")
10 printf("Standard formula used \n ")
11 printf(" M = I*a \n")
12 M = e * f * %pi * r^2
13 mu = (e * h) / (4 * %pi * m)
14 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

```
1  clc
2  // Given that
3  X = -4.2e-6 // magnetic susceptibility
4  H = 1.19e5 // magnetic field in A/m
5  mu_ = 4 * %pi * 1e-7 // magnetic permeability of
       space
6  // Sample Problem 2 on page no. 18.21
7  printf("\n # PROBLEM 2 # \n")
8  printf("Standard formula used \n ")
9  printf(" I = cai*H  \n")
10 I = X * H
11 B = mu_ * (H + I)
12 mur = (1 + I/H)
13 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

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

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

Scilab code Exa 18.4 Calculation of Magnetization and Magnetic flux density

```
1  clc
2  // Given that
3  X = -0.4e-5 // magnetic susceptibility of material
4  H = 1e4 // magnetic field in A/m
5  mu_ = 4 * %pi * 1e-7 // magnetic permittivity of
       space
6  // Sample Problem 4 on page no. 18.22
7  printf ("\n # PROBLEM 4 # \n")
8  printf (" Standard formula used \n ")
9  printf (" I = Chi *H \n")
10 I = X * H
11 B = mu_ * (H + I)
12 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

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

```
4  mu_ = 4 * %pi * 1e-7 // magnetic permeability of
        space
5  // Sample Problem 5 on page no. 18.23
6  printf(" \n # PROBLEM 5 # \n")
7  printf(" Standard formula used \n ")
8  printf(" mu_r = 1 + Chi \n")
9  mur = 1 + X
10 mu = mu_ * mur
11 printf(" \n Permeability of aluminium is %e N/Aˆ2.",
        mu)
```

Scilab code Exa 18.6 Calculation of Absolute permeability and Relative permeability

```
1  clc
2  // Given that
3  X = 9.4e-2 // magnetic susceptibility
4  mu_ = 4 * %pi * 1e-7 // magnetic permeability of
        space
5  // Sample Problem 6 on page no. 18.23
6  printf(" \n # PROBLEM 6 # \n")
7  printf(" Standard formula used \n ")
8  printf(" mu_r = 1 + Chi \n")
9  mu_r = 1 + X
10 mu = mu_ * mu_r
11 printf(" \n Absolute permeability is %e N/Aˆ2.\n
        Relative permeability is %f.",mu,mu_r)
```

Scilab code Exa 18.7 Calculation of Magnetic susceptibility and Relative permeability

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

Scilab code Exa 18.8 Calculation of Diamagnetic susceptibility

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

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

Scilab code Exa 18.9 Calculation of Permeability and Susceptibility

```
1 clc
2 // Given that
3 H = 1e3 // magnetisation field in A/m
4 phi = 2e-5 // magnetic flux in Weber
5 a = 0.2e-4 // area of cross section in m^2
6 mu_ = 4 * %pi * 1e-7 // magnetic permeability of
      space
7 // Sample Problem 9 on page no. 18.24
8 printf("\n # PROBLEM 9 # \n")
9 printf("Standard formula used \n ")
10 printf(" mu_r = 1 + Chi \n")
11 B = phi / a
12 mu = B / H
13 X = mu / mu_ - 1
14 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

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

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

Scilab code Exa 18.11 Calculation of Current through the winding

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

Scilab code Exa 18.12 Calculation of Radius of atom

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

Scilab code Exa 18.13 Calculation of Susceptibility

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

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

Scilab code Exa 18.14 Calculation of Magnetization

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

Scilab code Exa 18.15 Calculation of Total loss of energy

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

Scilab code Exa 18.16 Calculation of Current in solenoid

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

Scilab code Exa 18.17 Calculation of Number of turns

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

Scilab code Exa 18.18 Calculation of Permeability and Susceptibility

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

```
10  printf (" mu_r = 1 + Chi \n")
11  B = phi / a
12  mu = B / H
13  X = mu / mu_ - 1
14  printf ("\n Permeability is %f N/Aˆ2.\n
         Susceptibility is %f.",mu,X)
```

Scilab code Exa 18.19 Calculation of Relative permeability

```
1  clc
2  // Given that
3  X = 9.5e-9 // susceptibility of medium
4  mu_ = 4*%pi * 1e-7 // permeability of space in N/Aˆ2
5  // Sample Problem 19 on page no. 18.28
6  printf ("\n # PROBLEM 19 # \n")
7  printf ("Standard formula used \n ")
8  printf (" mu_r = 1 + Chi \n")
9  mu = mu_ * (1 + X)
10  mu_r = mu / mu_
11  printf ("\n Relative permeability is 1 + %e",mu_r -1)
```

Scilab code Exa 18.20 Calculation of Energy loss

```
1  clc
2  // Given that
3  a = 250 // area of the B–H loop in J/mˆ3
4  f = 50 // frequency in Hz
5  d = 7.5e3 // density of iron in kg/mˆ3
6  m = 100 // mass of core in kg
```

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

Scilab code Exa 18.21 Calculation of Hysteresis loss

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

Chapter 19

SUPERCONDUCTIVITY

Scilab code Exa 19.1 Calculation of Penetration depth

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

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

```
1  clc
2  // Given that
3  Hc1 = 1.41e5 // first critical field at 14.1K
4  Hc2 = 4.205e5 // second critical field at 12.9K
5  T1 = 14.11 // temperature in K
6  T2 = 12.9 // temperature in K
7  T = 4.2 // temperature in K
8  lambda_ = 380 // penetration depth at 0 K in A
9  // Sample Problem 2 on page no. 19.13
10 printf(" \n # PROBLEM 2 # \n")
11 printf(" Standard formula used \n ")
12 printf(" H = H_0 * (1 - (T / T_c)^2) \n")
13 Tc = sqrt((Hc2*T1^2 - Hc1*T2^2) / (Hc2 - Hc1))
14 H_ = Hc1 / (1 - (T1 / Tc)^2)
15 Hc = H_ * (1 - (T/Tc)^2)
16 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

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

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

Scilab code Exa 19.4 Calculation of Critical temperature

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

Scilab code Exa 19.5 Calculation of Penetration depth

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

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

Scilab code Exa 19.6 Calculation of Critical temperature

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

Scilab code Exa 19.7 Calculation of Critical temperature

```
1  clc
2  // Given that
```

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

Scilab code Exa 19.8 Calculation of Energy gap

```
1  clc
2  // Given that
3  k = 1.38e-23 // Boltzmann's constant in J/K
4  h = 6.62e-34 // Planck constant in J sec
5  Tc = 4.2 // critical temperature of Hg in K
6  c = 3e8 // speed of light in m/sec
7  // Sample Problem 8 on page no. 19.16
8  printf("\n # PROBLEM 8 # \n")
9  printf("Standard formula used \n ")
10 printf(" E = 3 * k * Tc \n")
11 E = 3 * k * Tc
12 lambda = h * c / E
13 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

```
1  clc
2  // Given that
3  V1 = 40e3 // voltage in first case in V
4  V2 = 20e3 // voltage in second case in V
5  V3 = 100e3 // voltage in second in V
6  // Sample Problem 1 on page no. 20.7
7  printf("\n # PROBLEM 1 # \n")
8  printf("Standard formula used \n ")
9  printf("1/2*m*v^2 = eV \n")
10 v1 = 0.593e6 * sqrt(V1)
11 lambda1 = 12400 / V1
12 v2 = 0.593e6 * sqrt(V2)
13 lambda2 = 12400 / V2
14 v3 = 0.593e6 * sqrt(V3)
15 lambda3 = 12400 / V3
16 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

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

Scilab code Exa 20.3 Calculation of Minimum wavelength

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

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

Scilab code Exa 20.4 Calculation of Maximum speed of electron

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

Scilab code Exa 20.5 Calculation of Velocity of electron

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

Scilab code Exa 20.6 Calculation of Highest frequency and Minimum wavelength

```
1  clc
2  // Given that
3  V = 9.8e3 // voltage in V
4  i = 2e-3 // current in amp
5  c = 3e8 // speed of light in m/sec
6  // Sample Problem 6 on page no. 20.8
7  printf("\n # PROBLEM 6 # \n")
8  printf("Standard formula used \n ")
9  printf("h*c/lambda = eV \n")
10 lambda = 12400 / V
11 f = c / lambda
12 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

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

```
 8  printf("Standard formula used \n ")
 9  printf("I = ne \n 1/2*m*v^2 = eV \n")
10  n = i / e
11  v = 0.593e6*sqrt(V)
12  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

```
 1  clc
 2  // Given that
 3  V = 10e3 // voltage in V
 4  i = 15e-3 // current in amp
 5  e = 1.6e-19 // charge on an electron in C
 6  // Sample Problem 8 on page no. 20.9
 7  printf("\n # PROBLEM 8 # \n")
 8  printf("Standard formula used \n ")
 9  printf("I = ne \n 1/2*m*v^2 = eV \n")
10  n = i / e
11  lambda = 12400 / V
12  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

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

Scilab code Exa 20.10 Calculation of Applied voltage

```
1  clc
2  // Given that
3  lambda1 = 40e-12 // minimum wavelength in first case
       in m
4  lambda2 = 1e-10 // minimum wavelength in second case
       in m
5  // Sample Problem 10 on page no. 20.10
6  printf(" \n # PROBLEM 10 # \n")
7  printf("Standard formula used \n ")
8  printf("lambda_min = 12400/V \n")
9  V1 = 12400e-10 / lambda1
10 V2 = 12400e-10 / lambda2
11 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

```
1  clc
2  // Given that
3  V1 = 44e3 // voltage in first case in V
4  V2 = 50e3 // voltage in second case in V
5  lambda1 = 0.284e-10 // shortest wavelength in first
       case in m
6  lambda2 = 0.248e-10 // shortest wavelength in second
        case in m
7  e = 1.6e-19 // charge on an electron in C
8  c = 3e8 // speed of light in m/sec
9  // Sample Problem 11 on page no. 20.10
10 printf("\n # PROBLEM 11 # \n")
11 printf("Standard formula used \n ")
12 printf(" h*c/Lambda = eV \n")
13 h1 = e * V1 * lambda1 / c
14 h2 = e * V2 * lambda2 / c
15 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

```
1  clc
2  // Given that
```

```
3  lambda = 1e -11 // K−absorption limit for uranium in
      m
4  // Sample Problem 12 on page no. 20.10
5  printf(" \n # PROBLEM 12 # \n")
6  printf(" Standard formula used \n ")
7  printf(" lambda_min = 12400/V \n")
8  V = 12400e -10 / lambda
9  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

```
1  clc
2  // Given that
3  lambda = 1.4 e -11 // K−absorption edge for lead in m
4  V = 88.6 e3 // minimum voltage required for producing
      k−lines in V
5  c = 3e8 // speed of light in m/sec
6  // Sample Problem 13 on page no. 20.11
7  printf(" \n # PROBLEM 13 # \n")
8  printf(" Standard formula used \n ")
9  printf(" h∗c/Lambda = eV \n")
10 r = V ∗ lambda / c
11 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

```
1  clc
```

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

Scilab code Exa 20.15 Calculation of Wavelength

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

Scilab code Exa 20.16 Calculation of Wavelength of xray

```
1  clc
```

```
2  // Given that
3  Z = 79 // atomic no. of element
4  b = 1 // a constant
5  a = 2.468e15 // a constant in per sec
6  c = 3e8 // speed of light in m/sec
7  // Sample Problem 16 on page no. 20.12
8  printf("\n # PROBLEM 16 # \n")
9  printf("Standard formula used \n ")
10 printf(" nu = a*(Z-b)^2 .......Moseley law \n")
11 f = a * (Z - b)^2
12 lambda = c / f
13 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

```
1  clc
2  // Given that
3  Z = 29 // atomic no. of Cu
4  R = 1.097e7 // Rydberg constant in m^-1
5  c = 3e8 // speed of light in m/sec
6  h = 6.62e-34 // Planck constant in J sec
7  // Sample Problem 17 on page no. 20.12
8  printf("\n # PROBLEM 17 # \n")
9  printf("Standard formula used \n ")
10 printf(" nu = a*(Z-b)^2 .......Moseley law \n")
11 f = 3/4 * (R * c) * (Z-1)^2
12 E = h * f / 1.6e-16
13 E_L = 0.931 // let E_L = 0.931 KeV
14 E_ = E + E_L
15 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

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

Scilab code Exa 20.19 Calculation of Energy and Wavelength of xray

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

```
12  E = h * f
13  lambda = c / f
14  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

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